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DEVELOPMENT AND EVALUATION OF
THE SHEFFIELD MOTOR ASSESSMENT CHART

Anne White Parry

Thesis submitted to the Council for National
Academic Awards in partial fulfilment of the
requirements for the degree of Doctor of Philosophy

Department of Health Studies,
Sheffield City Polytechnic,
in collaboration with
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Remedial Therapy Research Fellowship Scheme.

October 1982.



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ABSTRACT

TITLE; Development and evaluation of the Sheffield Motor Assessment Chart

AUTHOR: Anne White Parry

This research was undertaken in order to develop and evaluate a physiotherapeutic assessment of hemiplegic patients to be called the "Sheffield Motor Assessment Chart". Specifications for its performance and appearance are described on the basis of an extensive review of the literature. Discussion covers aspects of clinical acceptability concerning stroke and hemiplegia, and physiotherapy and rehabilitation; criteria of scientific acceptability; and the presentation and communication of information.

Original observations are recorded which were made during development and evaluation of both the protocol of items of assessment and the graphic display of findings of assessments. A sequence of recovery of control of movement and balance was identified using data collected from sixty-three patients, and it was confirmed against data from one hundred and thirty-one patients. Items of assessment based on this sequence are described in two homogeneous scales ($r_s = 0.79$; $p < 0.01$) according to the World Health Organisation's definitions of impairment and disability. The Guttman scalogram technique shows the items to be a valid representation of recovery from hemiplegia ($CR = 0.92$; $CS = 0.75$). Tests of inter-observer reliability show each item to be reproducible ($p < 0.05$). From physiotherapists' responses to questionnaires, it is estimated that 0.79 ± 0.21 of the whole population of physiotherapists will find the assessment acceptable. Its potential contribution to multidisciplinary rehabilitation of stroke patients was also investigated during interviews with practitioners and patients.

It is concluded that the specifications have been fulfilled so that a valid and reliable physiotherapeutic assessment is available which:

- (A) is suitable for routine clinical use;
- (B) offers an aid to communication between physiotherapists and other practitioners;
- (C) is suitable for gathering data for research;
- (D) provides a model for other assessments so that multidisciplinary "patient profiles" could be developed for the use of teams of practitioners involved in rehabilitation of stroke patients.

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1. INTRODUCTION

Stroke is a common occurrence, especially among the elderly. Those who survive are often permanently disabled and need the support of people and institutions to enable them to lead as full lives as possible. In order to accommodate increasing demands for treatment of the physical disability, physiotherapists need an assessment of stroke patients which will help them to plan and monitor their treatment more efficiently and more effectively.

Stroke has typical and easily recognisable effects on the victim's ability to move one side of his body. This obvious disorder of movement, posture and balance, known as hemiplegia, is not the only sequela. Depending on the side of the brain which is insulted, stroke victims may have difficulties in communicating with other people or be unaware of the position of their affected limbs without looking at them. They may become emotionally labile with episodes of tearfulness for no known reason; and they may have other emotional problems because they are frustrated at being unable to move and concerned about the future.

The eventual outcome for the patient will depend upon the care and rehabilitation he receives, on his capacity to respond to treatment, and on the attitudes of his family, his friends and the practitioners of several health care professions who treat him. Although physiotherapy is directed at resolving the hemiplegia, the patient's potential for rehabilitation is profoundly affected by his morale, by his motivation to collaborate in treatment, by

his past experiences, and by his intellectual capacity. For example, younger and professionally qualified people may feel stigmatised by the hemiplegia: older and less well-educated people are often more accepting of disability. Additionally, while some patients enthusiastically practice what they have been taught in treatment, some behave aggressively towards the physiotherapist; and others are passive and apathetic recipients of treatment.

Currently, physiotherapy for individuals is limited by lack of information about the process of recovery and the effectiveness of physiotherapy for hemiplegia.

Physiotherapy for individuals would be enhanced by an assessment which charted the sequence of recovery, allowed the different methods of physiotherapy to be compared, and allowed the contributions of physiotherapy to the wider context of stroke rehabilitation to be evaluated. The present study was designed to develop a physiotherapeutic assessment of hemiplegic patients to be called the Sheffield Motor Assessment Chart. Such an assessment would provide physiotherapists with the specific information about how a patient moves which they need to formulate aims of treatment and to evaluate its effectiveness in enabling him to progress towards recovery. It would also provide all practitioners in rehabilitation teams with information about the patient's progress and basic activities he can perform when they need to make decisions about his future care. The record of such an assessment needs to be like a moving picture of the patient which demonstrates clear continuity throughout the phase of recovery.

Traditionally, assessment of stroke patients has depicted physical progress in terms of "activities of daily living", either to provide an overall picture of the patient's status at one time or to show changes. Simple rating scales have been created from "check lists" of these activities in an attempt to introduce greater precision and objectivity. The use of rating scales and arbitrary numbers assumes that an absolute number is a valid indicator of recovery status and that it has a real significance. Representing the patient's status by an absolute number is of doubtful value clinically and for evaluative studies. Firstly, no two individuals with the same score on a rating scale are likely to have achieved the same sets of assessment items. Secondly, describing the patient by an absolute number loses the detail of how the score was achieved. Thirdly, the number gives no indication of the rate of progress.

A reliable assessment is needed to identify patients who have the best chance of recovery so that limited resources are used efficiently and physiotherapy is related both to the severity of the patient's disability and to his potential for recovery. Such an assessment might also provide an index of the rate of progress in treatment which could be used in evaluative studies of different methods of physiotherapy.

Additionally, an optimal assessment would identify, assess and record factors which influence recovery and treatment, such as the patient's motivation and sensory disturbances. Objective charting of the patient's recovery of movement is

seen as the first priority for a physiotherapeutic assessment for several reasons:

Firstly, physiotherapy is focussed on the patient's motor dysfunction.

Secondly, movement is directly observable.

Thirdly, from their experience with many hemiplegic patients, physiotherapists believe that movement is recovered in an orderly sequence.

Fourthly, influencing factors are not observed to improve in the same sequential manner.

Therefore, it was considered more feasible to concentrate on the development of a valid scale to record restitution of movement. Subsequently, this scale might provide a foundation for a "patient profile" which would demonstrate the influencing factors and include assessments made by other practitioners.

The development of the Sheffield Motor Assessment Chart is aimed at creating a motor assessment of hemiplegia which will record the patient's recovery of movement and functional abilities on a single-sheet graphic display. Such an assessment will provide physiotherapists with the information they need for planning and monitoring their treatment. At a glance it will also show the patient's status and progress to other practitioners and to the patient himself. As an evaluated clinical assessment, it might also provide an instrument for gathering data for research in physiotherapy and into the associated factors.

Before the development and evaluation of the assessment is described, a review will be made of those epidemiological studies which attempt to identify the extent of stroke and

hemiplegia. Next, the nature of the residual hemiplegia and the methods of physiotherapy will be described. Assessments available in the literature will be discussed in relation to an optimal assessment which would fulfil the needs of physiotherapists for a standardised motor assessment of hemiplegia. Methods of scaling to create a sequence of items of assessment will also be discussed and a method appropriate to a condition characterised by progressive recovery will be selected. Finally, methods of surveying practitioners to collect data concerning the validity of the assessment will be discussed.

Throughout the thesis the common practice of referring to the patient as "he" and to the physiotherapist as "she" has been adopted.

2. REVIEW OF THE LITERATURE

2.1 STROKE

2.1.1 Classification of Stroke

Stroke is classified by the rubric of the International Classification of Diseases¹ which codes eight cerebrovascular diseases² (World Health Organisation³, 1977). A universally accepted definition of CVD was agreed comparatively recently at an international conference sponsored by the WHO in 1970 in recognition of CVD as a major health problem. A detailed classification of CVD was given in the report of the conference (WHO, 1971) and the coding procedure has been revised with each new edition of the ICD.

Cerebrovascular accident⁴ describes those CVD manifest as stroke. The results of the epidemiological surveys referred to later in this review are classed according to the following common pathological causes of CVA. The codes are those of the ninth edition of the ICD (WHO, 1977).

Subarachnoid haemorrhage⁵ (code 430) occurs when blood leaks from a ruptured artery into the space under one of the membranes enclosing the brain, the arachnoid mater. In the majority of individuals, SAH strikes without warning; and it may be almost instantaneously fatal.

Cerebral haemorrhage (code 431) occurs when a blood vessel ruptures and blood lacerates the brain tissue. The clot of extravasated blood presses on brain tissue and damages it. Usually the patients are elderly and hypertensive and the stroke may occur during activity.

Hereafter the following conventional abbreviations are used:

1. ICD: International Classification of Diseases.
2. CVD: Cerebrovascular disease.
3. WHO: World Health Organisation.
4. CVA: Cerebrovascular accident.
5. SAH: Subarachnoid haemorrhage.

Cerebral thrombosis (code 434.0) describes the formation, development and presence of a clot which blocks a blood vessel. The tissue distal to the blockage is starved of oxygen and nutrition.

Cerebral embolism (code 434.1) describes the sudden blocking of a cerebral artery, by a clot of blood or other material such as fat or air carried in the blood stream, with ischaemic consequences.

Several authors have pointed out that information about these pathological subdivisions of CVA is imprecise (cf., e.g. Ford and Katz, 1966; Stallones, Dyken, Fang and Heyman, 1972). According to Marquandson (1976), the distinction between embolic and thrombotic stroke is inadequate in epidemiological surveys. He is supported to a certain extent by the WHO. In earlier editions of the ICD, cerebral thrombosis and cerebral embolism were classified separately under codes 433 and 434 respectively. In the latest revision (1977) they are classed as subdivisions of code 434: occlusion and stenosis of cerebral arteries.

The pathological classification is also said to be inadequate "at the bedside" because it deals in static pathological states rather than in dynamic clinical phenomena (Shaw, 1972). Shaw's criticism appears to be supported by the Hospital Activity Analysis, Area Diagnostic Index of the Sheffield Area Health Authority. For 1980 it records that forty-one residents of Sheffield were admitted to the city's hospitals with SAH, thirty-six with cerebral haemorrhage, seven with cerebral thrombosis and fourteen with cerebral embolus. Eight hundred and fifty residents were admitted with "acute but ill-defined CVD including apoplexy, CVA not otherwise specified, and stroke (code 436)".

These figures suggest that medical practitioners in Sheffield are using a classification which is based on observable temporal patterns rather than on pathology:

Impending stroke (Millikan, Siekert and Whisnant, 1960) described an episode of neurological dysfunction lasting less than twenty-four hours. It is now known as TIA or transient ischaemic attack (Evans, 1981), or transient cerebral ischaemia (code 435), because it leaves no residual deficit and does not necessarily herald a major stroke.

Advancing or developing stroke describes neurological manifestations evolving with time.

Completed stroke is the evolved stroke or the abrupt onset of neurological manifestations.

Adams (1974) has observed that stroke refers to the rapidity of onset of signs and symptoms and not to the underlying cause or pathology. In reporting the result of a four year descriptive study of home and hospital care sponsored by the Department of Health and Social Security¹, Weddell and Beresford (1979) did not distinguish between pathological types of CVA. They defined stroke as:

"A focal neurological deficit of sudden onset caused by a local disturbance in blood supply to the brain which lasted more than twentyfour hours and for which the patient was given medical care."

The majority of patients are referred for physiotherapy with a diagnosis of right or left CVA, or left or right hemiplegia, and with a report of current medical stability which might influence the inauguration or extent of active treatment.

1. Hereafter, the Department of Health and Social Security will be represented by DHSS.

2.1.2 Epidemiology

Stroke is common historically as well as contemporaneously (cf. Sprengel, 1755, for Hippocrates; Charcot, 1881; Gowers, 1888). The current absolute incidence of stroke in the United Kingdom is not known; but a number of studies provide information about people living with hemiplegia by documenting the mortality, survival and disability of particular cohorts of patients. There are no representative morbidity statistics and all rates of incidence are estimates based on the samples surveyed; the loss of quality of life for survivors cannot be quantified.

Despite the ICD, interpretation of results of epidemiological studies is complicated by the lack of a common definition of "stroke". Additionally, researchers have not used age-adjusted or sex-adjusted rates which are appropriate to disorders such as stroke which vary with age and sex. These variations will be discussed later in more detail. In general, there appears to be agreement that incidence, mortality and prevalence occur most frequently in the age group over forty years, and increase with age. There is less unanimity of opinion with regard to the contribution of such factors as race and pathological type of stroke.

Incidence

According to WHO statistics (1971) the annual incidence of stroke in the United Kingdom lies between 1.8 and 2.0 per 1,000 population. Geographical differences are discernible which may be due to environmental factors. For example, the rate of incidence calculated for a population of 250,000 in Surrey (Weddell and Beresford, 1979) compares favourably with the rate calculated for the population of an industrial city. From their survey, Weddell and Beresford calculated a crude rate of incidence of 1.4 per 1,000; but said that if all those certified as dying from CVD had been included the rate would have been nearer 2.09 per 1,000. The Sheffield Area Hospital Activities Analysis shows that 948 residents from a population of 544,000 were admitted to hospital in 1980 with a primary diagnosis of CVA or stroke. There are no aggregated data from general practice; but it is likely that the number of stroke patients cared for at home or who die before admission to hospital would raise the rate of 1.7 per 1,000 to the level of the WHO estimates, and maybe beyond them.

Studies of mortality statistics based on death certification suggest that the incidence of stroke has declined since the Second World War (Acheson, 1960; Wylie, 1962; Metropolitan Life Insurance Company, 1975; Weddell and Beresford, 1979). However, Weddell and Beresford also claim that CVD is overdiagnosed; and Heasman and Lipworth (1966) in the United Kingdom and Florey, Senter and Acheson (1967, 1969) in the United States found poor correlations between death certification and findings at post mortem examinations. Wylie (1970a) expected the eight revision

of the ICD to bring about a change in reporting due to improved specificity of diagnosis; but Israel and Klebba (1969) say that each revision of coding practice creates anomalies.

Consequently, the changing pattern of stroke is much less well documented than are the patterns of notifiable communicable diseases such as measles and poliomyelitis which are diagnosed accurately. According to Garraway (1979) declining incidence of stroke is not accompanied by any change in prevalence; and he deduces that the probability of survival has increased. However, his data show an improvement of only two per cent in the number of patients who survive for 30 days. CVD is a cerebral manifestation of a vascular condition which is usually generalised and may give rise to hypertension and coronary heart disease. Therefore, improvement in prospects for survival do not appear to be due to improved probability of surviving the acute CVA. It seems more likely that the decline in incidence and the improved prospects for survival are both due to improvements in health which have increased longevity in the whole population.

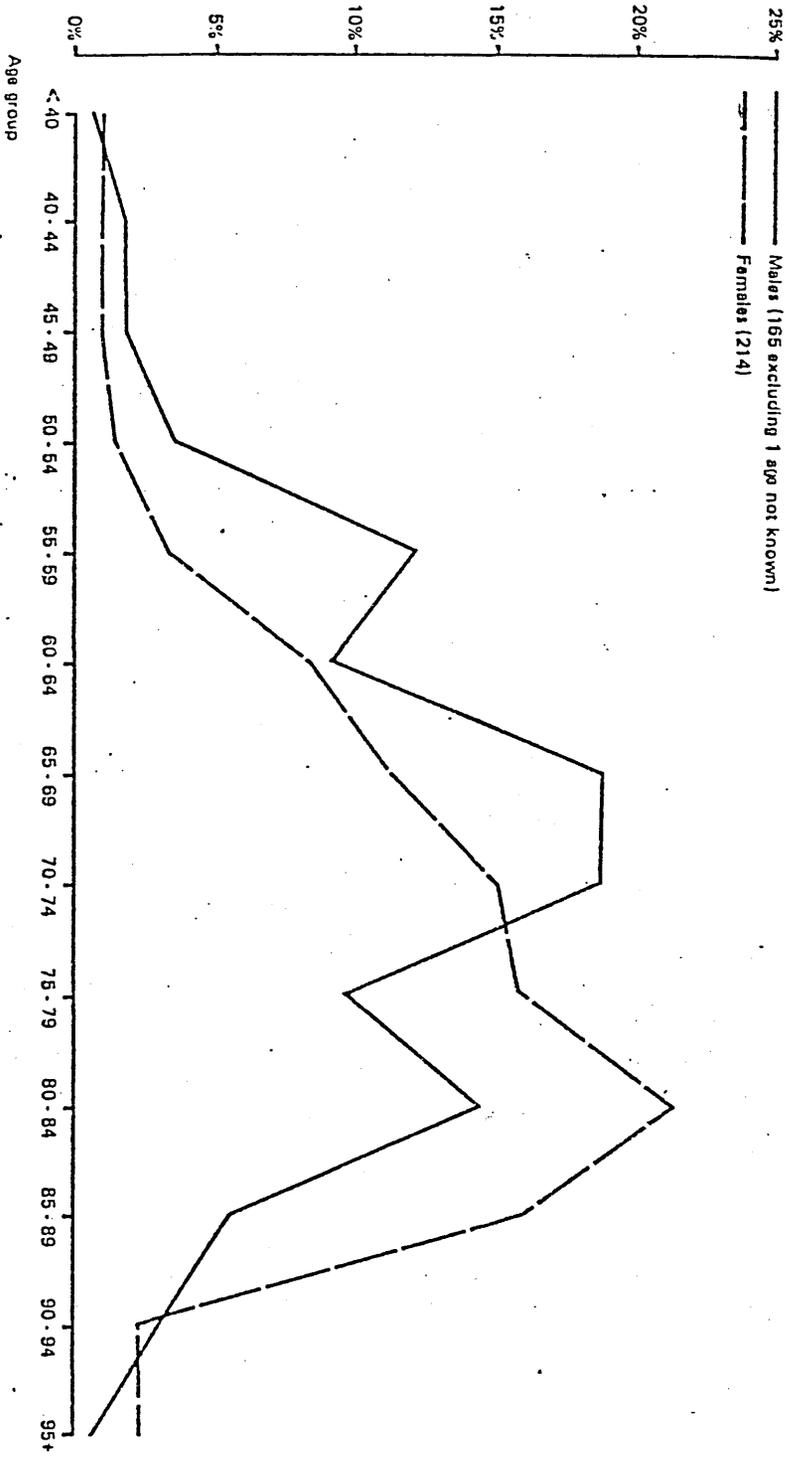
Table 1

Annual incidence of stroke related to age in the United Kingdom.

Age	Annual incidence per 1,000 population
35-44	0.25
45-54	1.00
55-64	3.50
65-74	9.00
75-84	20.00
84+	40.00

Source: Royal College of Physicians (1974)

FIGURE 1
AGE-SEX DISTRIBUTION OF 379 stroke patients registered between May 31st, 1971, and June 1st, 1972.



Source: J M Weddell and S A A Beresford (1979)
 Planning for Stroke Patients: A four-year descriptive study of home and hospital care. London: Her Majesty's Stationery Office

Incidence rises steeply with advancing age (Table 1). The age-sex distribution of 379 patients in Surrey (Figure 1) shows a preponderance of elderly women; this probably reflects the greater longevity of women. A ratio of 186 men to 145 women is obtained from the age-adjusted rates of fifteen different surveys (Dalsgaard-Neilson, 1955; Sjöström, 1967; Eckstrom, Brand, Edlavitch and Parrish, 1969; Alter, Christoferson, Resch, Myers and Ford, 1970; Acheson and Fairburn, 1970, 1971; Heyman, Karp, Heyden, Bartel et al, 1971; Bruun and Richter, 1973; Gordon, Sorlie & Kannel, 1973; Matsumoto, Whisnant, Kurland and Okazaki, 1973; Melamed, Cañane, Carmon and Levy, 1973; Stallones et al, 1972; Abu-Zeid, Choi and Nelsonna, 1975; Zupping and Roose, 1976). Proportionately, this ratio of 0.56 to 0.43 indicates that men are more at risk of stroke than are women to a modest degree.

Marquandson (1976) found a ratio of 121 men to 166 women in a series of patients in Denmark. When these figures were adjusted for sex rather than age they revealed that the incidence was higher for men than for women in each ten year age group over fifty-four years. This suggests that if the data from the other fifteen surveys were adjusted for sex the risk to men might be less modest than it appears.

Several community based studies provide data by pathological type of stroke (Eisenberg, Morrison, Sullivan and Foote, 1964; Kannal, Dawber, Cohen and McNamara, 1965; Wallace, Clark, Coles, Coombes, Crawford et al, 1967; Alter et al, 1970; Whisnant, Fitzgibbons, Kurland and Sayre, 1971; Matsumoto et al, 1973). Collation of these data indicates that approximately 8 per cent of strokes are due to SAH, 12 per cent to cerebral haemorrhage,

69 per cent to thrombo-embolic pathology, and 11 per cent to ill-defined cerebrovascular disease.

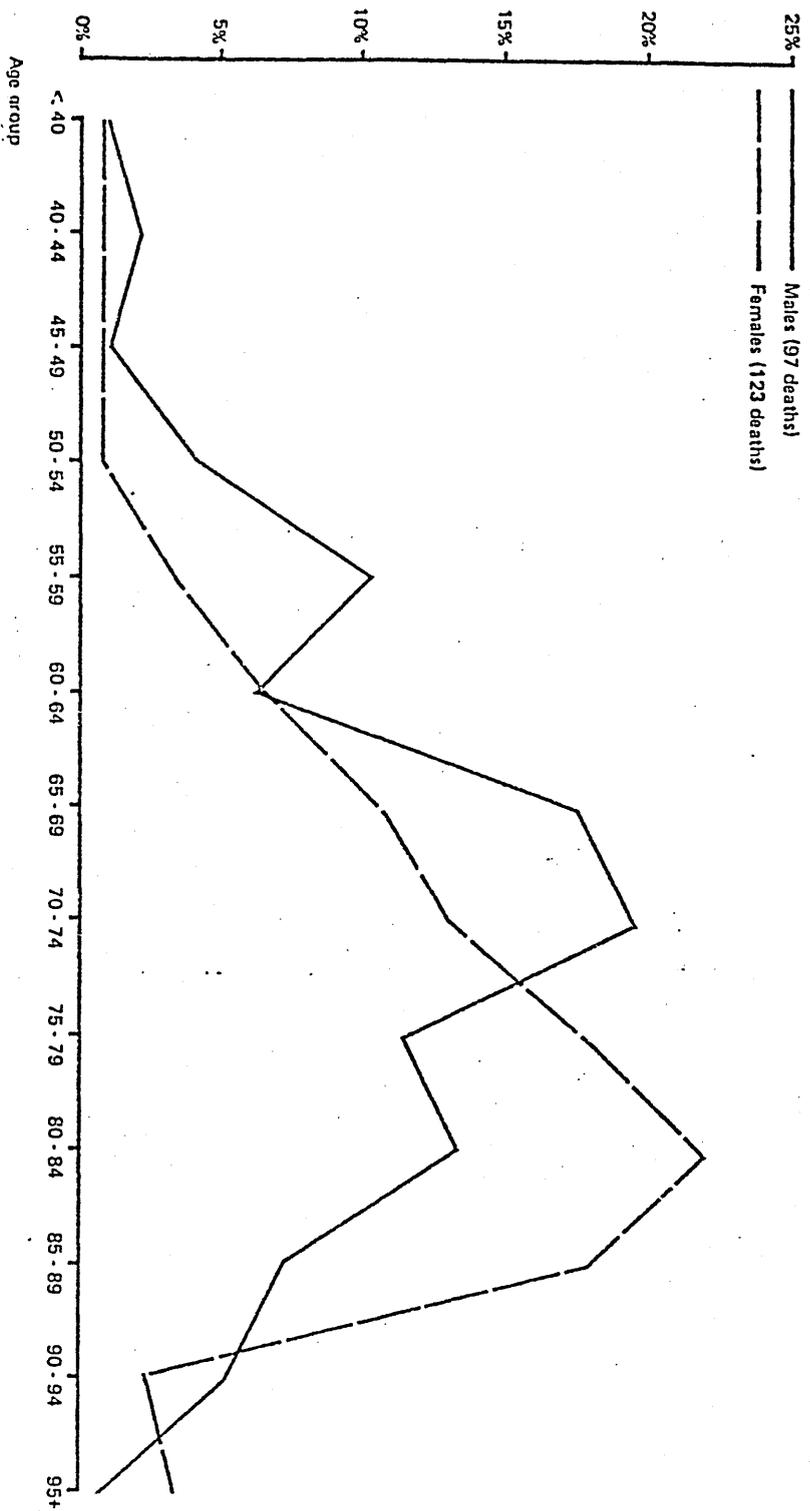
Unlike other pathologies, SAH is particularly associated with younger age groups. More than half the total number of aneurysms, or small balloon-like weaknesses of vessel walls, are said to cause symptoms first between forty and fifty-five years of age (Walton, 1977). From a survey of 135 patients in Sheffield who suffered SAH due to an aneurysm bursting, 69.6 per cent had their first symptoms after they were forty years old. Only 22.2 per cent were over fifty-five and 14.8 per cent were less than thirty years of age: 47.4 per cent were in the forty to fifty-five age group (Parry, 1976).

The contraceptive pill is implicated in CVAs in women under forty-five years of age (Kannel, 1971): the case against other suspected factors is not proven. There is argument about race as a factor in the incidence of stroke in the United States. Rates for the American black population are variously reported, and in general they are higher than for the white population (Alter et al, 1970; Wylie, 1970b; Heyman et al, 1971; Stallones et al, 1972; Bruun and Richter, 1973). The validity of data on race has been questioned by Kurtzke (1969) who says that differences in incidence may be explained by socio-economic and environmental factors.

The incidence rates quoted are very variable, and the disparity probably reflects different definitions of stroke in different studies as well as real differences associated with geographical distribution and environmental factors.

FIGURE 2

AGE-SEX DISTRIBUTION OF DEATHS FROM STROKE of patients registered between May 31st, 1971 and June 1st, 1972.



Source: J M Weddell and S A A Beresford (1979) Planning for Stroke Patients: A four-year descriptive study of home and hospital care. London: Her Majesty's Stationery Office.

Mortality from stroke

In 1966 CVD appeared on the list of ten leading causes of death in fifty-four out of fifty-seven countries reporting to the WHO. It ranked among the three leading causes of death in forty countries and accounted for 11.3 per cent of all deaths in the fifty-seven reporting countries.

Authors report varying mortality patterns and rates for the different pathologies: cerebral haemorrhage is identified by all as the most fatal type. While CVD in general is a common cause of death, the number of deaths registered as due to the disease is probably overestimated unless the diagnosis has been confirmed by post mortem examination (Heasman and Lipworth, 1966; Florey et al, 1967; Kurtzke, 1969).

Wylie (1970a) calculated that there was a 1:3 probability of dying from CVA. American and European authors have reported initial mortality rates as high as 50 per cent (Eisenberg et al, 1964; Drake, Hamilton and Carlsson, 1973; Pitner and Mance, 1973; Fugl-Meyer, Jääskö, Leyman, Olsson and Steglind, 1975). Langton Hewer (1976) estimated that between 35 and 40 per cent of stroke patients in the United Kingdom die within three weeks of their CVAs.

Figure 2 shows the age-sex distribution of deaths from stroke in Weddell and Beresford's study. They reported mortality rates of 61.6 per hundred for men and 57.5 per hundred for women within three months of the CVA. Age-adjusted rates of death show an increasing rate with advancing age which accelerates more than

incidence rates. In general, the death rate doubles with each five year increase with age (Kurtzke, 1969).

Prevalence of survivors of stroke in the United Kingdom

Prevalence of survivors with residual hemiplegia is the necessary dimension to consider in this study. Rational planning of the resources of the National Health Service, whether locally or nationally, whether fiscal or in terms of manpower, requires estimation of the number of people requiring rehabilitation at any given time. However, there are virtually no relevant data on current rehabilitation in general (Central Health Service Council, 1976). More specifically, in 1974 the Royal College of Physicians found that there were few studies to indicate the true extent of the burden of stroke on the community.

The survey of disability in Great Britain published by Harris, Cox and Smith in 1971 highlighted stroke as the single most important cause of severe disability. They estimated that there were 130,000 people in Great Britain with significant impairment from stroke and that 93,000 people were severely affected. Weddell and Beresford's study, published in 1979, found that the prevalence rate for survivors was four times the annual rate of incidence. They emphasised that this may be an underestimate because their calculations were based on the assumption that the age-sex structure of the population had remained constant from 1902 to 1971.

Isaacs (1976) and Evans (1981) estimate that the average life expectancy of those who survive for one month is three years. Although life expectancy is shortened by stroke, Adams and Merrett (1961) estimated that recovered hemiplegic patients may have relatively active lives for about six years if they

are under 65 years of age when they suffer their strokes, or three to four years if they are over 65. From comparison of seven studies of the level of functional ability achieved by survivors, Kottke (1974) estimated that 35 per cent of survivors will return to "normal" or "nearly normal" status and that three to five per cent will remain totally dependent.

Applying the WHO estimate of incidence in the United Kingdom and Weddell and Beresford's estimate of prevalence in Surrey to the average population of 250,000 served by a district general hospital, there are likely to be 2,000 survivors in a health district at any given time. More than half of them will be over 65 years of age (Weddell and Beresford, 1979).

In order to reduce the burden on the community, elderly and retired patients will need rehabilitation to enable them to feed, bathe and dress themselves and to undertake social and domestic activities commensurate with their ages and lifestyles. More exploitive and vigorous treatment is needed for the smaller proportion of younger survivors, to enable them to maintain their previous level of occupational activity as well as their social and domestic activities. As younger patients have a longer life expectancy than older patients, the population of long-term survivors must include many people whose stroke occurred in middle life. Little is known about the quality of their lives (Collins, Marshall and Shaw, 1960).

SUMMARY

"Stroke" describes the rapid onset of neurological signs and symptoms caused by a cerebrovascular accident, a sudden disturbance of the blood supply to the brain. Hemiplegia is the most common sequela of stroke: the patient is unable to move one side of his body normally.

In general, for every thousand members of the population of the United Kingdom, two new strokes can be expected each year. A third of them is likely to end fatally within a month. The risk of stroke is higher for men than for women and it is strongly related to age; mortality also increases with age. Less is known about the prevalence of people with residual hemiplegia.

The absolute number of people referred to the therapeutic services with hemiplegia is not precisely known. Commonly, it would include people with moderate and severe impairment and disability, and more mildly affected people who are admitted to hospital immediately after the stroke. The data indicate that a physiotherapy department in a District General Hospital can expect at least two hundred new stroke patients to be referred each year who will need extensive treatment for residual hemiplegia: half of them are likely to be above sixty-five years of age.

2.2 RESIDUAL HEMIPLEGIA

Stroke has a catastrophic effect because the brain is particularly vulnerable to disorders of its circulation and to metabolic deprivation. It has no means of storing energy and requires an unvarying rate of blood flow to function optimally (Keele and Neil, 1966).

Among its many functions, the brain serves as a "movement memory bank" which the individual establishes through years of practice. Each person's everyday movements, from the most mundane to the very skilful, become so automatic that he does not know how they are performed and finds it difficult to describe them in detail (Carr and Shepherd, 1979). Additionally, the control of movement is so flexible and so adaptive that the brain can generate original and creative patterns of movement. From the sensory information it receives, it is able to represent the environment internally. Using this model, it computes the position of the body in space and the position of a target, and represents the change of position needed as a route between the two. This representation of the route is translated into a pattern of movement which will carry the limb from its initial position to the target.

Following a stroke, the control of movement on one side of the body is no longer flexible and adaptive. The hemiplegic patient may have only a few stereotyped patterns of movement at his disposal and the internal representation of his relationship to his environment may be inaccurate.

The motor deficit is most apparent in the limbs, because they normally move in a very wide variety of patterns, but the trunk and neck are also involved (Adams, 1974; Todd, 1974; Dardier, 1980).

2.2.1 Mechanisms of hemiplegia

Anatomically, there are two nervous systems: the peripheral nervous system and the central nervous system. The peripheral nervous system carries sensory information from the skin, muscles and joints to the spinal cord and motor impulses from the spinal cord to the muscles.

The central nervous system¹ consists of a sensory input system from the spinal cord to the brain, connections and centres for integrative activity in the brain, and a motor output system. The motor system is usually considered as two pathways which impinge on the motor nerves of the peripheral nervous system (Bowsher, 1979): (A) the pathway for willed movement from the motor cortex of the cerebrum, called the cortico-spinal tract; and (B) the extrapyramidal pathway which controls posture, muscle tone and coordination.

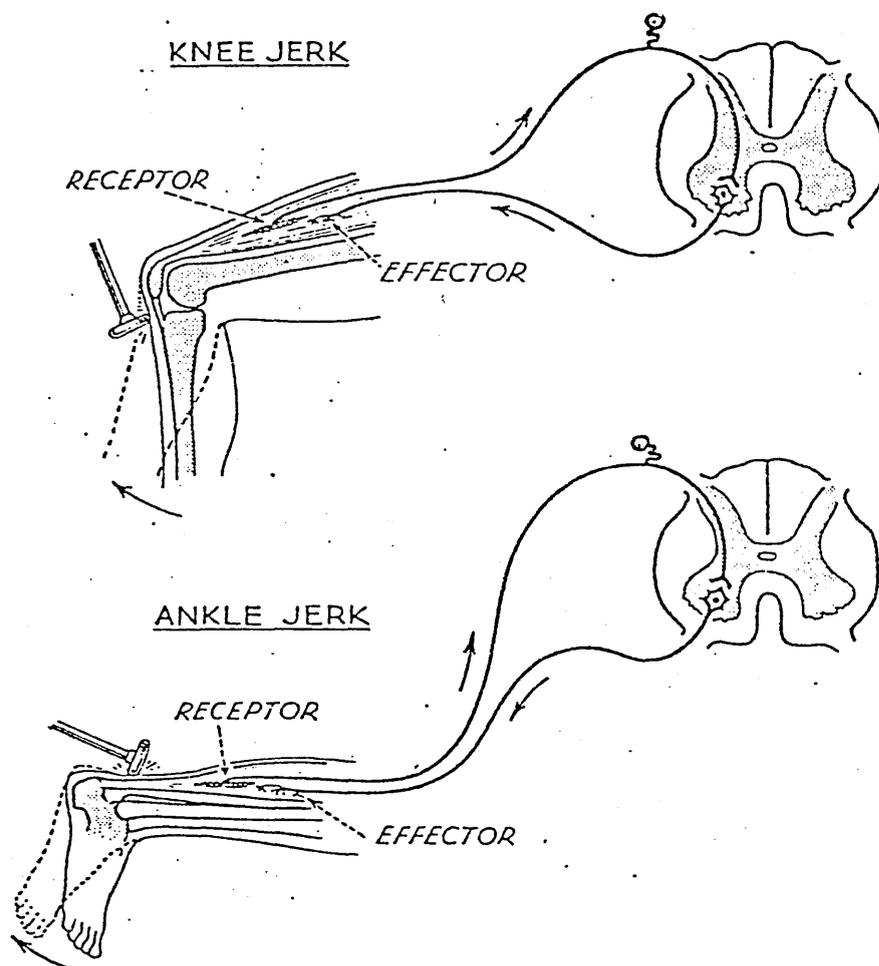
Coordinated movement results from harmonious activity of the components of the nervous systems. All purposive movements are initiated and guided through their execution by a constant stream of sensory information which reaches the brain from a wide variety of receptors in the skin, muscles, joints, ears and eyes. Disorders of movement and posture result from the activity of components of the CNS which are intact combined with the defective activity of damaged and deprived areas.

1. Hereafter, the central nervous system is referred to by CNS.

FIGURE 3

THE MYOTATIC STRETCH REFLEX

In the lower limb, the excitability of the "knee jerk" and the "ankle jerk" is tested:



When the tendon is tapped sharply, the muscle is stretched. Nervous impulses pass into the spinal cord and stimulate motor fibres: the muscle contracts and the stretch is relieved.

Source: A B McNaught and R Callender (1967)
Illustrated Physiology; Edinburgh and London:
Livingstone.

According to its severity, a CVA destroys variable amounts of fibres of the pathway for willed movement and other tracts; commonly, as they are channelled through a bottleneck called the "internal capsule". Consequently, the patient is unable to make smooth coordinated movements, even though the muscles are capable of contracting. The CVA also releases reflexes from modification by the highest centres of the CNS. Two spinal reflexes are particularly implicated in hemiplegia: (1) the stretch reflex and (2) a modified form of the extensor thrust reflex.

1. The stretch reflex: The reflex arc of the myotatic stretch reflex connects receptors of stretch in a muscle with the contractile muscle fibres (Figure 3). The stretch may be applied by contraction of antagonistic muscles, by the body starting to fall in any direction, or by an external force. Normally, the threshold of the receptor is controlled by higher centres of the CNS so that it is sensitive to stretch according to postural needs at any time. When the CVA releases the reflex it becomes hyperactive. The threshold is lowered and the muscle contracts inappropriately. The resulting increase in the elastic tension of muscle is called "spasticity".

2. The positive supporting reaction (Magnus, 1926): This reaction is a modification of the extensor thrust reflex (Sherrington, 1947). In the lower limb, it is principally evoked by pressure on the ball of the foot: the moveable limb is transformed into a rigid pillar by simultaneous contraction of the flexor and extensor muscles. When the pressure is removed, the negative supporting reaction occurs: the limb

becomes loose at all joints and free to move again. These alternating states are inappropriate for activities in which weightbearing and movement occur simultaneously. Fixation which can only be released when pressure or weight is removed from a limb prevents the fine grading which is necessary for rising from a chair and sitting down, for walking, for climbing and descending stairs and for balancing.

2.2.2 The impairment of motor function

The characteristic effects of CVA which constitute hemiplegia are due to alterations in direct and indirect influences on the motor nerves of the peripheral nervous system:

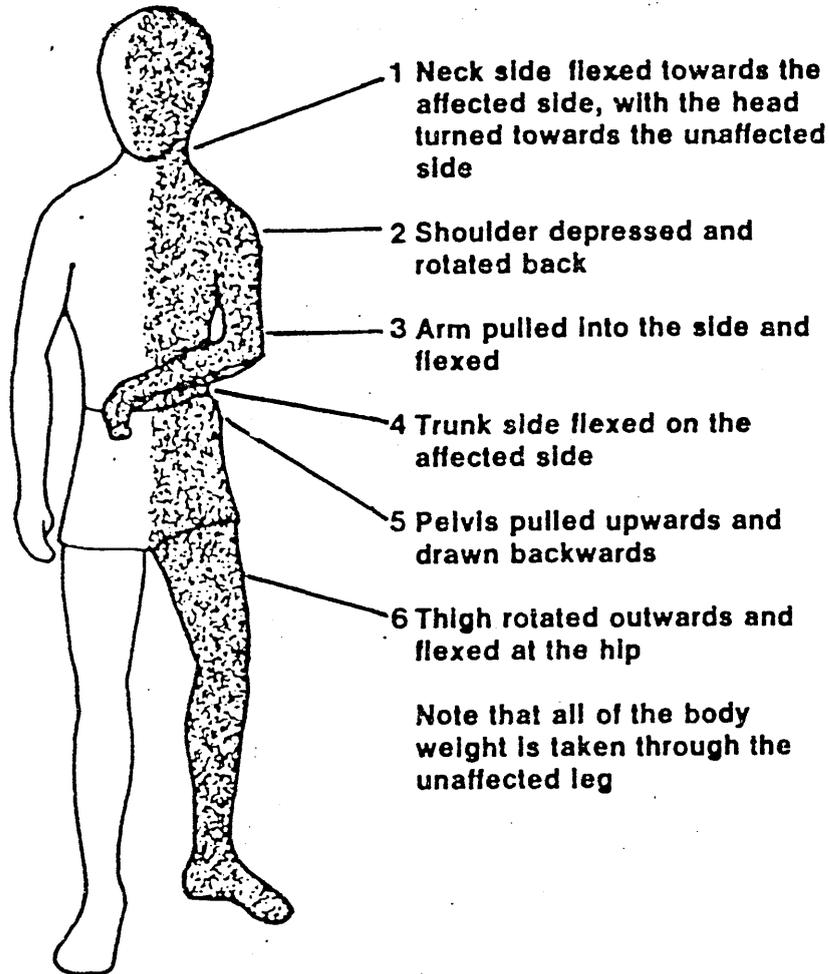
- A. The patient is unable to initiate voluntary movement.
- B. Immediately, the muscles lose their normal state of tone and are flaccid. Eventually, muscle tone rises; usually to a high level of tension called spasticity.
- C. Postural control of the stability and balance of the body is inadequate.

Loss of voluntary movement: Several authors have emphasised that loss of voluntary movement is not due to weakness of muscles (cf. e.g. Adams, 1974; Todd and Davies, 1977; Bobath, 1978; Carr and Shepherd, 1980). What might be called "weakness of movement" is due to lack of cortical drive, or central initiation and control of movement, due to interruption of the pathway for willed movement. Muscles may be activated in a few stereotyped mass patterns of flexion and extension by the motor centres of the brain and spinal cord. Even though they can function in these patterns, they cannot be recruited to perform with other muscles to create the almost infinite variety of patterns used in everyday life. The overall impression is of poverty of movement.

Generally, recovery of movement proceeds proximally to distally (Twitchell, 1951; Bobath, 1959; 1960; Bard and Hirschberg, 1965). More specifically, mass actions of the shoulder and hip joints are recovered first: selective use of distal groups of muscles may return later allowing a clumsy grasping action of the fingers.

FIGURE 4

A TYPICAL HEMIPLEGIC STANCE



Source: A W PARRY and C A EALES (1976)
Management of the hemiplegic patient, Nursing Times;
72, (41-45), October/November.

and sufficient dorsiflexion of the foot to clear the ground in walking. Fine skilled movements of the hand may never be recovered, unless movement of the thumb independent of the fingers is restored.

Muscle tone: Tone must be high enough to withstand gravity yet still permit movement. Immediately after the stroke the muscles may be flaccid, but tone usually rises as cerebral shock is dissipated. In some patients it never reaches the normal state of tension, and the muscles remain hypotonic. Consequently, the patient has difficulty in shifting his weight, in moving from one point to another and in bearing weight. If hypotonia persists, he will lack stability at the pelvic girdle, which will affect the control of the pelvis on the thighs in sitting and standing, and at the shoulder girdle, which will prevent effective use of the hands.

Usually muscle tone rises above normal to a spastic state. Spasticity gives stability without mobility; and it is manifest in definite stereotyped patterns of abnormal coordination (Bobath, 1978). On the hemiplegic side, the shoulder girdle is depressed and retracted and the pelvic girdle is elevated and retracted (Figure 4). In the upper limb, spasticity is dominant in the muscles which draw the arm into the side, bend the elbow, wrist and fingers and pronate the forearm so that the palm of the hand faces the floor. There is usually more competition of patterns in the lower limb than in the upper limb. Typically, the lower limb is held in a mid-position, but moved by alternating patterns of total flexion and total extension.

Jackson (1884) coined the term "clotted movement" to describe the way in which spasticity interferes with the quality of movement. This alteration in muscle tone and the loss of voluntary movement give the patient characteristic appearances in sitting and standing, and typical patterns of movement.

Postural control: Posture is the background of automatic and voluntary activity which precedes and underlies all willed movement (Critchley, 1954). Adams (1974) has referred to the "vocabulary of posture", a collection of memories which ensure immediate and accurate response to prevent loss of balance.

Postural control requires fine changes in the distribution of muscle tone. To be safe, all movement needs to be performed on a constantly changing background of postural adjustment which is graded to the degree of voluntary control required. Disordered postural control in hemiplegia is attributed to the distribution of spasticity (Bobath, 1965), or to persistent hypotonia, or to dense sensory deficit (Fisher, 1968).

2.2.3 The overall picture of motor dysfunction

The loss of voluntary movement, the changes in muscle tone and the loss of balance and postural reactions must be considered together to gain a true picture of the problems experienced by the hemiplegic patient. The net result is a person whose movement is confined to patterns of limited utility, which are also inherently unsafe. The automatic unconscious activity which controls normal movement is lost to him. Not only is he unable to move his hemiplegic side voluntarily to produce the movement he wants to make, but he is unable to make the automatic adjustments necessary to control his posture and balance.

The physiotherapist aims to improve the patient's ability to perform his ordinary domestic and social activities by resolving the impairment of motor function. To make her aims compatible with his, usually she must link them to the activity which is probably the single most important aim of every hemiplegic patient: the ability to walk independently. To enable him to rise from a chair and walk she must counteract the effects of spasticity and the positive supporting reaction: they interfere with the recovering patient's ability to bear weight through his affected leg, to transfer weight over it and to balance on it.

The normal way of rising from a chair is to move the weight of the body over the feet first of all, by moving the head and the trunk forwards from the hips. Next, the flexed legs take the weight as the buttocks are raised from the seat. Finally, the

hips, the knees and the spine are straightened so that the body becomes upright.

As the spastic hemiplegic person tries to take weight through his affected leg to stand up, the positive supporting reaction is evoked by the pressure of his forefoot on the ground. Consequently, his foot is pushed against the ground; and the extension thrusts up his leg, stiffening his knee and hip. Instead of his weight being brought forward over his feet, his hemiplegic side is thrust further back into the chair. If he is able to haul his trunk forwards with his hands and arms, he may be able to stand up with great effort; but with little or no weight borne through his affected leg. When he tries to sit down again, he falls back into the chair: he can neither bend the limb while he has weight on it nor control the placing of his buttocks on the seat.

Typically, the hemiplegic patient who can walk does not strike the ground with his heel. The ball of his foot strikes the ground first; because he can only activate mass patterns of flexion and extension, his ankle is plantarflexed as his knee extends. Again, the positive supporting reaction is evoked, and his leg becomes stiff. The rigid limb may bear the weight of his body but the joints are fixed. There is no "give and take" between the muscles while he bears weight, and he cannot transfer his body weight over the standing leg normally. Although the rigidity may allow him to bear weight to walk, his gait is inherently unsafe: the rigidity also prevents the fine adjustments needed to maintain and regain

balance. He has to make compensatory attempts with his unaffected side to maintain his balance.

If the hemiplegic person tries to climb and descend stairs the problems are compounded by gravity and the need for more sophisticated postural control. Normally, gradual flexion of the weightbearing leg is essential while the free leg descends to the lower step and, like rising from a chair, the flexed leg on the upper step normally takes weight and then extends to raise the body.

Many hemiplegic patients never recover sufficiently to climb and descend stairs reciprocally; many of them are given walking aids, to compensate for loss of balance reactions, and to enable them to walk with a typical hemiplegic gait. They may still be unable to rise from a chair without assistance or great effort. Some people are readmitted to hospital because they have fallen and sustained fractures or other injuries, or because relatives and other carers are afraid that they will do **be injured if** left alone for short periods.

2.2.4 Factors influencing recovery and rehabilitation

The patient's recovery and his capacity to respond to physiotherapy and rehabilitation may be affected by associated disorders of sensory appreciation or communication and by his motivation to collaborate in treatment.

Disorders of sensory appreciation: Sensory loss is common after stroke because afferent nerve fibres also pass through the internal capsule. The importance of sensory input for the control of movement was elucidated first by Mott and Sherrington in 1895. Recognition of objects, body awareness and visual-spatial orientation depend upon integration of sensation from the skin, muscles and joints, visual information and sound. A store of sensory memories is said to exist as a basis for action in response to things perceived by sight and touch (Walton, 1977). Severe sensory defects (Garston, 1967) and persistent sensory defects (Buskirk and Webster, 1955; Hurwitz and Adams, 1971) affecting input and integration of sensory information are detrimental to further functional achievement.

The sensory loss may be slight, with minor loss of appreciation of light touch or the prick of a pin, to severe, with complete loss of joint position sense and appreciation of movement for half of the body (Macleod and Williamson, 1967). Defective proprioception denies the patient information which is essential for the control of movement: knowledge of the relationships of the parts of the body to each other and knowledge of the position of his limbs in space. It also disrupts the feedback mechanisms which affect the control of balance: he may not be

able to balance safely when he is sitting, and standing and walking may be impossible.

A large class of perceptual and cognitive disorders, called "the agnosias", is particularly associated with left-sided hemiplegia, usually caused by lesion of the non-dominant cerebral hemisphere. (Corresponding syndromes associated with right-sided hemiplegia are less frequently seen in left-handed patients.) The patient may completely ignore objects or activities in the left half of his field of vision; he may be unaware of his hemiplegic side or part of it and reject it (asomatognosia); or he may deny his hemiplegia totally (anosognosia (Critchley, 1955)). Although they are able to see an object, many patients cannot assess its position, size or movement relative to themselves. Consequently, they are unable to perform simple tasks, such as placing the arm in a sleeve to dress themselves.

Currently, there is very little information on the treatment, rather than the description, of sensory disorders. Isaacs (1962) states that widespread sensory dysfunction is difficult to rehabilitate and Marquandson (1969) says that self-care activities may be unattainable.

Disorders of communication: Disturbances of language are said to occur in two-thirds of right-handed patients with right-sided hemiplegia (Marquandson, 1969). They occur rarely in left-handed patients with left-sided hemiplegia; but, in a study of 148 survivors of stroke, Gresham, Phillips, Wolf, McNamara, Kannel and Dawber (1979) found thirteen

people with an expressive disorder who had no apparent motor deficit.

Disorders of communication may be receptive, integrative (comprehension) or expressive, and no communication may be possible through speaking (aphasia), reading or writing (agraphia). More mildly affected patients have difficulty selecting the correct word or phrase (dysphasia) (Hurwitz, 1971).

Although an expressive loss is a handicap to social and vocational rehabilitation, it is not incompatible with achievement of self-care. It is an adverse factor in rehabilitation, principally because it places a barrier between the patient and the practitioners. He is likely to be extremely frustrated at being unable to communicate (Hagan, 1969), and this may affect his willingness or ability to cooperate in treatment.

Any loss of ability to understand will make it very difficult for the patient to cooperate effectively in most forms of treatment, and persistent and severe receptive aphasia is a sign of poor prognosis (Hurwitz and Adams, 1971).

Motivation: The patient's motivation is recognised as a very important factor in rehabilitation (Lee, 1958). He may not have the capacity to respond, or be so demoralised that he is unable to respond. He may be hostile, depressed, emotionally labile, or resentful and uncooperative (McCollough and Sarmiento, 1970). Apathy (Marquandson, 1969) and depression (Hurwitz and Adams, 1971) have been identified as indicators of poor functional prognosis. Knowledge of the patient's pre-stroke personality is

necessary in deciding whether current behaviour and reactions are a new development or are habitual (Robinson, 1976).

Davidson (1963) described fear as a universal reaction to stroke. It may be transferred as anger directed at members of the rehabilitation team. The fear is said to be followed by a period of insecurity, manifest as resentment and non-cooperation. Patients who might be expected to make the best recovery, on the basis of their personal drive and intelligence, may respond worst, as if they are unable to accept their limitations (Adams, 1971). Hyman (1970) suggests that feelings of stigma impair motivation and functional improvement; and Roberts (1972) is concerned about the way in which decisions which affect the quality of the patient's life are made "for" and not "with" him. Most patients with a neurological deficit are said to experience rejection of their abilities to think and act maturely (Miller, 1975): suspicion or hostility may be a rational response to such experience.

Constant encouragement of the patient is recommended, and repeated assurance that he will achieve independence in self-care activities, even though the assurance may not always be fulfilled (Adams, 1974). The morality of promising an uncertainty is questionable: even if the assurance appears to be appreciated, it is doubtful if it is in his best interests. Failure is likely to cause greater despondency, and he may not achieve the attainable. The greater need would appear to be for realistic goals, so that his capacity for gradually overcoming difficulties can be demonstrated and recovery can be marked by the setting of progressively more difficult targets.

SUMMARY

A hemiplegic person is unable to control movement of one side of his body in the flexible and adaptive way necessary for ordinary everyday activities as well as adroit and accomplished skills. He has very few patterns of voluntary movement at his disposal, the tone of his muscles may be above or below the normal level of elastic tension, and his postural adjustment is disordered. Consequently, he may be able to move in a few stereotyped pathological patterns of movement; but these patterns will be more or less inadequate, both to control his balance, whether he is sitting down or standing up, and to allow him to take care of himself.

A realistic approach to rehabilitation includes recognition of the limitations imposed by the neurological deficits which are associated with hemiplegia:

Patients who have suffered a cerebrovascular accident of the left cerebral hemisphere may be expected to show motor dysfunction and alteration or loss of sensory appreciation on the right side of the body. They may also have problems with comprehension of language and word-finding (dysphasia) and with the mechanics of speech (dysarthria).

If the stroke has affected the right cerebral hemisphere, in addition to motor dysfunction of the left side of the body, these patients may have major perceptual problems in spatio-temporal relationships (agnosia); be unaware of the position and movement of the left arm and leg; and suffer handicapping impairment of execution of movement (apraxia).

Each individual survives a stroke with a particular combination of these problems resulting from the singular insult to his central nervous system. Many factors may influence the extent of his recovery - for example, the severity of his motor dysfunction; his perceptual and cognitive deficits; and motivational disturbances. His progress will also depend upon the attitudes of the people with whom he comes into contact immediately following his stroke; the support of his family and his friends; the way in which health care practitioners view his problems; and the treatment he receives.

2.3 PHYSIOTHERAPY FOR HEMIPLEGIA

2.3.1 Theories of recovery related to approaches to physiotherapy

Rehabilitation has been described as the means of promoting (Isaacs, 1973) and exploiting (Adams, 1974) the spontaneous recovery of most people who survive. Early, rapid improvement is attributed to dissipation of shock and oedema caused by the infarct. Monakow (1914) offered "diaschisis theory" to explain the aftermath of stroke: the intact areas of the CNS which are deprived of their normal input function poorly until the shock is dissipated; then, these symptoms disappear and recovery occurs. Residual symptoms are directly attributable to the particular damaged area. This theory is consistent with two sets of observations. (A) Negative effects, such as loss of voluntary movement and loss or alteration of sensory appreciation, are due to direct destruction. (B) Positive effects, such as spasticity and abnormal reflexes, are manifestations of the hyperexcitability of motor centres of the brain stem and spinal cord which are deprived of higher control (Jackson, 1882).

The theories of both Jackson and Monakow are linked by the postulate that components of the CNS make unique and specific contributions to the control of movement. They are supported, to a certain extent, by Mooney (1969). He attributes functional improvement in hemiplegic patients to the ability of the motor cell of the spinal cord to modify its response to influences upon it. This hypothesis of ability to modify response is related to theories of plasticity of the CNS (Stein, Rosen and Butters, 1974).

The theories of plasticity are linked by the postulate that areas of the CNS have a latent capacity to mediate functions if the primary area is abolished. Munk (1881) suggested that relatively unspecialised areas have the capacity to adopt roles because they are not occupied by other functions. In Kennard and Ectors' view (1938) functional reorganisation occurs as a "take-over" mechanism of permanent change in the function of intact areas. Kuypers (1964) and Brodal (1965) called this latent capacity a "fail-safe" mechanism.

Others (Sperry, 1947; Luria, Naydin, Tsvetkova and Vinarskaya, 1969) have described behavioural models of dynamic reorganisation. According to these models, lost functions are carried out in new ways so that the restored behaviour appears the same as that which was lost. This is supported by empirical evidence from observation of monkeys which shows that a recovered motor act will not be performed in the same way as it was before the lesion (Goldberger, 1974).

These theories are divided by agreement or dispute with the idea that specific functions are located in particular parts of the CNS. Through their daily clinical observation of hemiplegic patients and their use of techniques to restore motor function, physiotherapists are well placed to relate such theories to observed recovery from hemiplegia. In each case, certain difficulties arise:

Firstly, it is difficult to reconcile a postulate that components of the CNS make unique and specific contributions of the control of movement with empirical evidence of return of function after abolition of the neural structure which modified it.

Alternatively, the fact that most hemiplegic patients experience permanent loss of function is incompatible with a postulate that latent undamaged areas of the CNS will mediate lost functions.

One explanation may lie with Goldberger's conclusion that no one theory, model or mechanism accounts for all observable recovery. Approaches to physiotherapy for hemiplegia may also be seen as points of a debate of these postulates.

Physiotherapy is aimed at enabling each hemiplegic patient to reach the highest level of functional ability possible.

Broadly, there are two approaches to achieving this: the functional approach and the neurophysiological approach.

The distinction between them cannot be entirely clear-cut, but in general, they reflect different perceptions of the consequences of compensation for hemiplegia by reliance on the unaffected side.

The functional approach may be explained by Monakow's "diaschisis theory": residual symptoms are accepted as evidence of permanent damage and the patient is trained to use residual motor function to perform necessary activities.

The neurophysiological approach is based on theories of plasticity and dynamic reorganisation: the proponents of these methods aim to reduce the impairment of motor function to enable the patient to perform functional activities.

2.3.2 The Functional Approach

Functional physiotherapy for hemiplegia represents traditional physiotherapy because it is directed at the musculo-skeletal manifestations of the neurological insult. The motor loss is seen as a relatively irrevocable modification in functional capacity of the affected side. The therapeutic task is to train the patient to use his residual motor function to achieve maximum self-sufficiency and responsiveness to environmental demands (Birch, Proctor, Bortner and Lowenthal, 1960).

The general principles of physical rehabilitation relate to maintenance and improvement of joint mobility, preservation and increase of muscle power, and restoration and improvement of functional ability. The physiotherapeutic techniques used in the treatment of hemiplegia include group exercises and mechanical aids such as slings and calipers.

In the acute stage, passive movements and supportive splints or slings may be used to prevent deformities (Nichols, 1971). Early exercises emphasise symmetry of the body and weight bearing through the affected limbs. Later, when the extent of functional return has begun to be defined, the patient is taught to compensate for deficiencies in his hemiplegic side by adaptation using his unaffected side (Bullock, 1975). This approach is intended to assist the patient to adjust to life with little or no use of his affected limbs and to reduce interference with self-care activities and other tasks.

2.3.3 The Neurophysiological Approach

Physiotherapists who take a neurophysiological approach to treatment consider that a physiotherapeutic or rehabilitative approach which accepts disregard of the affected side and teaches compensation deprives the patient of the possibility of interplay between the two sides of the body. They conceive that the effects of the lesion might be mitigated, that a measure of coordinated movement can be restored, and that there is potential function to be recovered in the hemiplegic side.

The neurophysiological methods have been developed since the Second World War by physiotherapists who have described techniques of treatment to demonstrate their theoretical bases (Rood, 1954; Knott, 1967; Brunnstrom, 1970; Bobath, 1978). "Proprioceptive neuromuscular facilitation" (Knott, 1967) was developed in the United States of America and was the first neurophysiological method to be widely taught to British students of physiotherapy. In general, it has been superceded by the Bobath method when spasticity is present. Bobath and Brunnstrom developed their methods concurrently in the United Kingdom and the United States of America respectively. Rood's method of neuromuscular facilitation has been used principally for the treatment of children with cerebral palsy in the United States of America, although its general application has been promoted in the United Kingdom (Goff, 1972) as well as in America (Stockmeyer, 1967). Knott, Bobath and Brunnstrom have several precepts in common:

- A. They aim to restore the hemiplegic patient to bilateral activity which is as near normal as possible.

- B. They state that functional ability is improved by resolution of the impairment. More specifically, direct training of functional activities is unnecessary if normal muscle tone and normal patterns of movement are restored. Unlike the stereotyped patterns of movement released by the CVA, normal patterns of movement can be combined in an almost infinite variety of ways for the performance of skilful or mundane activities.
- C. They emphasise the integrity of the sensory input-integration-motor output system for normal function. "Handling" is the generic term for techniques whereby the physiotherapist uses her hands to provide sensory input in order to influence the patient's motor output.

Their theoretical bases, intermediate aims and techniques of treatment are quite different.

Proprioceptive Neuromuscular Facilitation¹ (Knott and Voss, 1968): This method is said to be theoretically based on the postulate that recovery is due to plasticity of the CNS through undamaged pathways taking over mechanisms underlying voluntary movement (Quin, 1971). Proprioceptors are the receptors in muscles, tendons and joints which transduce pressure and stretch to inform the CNS about the posture of the body and the action of muscles. The basic principle of PNF is stimulation of the proprioceptors to facilitate activation of weak muscles and to inhibit the activity of antagonistic muscles. Where there is a decrease in the pathway for voluntary movement, as in hemiplegia, Knott (1967) says that techniques of PNF recruit and increase nervous impulses and contribute to more effective functioning of remaining nerve cells. The physiotherapist supplements her handling with verbal commands; but disorders of communication and psychological disturbances may make it impossible for the patient to understand instructions, to respond and to cooperate in treatment.

1. Hereafter, Proprioceptive Neuromuscular Facilitation will be referred to as PNF.

The Bobath method: This method draws on the neurophysiological research of Sherrington (1913, 1947), Magnus (1926) and Schaltenbrand (1928). It is based on the neurodevelopmental sequence demonstrated by the maturing infant and on the principle that every voluntary movement is performed on a background of automatic postural adaptation.

Bobath's techniques are used to inhibit spasticity and stereotyped pathological patterns of movement released by the lesion and to facilitate normally coordinated patterns. Treatment depends upon constant feedback between the patient and the physiotherapist. His ability to respond to instructions is not essential: he responds automatically to cutaneous and proprioceptive stimulation, and the physiotherapist alters her handling according to his performance. To establish normal patterns of movement, she aims to enable him (A) to experience the sensation of more normal muscle tone and patterns of movement and (B) to inhibit undesirable pathological neuromuscular function himself (Bobath, 1978).

Treatment is carried out in positions in which everyday tasks are performed. Movements which are common to many tasks are broken down into simple elements in the way in which all motor skills are learned. The patient practices them repeatedly, and chains them together to complete patterns which can be used for functional activities. In this respect, the Bobath method is a more behavioural model than are the other methods.

The Brunnstrom Method: This method is theoretically based on the concept of reintegration of the CNS discussed by Twitchell (1951). His observations supported the view that mass patterns of flexion and extension always precede restoration of advanced motor function in hemiplegia. Consequently, and in complete contrast to Bobath's concept, Brunnstrom sees development of spasticity as a necessary stage in the recovery process.

In the early stages of recovery, Brunnstrom aims to elicit the released stereotyped spastic patterns by influencing the lower functional levels of the CNS. Once these patterns are established, she aims to modify them by influencing intermediate levels of control. Subsequently, the patient learns to control voluntary movement at the highest level. Brunnstrom (1970) ignores functional activity until normally coordinated patterns of voluntary movement have been restored.

The Rood Method: Rood (1954) also developed a method of neuromuscular facilitation based on the sequence of development of postural stability and motor patterns seen in the maturing infant. Her techniques of sensory stimulation have been applied more universally in the treatment of adult hemiplegia than has her general concept. Her techniques of skin brushing and stroking to prepare proprioceptors to be more or less sensitive to stretch have been widely utilised and extended. She introduced the technique of using cold to affect muscle function which has since been followed up in greater detail (Knuttson, 1970; Lee and Warren, 1978).

2.3.4 The effectiveness of physiotherapy for hemiplegia

In recent years, neurophysiological methods of treatment have gained in popularity among physiotherapists who have found them effective. Several physiotherapists have offered approaches to stroke rehabilitation in which these methods have influenced the practice and expectations of all practitioners, e.g. Johnstone (1976) acknowledges Knott and Bobath, Carr and Shepherd (1979) acknowledge Bobath, and Dardier (1980) acknowledges Bobath and Brunnstrom.

Medical practitioners are less convinced of the efficacy of these methods than are physiotherapists. There is no hard evidence that the impairment of neuromuscular function can be resolved by physiotherapy, let alone that resolution of impairment automatically improves the patient's ability to perform self-care and other activities of daily living¹.

The crux of the matter might be that current neurophysiological theory does not explain unequivocally the changes in muscle tone and patterns of movement that physiotherapists can produce.

Consequently, there is continual debate about the effectiveness of physiotherapy in the rehabilitation of stroke. The conflicts and agreements between the functional and the neurophysiological approaches, and among the neurophysiological methods, lead doctors and physiotherapists to question their relative values. Although some medical writers have emphasised the importance of physiotherapy in the treatment of hemiplegia (cf., e.g. Rankin, 1957; Dervitz and Zizlis, 1970; Adams, 1974; Anderson, Baldrige

1. Hereafter, activities of daily living will be referred to as ADL.

and Ettinger, 1979), the influence of formal rehabilitation programmes and physiotherapy on outcome for the patient is not proven. Additionally, the comparative efficacy of the different methods of physiotherapy has not been evaluated.

Evaluations of physiotherapy and rehabilitation: Contradictory evidence can be cited from the literature. Some authors have confirmed beneficial effects from physiotherapy (cf., e.g. Wylie, 1967; Lehman, Delateur, Fowler et al, 1975a; Anderson et al, 1979); some have reported recovery after little or no physiotherapy (cf., e.g. Lowenthal, 1960; Waylonis, Keith and Aseff, 1973); and others have described little difference in outcome from formal rehabilitation or "functionally oriented care" (cf., e.g. Feldman, Lee, Unterecker, Lloyd, Rusk and Toole, 1962; Brown and Pozkanzer, 1969).

Several factors hamper appraisal and comparison of these studies:

- A. Rehabilitation of stroke and physiotherapy for hemiplegia are not always distinguished.
- B. Few of the studies in which they are distinguished state which physiotherapeutic techniques were used.
- C. Terms are not defined: "recovery", for example, may be used to describe performance of ADL without use of the affected side or restitution of normal bilateral activity.
- D. Some of the studies compare different descriptions of the same process rather than genuinely different approaches to the care and rehabilitation of stroke patients. For example, rehabilitation is "functionally oriented care"; and it would have been surprising if the study of Feldman and his co-authors mentioned above had found a significant difference in outcome.

Variables used in evaluative and descriptive studies: Two factors in research design also appear to be prime sources of contradictions:

- A. Self-care activities and ADL are emphasised as independent variables.
- B. Criteria of physical dependence are recorded as dependent variables to measure change in the patient's ability to perform activities.

For each successive study of hemiplegic patients a new set of activities is usually described, and varying descriptions of levels of dependence are used (cf., e.g. Feldman et al, 1962; Gordon and Kohn, 1966; Stern, McDowell & Miller, 1970).

Consequently, the content of some assessments appears to be directed more towards the goals of the studies in which they were used than to the true functional capacity of the patient. Some test a restricted range of abilities by repetitively measuring the same dimensions of integrated purposeful function - for example, reach and grasp. Additionally, the differences between the variables used in these studies, and the consequent differences in measuring outcome from treatment, produce results which are not comparable.

The treatment being evaluated: There is little evidence in evaluative studies that physiotherapy and rehabilitation have been tailored to the individual needs of the patients who participated. It is not always clear what treatment an individual received, other than that he received a standardised regime as a member of a particular group. Partridge (1980) has stressed that physiotherapy is a dynamic process which alters immediately in

response to change in the patient. Therefore, standardisation of treatment for the purpose of research can mean that the "treatment" being evaluated bears little relationship to the physiotherapy an individual needs, and the evaluative study will have little value.

Future evaluation of physiotherapy: In assessing the results of treatment of peripheral nerve injuries, Bowden (1954) emphasised that it was not enough to assess the extent of restoration of motor and sensory function: success must be judged by, "the patient's ability to resume the enjoyment of a full and active life."

The mechanism and process of resolution of neuromuscular impairment following peripheral nerve injuries is well documented (cf. Seddon, 1954). Conversely, the greater volume of literature about CVAs concerns functional recovery, which is observed more easily than is resolution of impairment. However, Bowden's definition of success is still applicable to rehabilitation of stroke. Ultimately, the success of physiotherapy for hemiplegia will not be judged by the extent to which it alters the tone of the patient's muscles or his patterns of movement. It will be judged by his ability to perform the ordinary activities of his life.

However, in order to be more effective and to achieve such success, physiotherapy still requires both a description of the sequence of restoration of motor function and a means of estimating its extent. Consequently, the debate concerning the effectiveness of both physiotherapy and rehabilitation is unlikely to be resolved until data-gathering instruments are

standardised, tested for their reliability, and confirmed as valid for assessment of hemiplegia, or stroke, or both. Essentially, there should be no difference between a research instrument and a clinical assessment. Therefore, for evaluation of physiotherapy for hemiplegia, the data-gathering instrument needs to be a valid clinical assessment for physiotherapy; and the procedure for gathering data for research should be compatible with the routine use of the assessment. Although the success of physiotherapy is judged on a patient's functional ability, reliance on ADL and self-care activities deprives studies of the dimension which is important for evaluation of physiotherapy itself. That is, assessment of the quality of movement, or the effects of muscle tone on patterns of movement and postural control, and its relationship to observable changes in patients' functional ability brought about by physiotherapy.

Finally, it is necessary to return to the assertion of the proponents of the neurophysiological methods, that functional ability will improve as the impairment is reduced. No evaluative study has tested this assertion yet; although it offers an hypothesis for comparing the functional and neurophysiological approaches as well as the different neurophysiological methods.

SUMMARY

Hemiplegic patients who are referred for physiotherapy may be treated by functional or neurophysiological approaches. Practitioners of the functional approach accept that the neuromuscular impairment is not going to alter significantly. They aim to reduce disability by training the patient in activities such as walking and negotiating steps. Practitioners of the methods of the neurophysiological approach aim to reduce the functional disability by improving the patient's control of his movement and balance.

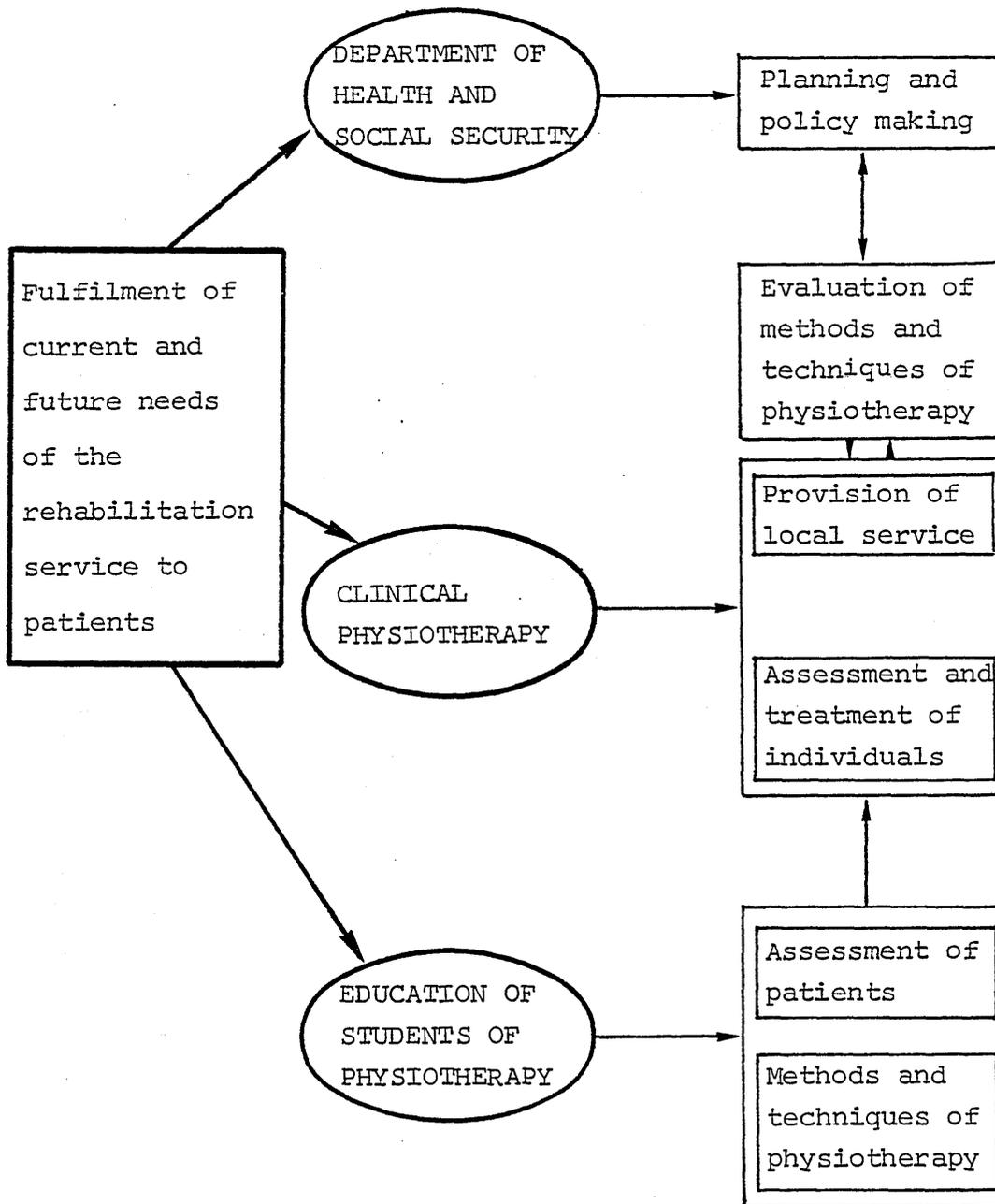
The theories and models of recovery after lesion of the central nervous system do not appear to support any one approach or method of physiotherapy above another. They do appear to possess varying degrees of power to explain them. The functional approach may be explained by "diaschisis theory" (Monakow, 1914), since this theory views recovery as the reestablishment of temporarily impaired neural mechanisms and as a function of the individual's capacity to realise repair. Conversely, practitioners of neurophysiological methods measure recovery by the quality of the performance, or recovery of execution of normal co-ordinated movement. They are supported by theories of the plasticity of the central nervous system which allow mediation by an undamaged area and restoration of patterns of movement which are acceptable as normal function (Stein, Rosen and Butters, 1974).

There is some dispute over the efficacy of physiotherapy for hemiplegia; and contradictory evidence can be cited from the literature. There can be no doubt that the most effective rehabilitation is that which enhances the hemiplegic person's capabilities outside the hospital or treatment centre. It is yet to be shown whether effective rehabilitation of stroke involves training of functional activities; or physiotherapy aimed at resolving the impairment; or a combination of these and other interventions, such as aids and adaptations in the home.

In order to evaluate the efficacy of physiotherapy in rehabilitation of stroke patients, a data-gathering instrument is required which would be both a clinical physiotherapeutic assessment usable with all methods of physiotherapy and a measure of outcome from treatment.

FIGURE 5

AREAS OF NEED FOR A STANDARDISED PHYSIOTHERAPEUTIC ASSESSMENT
OF HEMIPLEGIA



2.4 THE NEED FOR A STANDARDISED PHYSIOTHERAPEUTIC ASSESSMENT OF HEMIPLEGIA

The Concise Oxford Dictionary defines the noun "need" in relation to circumstances and the verb "to need" in relation to necessity and obligation. In descriptions of patient care, definitions of need have usually eluded the precision grip of those who have attempted to define it, and some of the qualities Macbeth ascribed to the dagger have been attributed to need (Acheson and Hall, 1976): perhaps it may be "... the false creation of his oppressed brain".

Bradshaw (1972) identified four types of need: normative need, or that which the expert or professional defines as need; felt need, or want; expressed need, which is felt need made explicit; and comparative need, which is obtained by observing characteristics of those who are in receipt of a service and then defining others with similar characteristics as in need.

This taxonomy provides a useful framework for assessing need for a standardised physiotherapeutic assessment of hemiplegic patients in three interrelated sets of circumstances (Figure 5). The practitioners and teachers of physiotherapy, the planners and the policy makers have different aims and objectives which they are obliged, or find necessary, to fulfil. However, they are all attempting to fulfil their own normative and felt needs, and comparative needs which they identify for rehabilitation of stroke, to answer the basic question posed by Evans (1981):

"How can rehabilitation techniques be employed constructively?"

2.4.1 The interrelated needs of practitioners, planners and policy makers

There are no standard criteria of eligibility for rehabilitation. The availability of services varies between localities and the level of provision determines accessibility (DHSS, 1972). Consequently, the limited financial income of the National Health Service is under pressure to redress inequalities in the provision of care, as well as to accommodate extensions of all aspects of the service. DHSS Research Liaison Groups for the Elderly and the Physically Handicapped are concerned with the potential for more effective and economic use of resources; and their priority objectives include evaluation of techniques of rehabilitation and physiotherapy.

Nichols (1974) wrote that, to provide adequate care, it is essential to identify the features which contribute to the success or failure of rehabilitation in different situations. Lane (1978) has also emphasised that the validity of physiotherapy for stroke patients must be tested if available resources are to be put to the best use. Therefore, practitioners, planners and policy makers are concerned with two dimensions of the provision of care described by Cochrane (1972) which are closely linked to the development of a standardised physiotherapeutic assessment of hemiplegia:

- A. Effectiveness: the ability of a procedure to alter the natural history of a condition for the better.
- B. Efficiency the more complex issue of the ratio of the effect achieved to the resources used.

In this instance, evidence that one technique, method or approach of physiotherapy is more effective than another at enhancing the rate or extent of recovery from hemiplegia, or both, would also contribute to greater efficiency. In this respect, resources include the physiotherapists, their handling skills and the settings in which the skills are used. While techniques of handling cause the provision of physiotherapy for hemiplegia to draw relatively lightly on capital and revenue resources; inevitably, physiotherapeutic manpower resources are used very heavily. In order for physiotherapists' skills to be used more efficiently, a standardised physiotherapeutic assessment might also be used to determine (A) if some patients have a greater or lesser potential than others to benefit from continued treatment, and (B) if the type of treatment centre influences the effectiveness of treatment.

2.4.2 The needs of physiotherapists

In all four of Bradshaw's areas, the needs of physiotherapists are clearly linked to changes in their role and function during the last twenty years.

In order to practice in the National Health Service physiotherapists, and other health care practitioners such as occupational therapists and dieticians, are required to register under the Professions Supplementary to Medicine Act, (1960). At the time this Act came into force, unless circumstances were "exceptional", rules of professional conduct required physiotherapists to treat only patients who had been referred by a registered medical or dental practitioner. Frequently, this referral included prescription of physiotherapy on the basis of the findings of the doctor's examination and his diagnosis. Physiotherapists made assessments and recorded their findings at the outset and throughout treatment in order to monitor patients' progress.

During the intervening years, the relationship between physiotherapists and the medical and dental professions has changed. Research in associated areas has provided physiotherapists with knowledge to develop new techniques of treatment and related skills, and to describe contraindications to use. In response to the effects of the new techniques, the focus of diagnosis and treatment has gradually changed. Physiotherapists have become more orientated towards symptoms and dysfunctions presented by the individual, such as limitation of range of movement of a joint; pain and muscle weakness; or hypotonia and

ataxia. Consequently, they have become more concerned with evaluation of their treatments of individuals against the background of the person's life as a whole; and detailed prescription of physiotherapy on the basis of the medical diagnosis has become inappropriate.

The changes in practice require critical assessment of the patient, in order to establish priorities in dealing with symptoms, and critical appraisal of physiotherapeutic techniques, in order to select the most appropriate for each individual. The 1970 Report of the Review Committee of the Chartered Society of Physiotherapy¹ recorded that the existing referral and prescriptive practices were outmoded. This report was before the Society's Examination Committee when it restructured the professional examination system. At that time, candidates for the Society's final examination were required to simulate treatment for a particular condition or diagnosis. The new Part II (final) examination reflects changes in the practice and role of physiotherapists: it examines candidates' ability to select and apply techniques of assessment appropriate to an individual patient; to analyse the findings and discuss them with the examiners; and to formulate a plan of treatment, including prescription of techniques of treatment (CSP, 1977).

Government reports appearing early in the decade also stressed physiotherapists' ability to assess patients for the purposes of planning their own treatment (DHSS, 1972; 1973). The McMillan Report (DHSS, 1973) recommended review of the administrative memorandum HM (62)18, which had required physiotherapists to work

1. Hereafter, the Chartered Society of Physiotherapy will be referred to as CSP.

under the direction of a medical practitioner, so that the nature and duration of physiotherapy would be determined by the physiotherapist treating the patient. This prescriptive role is implicit in the replacement circular, HC(77)33. Statements of Conduct of the Council for Professions Supplementary to Medicine and the CSP's Rules of Professional Conduct were also amended to allow physiotherapists to treat patients who have not been referred by a doctor or a dentist if they have "direct access to the patient's doctor".¹

Physiotherapists' acquisition of a prescriptive role can be seen as a developmental stage in the process of maturation of physiotherapy as a profession complementary, rather than supplementary, to medicine. The progress from fulfilment of medical prescription to prescription-by-self has implications for evaluation of methods and techniques of physiotherapy. The further development of physiotherapy is clearly linked to evaluation of physiotherapy by physiotherapists (Partridge, 1980). This is particularly evident in those areas, such as treatment of hemiplegia, where physiotherapists have propounded methods which contain uniquely physiotherapeutic elements.

In order to fulfil the obligations which accompany their new professional rights, physiotherapists need standardised assessments. They have expressed this need by devising check lists and other records; but many data are recorded only in an individual physiotherapist's memory. This ad hoc approach to

1. Statement of Conduct by the Disciplinary Committee of the Physiotherapists' Board of the Council for Professions Supplementary to Medicine, 1973/74; and Rule 2 of the Rules of Conduct of the CSP, approved by Privy Council, May, 1978.

making and recording assessments carries a professional disadvantage: knowledge of hemiplegia acquired through physiotherapeutic handling of many patients remains an individual and largely temporary phenomenon (Mitchelson, Holland and Mitchell, 1977). An accurate description of responses to physiotherapeutic handling, and their places in the sequence of restoration of normal patterns of movement, is needed in order to affect the general level of skills and to facilitate the learning of students and inexperienced physiotherapists.

A standardised assessment of hemiplegic patients would:

- A. facilitate both the teaching of assessment to students and transfer of knowledge from the students' clinical placements to post-qualification practice in other settings;
- B. enable a large volume of data to be collected in different treatment centres throughout the country which could be used in evaluative studies; and,
- C. primarily, fulfil the normative and felt needs of physiotherapists for a valid and reliable method of assessing hemiplegic patients (cf., e.g. Parker, Johnson and Johnson, 1970; Hughes, 1972; Davies, 1972; Shepherd, 1978; Lincoln and Leadbitter, 1979; Sødning, 1980).

2.4.3 Physiotherapeutic motor assessment for hemiplegia:

Criteria for acceptability

Assessment for physiotherapy for hemiplegia: The "first assessment" may take two or three sessions to complete. Usually, a general assessment is made at the first session, and specific areas are identified for more detailed examination subsequently. The patterns of the patient's movements, the tone of his muscles and his balance reactions are examined in relation to activities he is unable to perform safely or normally, such as rising from sitting in order to get out of bed. The results are used to formulate aims of treatment and to plan a programme of treatment to resolve problems.

Reassessments are made in order to monitor progress, to modify the programme of treatment and to record the patient's current status. They tend to be made at irregular intervals, when the physiotherapist perceives change in the patient. They are used to identify both newly-acquired abilities and problems which impede further progress.

The "final assessment" records the patient's abilities when treatment is completed. For those who return to their own homes it will include a "home assessment": commonly, this is made jointly with an occupational therapist. If the patient is unable to return to his home, the members of the rehabilitation team may pool the findings of their assessments to decide if he needs long-stay hospital care or accommodation in an elderly or disabled persons' unit.

Although the general plan of treatment is formulated in advance, each session of treatment is dictated by the physiotherapist's observations at the beginning of the session and by the patient's reactions to handling. The consensus of opinion among physiotherapists who have assessed and treated many hemiplegic patients is that restoration of normal control of movement, or recovery, occurs in a particular sequence.¹

At present, this sequence is an intuitive belief among physiotherapists. Some studies have identified sequences for the upper limb, or the lower limb and the trunk (e.g. Lincoln and Leadbitter, 1979); but a "continuum of recovery" has not been identified and recorded through standardised and objective observation of hemiplegic patients. As will be discussed later, many physiotherapeutic assessments are subjective and their reproducibility and stability are untested. There is a need for a standardised assessment of confirmed reliability and validity which would help physiotherapists to construct more effective programmes of treatment for individual patients.

Criteria for optimal assessment: According to normative and felt needs described in the literature and elicited in conversations with clinical physiotherapists, the optimal motor assessment should fulfil the following criteria:

1. Opinions expressed (1) in the literature (cf., e.g. Michels, 1959; Goff, 1976; Todd and Davies; 1977); and (2) in conversation with concerned physiotherapist (cf. 3.5)

- A. The assessment should be brief, convenient and easy to use.
- B. It should be compatible with all methods of physiotherapy.
- C. The items of assessment should be valid for physiotherapy for hemiplegia.
- D. The findings should be recorded easily and immediately, and readily retrieved.
- E. They should generate a logical plan of physiotherapy.
- F. They should be reproducible.
- G. The record should demonstrate the patient's progress.
- H. It should assist communication between physiotherapists and practitioners of other professions and between physiotherapists and patients.

Thus, the needs of clinicians provide criteria which include qualities essential for any scientific instrument for gathering data - objectivity, reliability and validity - as well as criteria of clinical acceptability related to professional and utilitarian needs. In reality, scientific and clinical acceptability are inseparable.

Firstly, the reliability of the assessment (criterion F) concerns the conciseness and clarity of the items of assessment. They should be unambiguous so that all physiotherapists pay attention to the same aspects of performance, interpret performances in the same way and record decisions by the same rules. In this way, reproducibility would be assured and reliable data could be collected from distant centres for evaluative studies. Of more immediate clinical significance would be the facilitation of continuity of treatment if a patient were transferred to the care of another physiotherapist.

Secondly, the validity of the assessment (criterion C) concerns both the truthfulness with which the order of items of assessment represents the sequence of restoration of normal control of movement and their appropriateness to physiotherapy for hemiplegia. Whilst this is also necessary for evaluative studies, clinically it cannot be separated from generation of a logical plan of physiotherapy (criterion E), demonstration of the patient's progress on the record (criterion G) and communication with patients and practitioners of other professions (criterion H).

Communication may represent the most complex issue of all, and it is discussed in greater detail in section 2.6. Communication of correct information is necessary between practitioners in order to convey treatment rationales as well as information about a patient's status and progress. The patients' need for information is not defined by them; but it is imperative that each patient receives a clear picture of his status and progress which is not complicated by medical or physiotherapeutic terminology.

2.4.4 Assessments published in the literature

There are many assessments of stroke and hemiplegia which can be compared with the proposed optimal assessment. In general, they have been drafted to fulfil the normative needs of physicians, occupational therapists or physiotherapists. They include:

1. Indices of assessment and prognosis
2. Assessments of activities of daily living
3. Assessments of discrete properties of neuro-muscular function
4. Assessment of hemiplegia

1. Indices of assessment and prognosis: These assessments have been derived by physicians to fulfil their need to predict both the probability of the patient's survival and his future functional capacity (cf., e.g. Rankin, 1957; Bourestom, 1967; Hurwitz and Adams, 1971; Isaacs, 1971; Lehmann, DeLateur, Fowler, Warren, Arnhold et al, 1975b). From the physician's point of view, decisions related to referral for physiotherapy may be based on the early prognosis for survival (Isaacs, 1971); but from the physiotherapist's standpoint, predictive information does not help her to determine priorities in the early weeks after onset (Lane, 1978).

Granger, Sherwood and Greer (1977), Feigenson, Polkow, Meikle and Ferguson (1979), and Jiminez (1979) have also proposed predictors of the patient's eventual functional level. To date there is no evidence that these predictors have any validity as criteria of selection for rehabilitation or physiotherapy, or that they generate a logical plan of treatment. Principally,

FIGURE 6

AN ADL ASSESSMENT

RIVERMEAD REHABILITATION CENTRE				
ACTIVITIES OF DAILY LIVING				
Name:				
Date of assessment:	i	ii	iii	AIDS REQUIRED/COMMENTS
Drinking				
Clean teeth				
Comb hair				
Wash face/hands				
Make up or shave				
Eating				
Undress				
Indoor mobility				
Bed to chair				
Lavatory				
Outdoor mobility				
Dressing				
Wash in bath				
In/out of bath				
Overall wash				
Floor to chair				
TOTAL				
Preparation of hot drink				
Preparation of snack				
Cope with money				
Get in/out of car				
Prepare meal				
Carry shopping				
Crossing roads				
Transport self to shop				
Public transport				
TOTAL				
Washing				
Ironing				
Light cleaning				
Hang out washing				
Bedmaking				
Heavy cleaning				
TOTAL				

SCORING:
 3 Independent with/without aid
 2 Verbal assistance only
 1 Dependent (if unfit, unsafe, too soon)

Dom. O.T. referral

Assessed by

they use criteria of physical dependence for performance of purposeful and functional activities. In this respect, they have more in common with the assessments of ADL than with those of the early medical prognosticators.

2. Assessment of activities of daily living: The ADL are activities uniformly and frequently required by custom (Figure 6). They are usually tested in an assessment room or a room cleared of hazards. They are scored according to the extent of the assistance the patient requires. Developers of these assessments have used grades of overall dependency (Carroll, 1962; Granger, Greer, Liset, Coulombe and O'Brien, 1975) or total scores of ability (Shoenig and Iverson, 1968).

Sainsbury (1970) has suggested that practitioners lay undue emphasis on independence which does not reflect the needs of disabled people. Williams, Johnston, Willis and Bennett (1976) have challenged criteria of assessment such as assistance required from other people, seeing them as value judgements which are interpretations of the customary values of society. On the grounds that the relative value of any particular activity is impossible to determine, Carroll (1962) doubted the validity of assigning a numerical value to each item of his own assessment and adding them to achieve an overall score. It is also doubtful if different levels of dependency are rated numerically. Even so, the ADL score is the most common expression of functional ability.

The first drawback of summing the scores and presuming some

characteristic of the patient by an absolute number is that the detail of how the total was achieved is lost. It is not possible to tell which activities the patient was unable to perform; which he could not perform independently, or for which he required the assistance of another person; and what stage of recovery he has reached. Although Wylie (1967) showed association between lower scores on the Barthel Index of functional ability (Mahoney and Barthel, 1965) and increased mortality, and between higher scores and "independent function", this is a gross distinction which Weddell and Beresford (1979) were able to make without resorting to elaborate methods.

Marquandson (1969) described the realistic goal of rehabilitation as "self care and return home". Therefore, it would seem appropriate to use assessments of ADL/self-care activities to determine the patient's capabilities. However, the validity of the findings depends (inter alia) on where the assessment was carried out. Kelman and Willner (1962) and Nichols (1974) focussed on discrepancies between a patient's adduced capacity from clinical observation and his actual performance at home. The potential discrepancy between his performance in the relatively hazard-free situation of the assessment room and his typical performance in more hazardous situations is generally recognised by the conduct of the "home assessment". It is also recognised in the Northwick Park ADL Index (Benjamin, 1976); although Benjamin distinguishes only between what the patient can do in the assessment room and what he reports he can do at home.

Both the Northwick Park ADL Index and the Rivermead ADL

Assessment (Whiting and Lincoln, 1980) have been developed to assist occupational therapists to record functional ability. Neither of them is concerned with the possible reasons for functional disability. The Northwick Park Index is offered as an aid to planning treatment of hemiplegia, if it is used in association with a physiotherapy assessment. Fugl-Meyer and Jääskö (1980) and Staff (1980) have also distinguished between functional assessment and physiotherapeutic motor assessment: the physiotherapeutic assessment is said to assess the basic motor function required before a functional/ADL assessment can be made. For example, sitting balance is a pre-requisite of putting on shoes and socks and patients must be able to balance when standing before they can re-arrange their clothes in the lavatory.

Physiotherapists have confirmed that, to treat hemiplegic patients effectively they need more information than is provided by a functional assessment of the ADL/self-care type (Davies, 1972; Todd, 1974; Dardier, 1980; Sødning, 1980). They assert that physiotherapy requires an assessment of the quality of the patient's movement, because abnormalities of neuromuscular function deprive the individual of patterns of movement and, therefore, of useful daily activity.

3. Assessments of discrete properties of neuromuscular function:
Most commonly, assessments of neuromuscular dysfunction test spasticity, muscle power and range of movement as discrete properties.

Several scales for grading spasticity are offered (Newman, 1972; Smyth, 1974; Stitchbury, 1975; Goff, 1976). A reliable method has not been developed because of the high variability of muscle tone which may fluctuate widely in the same person in different situations and at different times of the day. The pathophysiological mechanisms of spasticity are still being investigated but observers agree that muscle tone is materially affected by a number of extrinsic and intrinsic factors (Reynolds, Archibald, Brunnstrom and Thompson, 1958; Kelly and Gautier-Smith, 1959; Campbell and Green, 1965; Hudgson, 1976; Wyke, 1976; Pederson, 1980). These multiple factors have defied objective measurement and have prevented spasticity from being reduced to one measurable parameter.

Teitelbaum and Vyner (1949) also related fluctuations in muscle tone to other techniques of assessment. They noted that the range through which a joint can be moved will vary according to the level of muscle tone at any given time, and an accurate measurement may be unobtainable. They also pointed out that grading of muscle power will be inaccurate if spasticity assists or resists the movement. A most important point in relation to muscle power and hemiplegia was made by Bowden (1977): grades of muscle power give no idea of the patient's patterns of movement because the muscles are tested in isolation. Physiotherapeutically the effects of spasticity on the patient's patterns of movement and posture are more important than an accurate measure of spasticity or grading of muscle power (Bryce, 1976; Todd and Davies, 1977; Carr and Shepherd, 1980). In this respect the Oswestry Scale of Grading Spasticity (Goff, 1976) is more valid than other scales, because the grades are

described according to the effect spasticity has on patterns of movement; and restoration of movement of normal quality is recorded. Unfortunately this scale is not usable if recovery in the limbs does not follow the expected proximal to distal process, and it does not assess patterns of movement of the trunk such as rotation around the axis of the body to roll over in bed and to turn to one side.

4. Assessments of hemiplegia: A few assessments have been designed by physiotherapists for prescription and monitoring of physiotherapy specifically for hemiplegia (cf., e.g. Michels, 1959; Brunnstrom, 1966, 1970; Bobath, 1977, 1980; LaVigne, 1974; Lincoln and Leadbitter, 1979; Sødning, 1980; Ashburn, 1982).

Both Bobath and Brunnstrom identify "significant movements" at particular stages in the process of recovery. This approach to assessment commends itself for reducing what can be a lengthy procedure and for describing the process of resolution of hemiplegia. Unfortunately, the disadvantage of these assessments is that they are really subjective reports for and of the respective methods of treatment. While they may be adequate in specific situations, they cannot be used in comparative evaluations. LaVigne (1974) collaborated with Brunnstrom to make her assessment more universally acceptable; but the revised assessment is still appropriate only to Brunnstrom's method of treatment.

Neither of these assessments has been tested for reliability. Brunnstrom's assessment provided the model for a research

instrument for gathering data to evaluate outcome from rehabilitation (Fugl-Meyer et al, 1975). Fugl-Meyer claims that this is one of the very few standardised and reproducible protocols; but he also says that it does not provide physiotherapists with sufficient information for the planning of treatment, although it illustrates the effects of the treatment.

In Canada, an attempt is being made to develop the Chedoke Hemiplegia Assessment to "measure neurophysiological status independent of any treatment technique" (Gowland, 1979, personal letter). Its ten pages of assessment items reflect the techniques of Bobath, Brunnstrom, PNF, Rood and biofeedback methods being used at the Chedoke Hospitals. However, it cannot be regarded as truly independent of method, since both rationales and related tests derived from the treatments of Bobath and Brunnstrom are recognisable in different parts of the assessment. A more original development was begun in North Carolina (Parker, Johnson and Johnson 1970). The interim version of this assessment was also lengthy, and it was not finalised because the working group could not be sustained (Parker, 1979, personal letter).

In contrast to these protocols, the assessments of Lincoln and Leadbitter (1979), Sødning (1980) and Ashburn (1982) appear parsimonious. They are based on observation of the patient's abilities and activities, with the aim of identifying why he is unable to perform in the specified way, in order to generate a plan of treatment. Sødning stresses that all of her items of assessment have a close connection with functional activities.

FIGURE 7

THE RIVERMEAD STROKE ASSESSMENT

Rivermead Stroke Assessment - Motor

NAME AGE NO.

DATE OF STROKE SIDE AFFECTED HAND DOM.

AIDS - On Admission

On Discharge

ASSOCIATED HANDICAPS:

<u>Date</u>			
<u>Emotional State</u>			
<u>Speech</u>			
<u>Inattention</u>			
<u>Comprehension</u>			
<u>Hearing</u>			
<u>Vision</u>			
<u>Contractures & Deformities</u>			
<u>Comments</u>			

Score 1 or 0	Date:			
GROSS FUNCTION				
1. Sit unsupported				
2. Ly. to sitt. on side of bed				
3. Sit to st.				
4. Transfer from wheelchair to chair twds. unaff. side				
5. Transfer from wheelchair to chair twds. aff. side				
6. Walk 10 metres independently with an aid (KORDE)				
7. Climb stairs independently				
8. Walk 10 metres without an aid (KORDE)				
9. Walk 5 metres, pick up b.bag from floor, turn & carry back				
10. Walk outside 40 metres				
11. Walk up and down 4 steps				
12. Run 10 metres				
13. Hop on affected leg 5 times on the spot				
TOTAL:				
LEG AND TRUNK				
1. Roll to aff. side				
2. Roll to unaff. side				
3. $\frac{1}{2}$ bridging				
4. Sitt. to st.				
5. $\frac{1}{2}$ crk.ly; lift aff. leg over side of bed & return it to same posn.				
6. St. step unaff. leg on and off block				
7. St. tap ground lightly 5 times with unaff. foot				
8. Ly. d/flex. ankle with leg flexed				
9. Ly. d/flax. ankle with leg ext.				
10. St. with aff. hip in neutral position, flex. aff. kn.				
TOTAL:				
ARM				
1. Ly: protract sh. girdle with arm in elevn.				
2. Ly: hold ext. arm in elevn. some ext. rot.				
3. Flex. & ext. elbow with arms as in 2.				
4. Sitt: elb. into side pro. & sup.				
5. Reach fwd., pick up large ball with both hands & place down				
6. Stretch arm fwd, pick up tennis ball , release on mid thigh aff. side X 5				
7. As 6 with pencil X 5.				
8. Pick up piece of paper from table in front, release X 5				
9. Cut putty with knife & fork and put into container				
10. St: pat large ball on floor with palm of hand X 5				
11. Continuous opp. of thumb & alt. finger ^{more than 14X} in 10 secs.				
12. Sup. & pro. onto palm of unaff. hand 20 X in 10 secs.				
13. St: hand on wall sh. 90° flex. elb. ext. Walk round arm.				
14. Place string around head, tie bow at back.				
15. "Pat-a-cake" 7 X in 15 secs.				
TOTAL:				

They are not presented on a scale from onset of hemiplegia to recovery, and the assessment is designed for use with Bobath's method of treatment.

The "Physical Assessment of Stroke Patients" published by Ashburn (1982) contains two examinations. The items of the "Examination of upper and lower limb activity" assess patterns of movement in side lying, lying, sitting and standing. They are graded on a three-point scale: 0 = no movement; 1 = limited movement; 2 = completed range of movement. The eighteen items of the "Examination of functional movement activity" are said to reflect "a basic developmental pattern of total body movements and balance". These items are graded on a four-point scale: 0 = impossible; 1 = assistant required; 2 = independent with use of aid; 4 = independent. A total score of fifty-four is said to indicate total independence. Criticisms similar to those directed at the assessments of ADL can also be made of this examination. Problems inherent in requiring assessors to discriminate between several subcategories of an item are discussed in section 2.5.1. In particular, the usefulness of summated rating scales providing total scores is discussed in section 2.6.2.

At face value, the hemiplegia motor assessment developed by Lincoln and Leadbitter (1979) is the most valid: the version in use in April, 1981, is reproduced here. Lincoln and Leadbitter selected items which they consider will assess patients in all stages of recovery. The items are arranged in three scales and ordered to describe resolution of hemiplegia. The record is intended to communicate an idea

of the patient's status and progress along each of the three scales to other members of the rehabilitation team, but not to the patient himself.

On closer inspection, doubts arise regarding its validity. Firstly, although there is a separate "Gross Function" scale of items, the "Leg and Trunk" scale and the "Arm" scale contain items which assess functional ability as well as quality of movement. Secondly, no association is shown between achievement on all three scales. Thirdly, there are very few items which would assess a severely impaired patient immediately after his CVA and in the early weeks of recovery; but the scales appear to be top heavy with advanced items, such as being able to hop on the hemiplegic leg. Fourthly, some of the items on the "Gross Function" scale are qualified by distances the patient must walk for the performance to be recorded. These may be necessary in order to standardise the items, but an arbitrary distance such as 10 metres is not meaningful in terms of functional activities. Functionally, it would be more useful to know if the patient could walk from his bed to his usual chair in the living room or day room of the ward, or to the lavatory. Fifthly, there is no record of how the patient performs outside the physiotherapy department or assessment room.

Some of these criticisms may be explained by the status of the Rivermead Rehabilitation Unit as a Regional Unit which accepts patients from all over the country for intensive rehabilitation. Inevitably, few patients in the very early stages of recovery will attend the unit, and home assessments

would be costly to undertake. More importantly, the assessment was developed and evaluated using data provided by patients who were under sixty-five years of age.

Epidemiological surveys show that more than half of the people who suffer strokes are likely to be above this age, and their expected range of activities and abilities is naturally reduced by the ageing process. Consequently, the assessment seems to be more appropriate to younger recovering patients, who might expect to be vocationally rehabilitated, than to the majority of patients who are treated immediately after their strokes.

The Rivermead Hemiplegia Motor Assessment is also distinguished by published confirmation of its reproducibility and stability. The tests were made at the Rivermead Unit and they have not yet been repeated with different samples of physiotherapists and patients. Taking into account the comments concerning its validity, the extent to which the assessment has general application beyond the unit is not easy to determine.

2.4.5 Procedural areas in the development of an optimal assessment

All of these assessments fall short of the optimal assessment in several ways: some because they were designed to fulfil the normative needs of practitioners of other health care professions; some because they assess the patient's functional ability without assessing the possible reasons for disability; others because they assess discrete properties of neuromuscular function rather than the overall quality of the patient's movement.

The assessments of discrete properties and of ADL do not meet the criteria, principally because they are not founded on the sequence of restoration of movement of normal quality. Consequently, they do not unequivocally demonstrate recovery from hemiplegia nor do they generate a logical plan of physiotherapy. Therefore, they cannot be said to be valid as physiotherapeutic indicators for hemiplegia. Additionally, there is no published confirmation of the reproducibility of any but the Northwick Park ADL Index and the Rivermead Assessment of ADL. Finally, although some of them are used by several professions, none of them is intended to communicate with the patient.

Those designed as assessments for physiotherapy also fail to fulfil all of the desired criteria. Possible means of incorporating them in a physiotherapeutic motor assessment of hemiplegia appear to lie in three procedural areas which will be discussed in the following sections;

- A. The selection of items of assessment and the presentation of both the procedure for use and the findings of the assessment.
- B. The arrangement of items in an ordinal scale to describe the process of recovery.
- C. The collection of data to confirm the validity of the assessment for physiotherapy and for representation of the patient's status and progress.

SUMMARY

Physiotherapists within the clinical service to patients, policy makers and planners within the Department of Health and Social Security, and teachers of students of physiotherapy are three main groups of health care professionals who are in need of a standardised physiotherapeutic assessment of hemiplegic patients.

The physiotherapists' role in setting goals with patients, planning programmes of treatment, and encouraging collaborative efforts within rehabilitation teams requires a high level of professional competence. In order to fulfil this role, they need a means of making and recording assessments which will:

- A. provide a basis for formulating aims of treatment and planning a programme of treatment;
- B. provide a means of evaluating their treatment of each individual;
- C. present the patient's status and progress unequivocally in a readily understood manner to other practitioners in the rehabilitation team and to the patient;
- D. permit collection of data for evaluative studies of the role and efficacy of physiotherapy for hemiplegia which can contribute to resolution of the debate on the value and effectiveness of physiotherapeutic methods and techniques used in the United Kingdom.

Criteria for acceptability of an assessment to perform these functions can be drawn from needs expressed by physiotherapists. These lie in two main areas:

Firstly, its clinical usefulness in terms of the ease of its administration and recording; the comprehensiveness, adequacy and appropriateness of the items of assessment; and the compatibility of the procedure with the working methods of physiotherapists.

Secondly, its scientific usefulness in terms of its objectivity, reliability and validity for assessment of hemiplegic patients.

Numerous assessments of stroke and hemiplegia have been published. Four groups have been identified which are more or less satisfactory with regard to the criteria of the optimal assessment.

- A. Physicians' indices of prognosis do not provide physiotherapists with the information they need to plan and monitor physiotherapy.
- B. Functional assessments, or assessments of activities of daily living and self-care activities, are appropriate for occupational therapy; but they do not assess neuromuscular function and they do not provide the necessary information for planning, monitoring and evaluating physiotherapy.

- C. Current assessments of discrete properties of neuromuscular function are either invalid or insufficiently comprehensive for physiotherapeutic motor assessment of hemiplegia.
- D. Current assessments designed for planning and monitoring physiotherapy for hemiplegia do not have the extended application needed for universal physiotherapeutic use: they are either descriptions for treatment by a particular method or are based on specific groups of patients in particular treatment centres. For the same reasons, and because of the paucity of data on their reliability and validity, they are not yet suitable for genuine comparative evaluations of physiotherapy.

Therefore, there appears to be a need for standardised physiotherapeutic assessment of hemiplegia of which the items, the procedure and the findings are presented in ways which are clinically and scientifically acceptable.

2.5 SELECTION AND PRESENTATION OF ITEMS OF ASSESSMENT

2.5.1 Selection and judgment of items of assessment

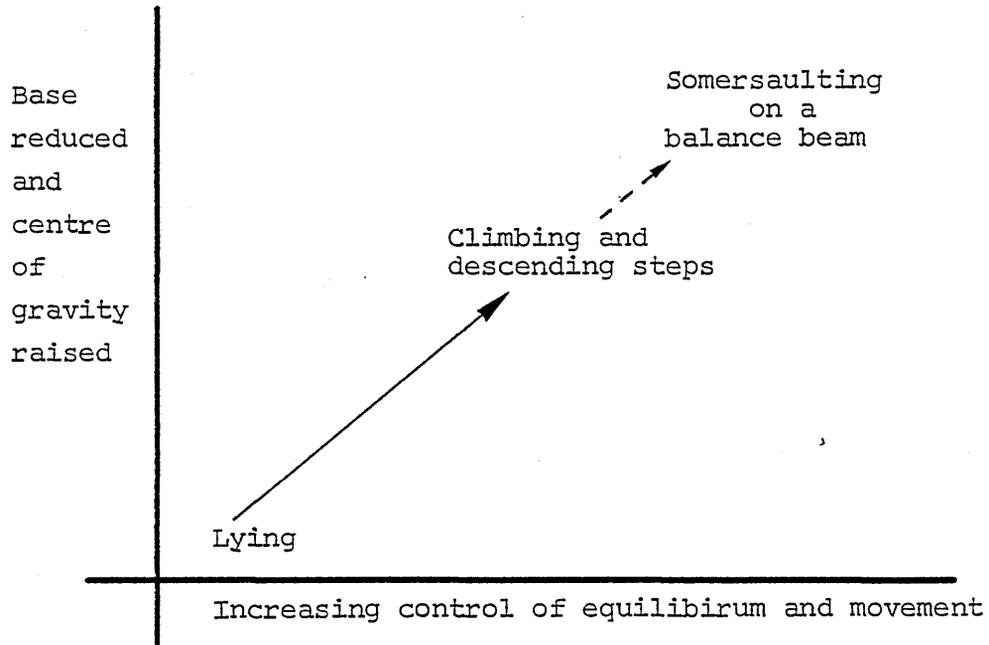
Various criteria could be used to select items for a protocol. Logically, the most valid and acceptable items might be assumed to be those which physiotherapists intuitively or empirically hold to be significant. These items might be selected for the new protocol. Similarly, items in both published and unpublished assessments of stroke and hemiplegia might be quantified by techniques of content analysis (Webb, Campbell, Schwartz and Sechrest, 1966; Holsti, 1969). However, the content of such protocols has already been criticised, and an "intuitive consensus" might not include the most important items. Some relatively uncommon items may be both more significant in the process of recovery and more valid for charting resolution of hemiplegia.

Therefore, it would seem appropriate for recovering hemiplegic patients to be instrumental in generating items of assessment themselves. As the data they provide must be collected by observing them and as the majority of recovering patients are receiving physiotherapy, three problems are created:

1. Description of a protocol which will allow data to be collected in a readily utilisable form.
2. Definition of the judgment to be made by assessors so that data are reliable.
3. Determination of the extent to which on-going treatment may invalidate such data.

FIGURE 8

DIAGRAMMATIC REPRESENTATION OF THE RELATIONSHIP BETWEEN THE POSITION OF THE BODY AND THE CONTROL OF EQUILIBRIUM AND MOVEMENT



1. Description of the protocol: The first problem may be resolved by basing the protocol on two biomechanical principles which are fundamental to physiotherapy (Atkinson, 1977):

- A. Postural control of the stability of the body becomes more complex as the base on which the body rests becomes smaller and the centre of gravity of the body is raised.

The body is most stable in lying, when the area of support is most extensive and the centre of gravity is at its lowest level. As the body becomes more erect, the base becomes smaller and the centre of gravity is raised. Consequently, finer and finer control is needed to maintain equilibrium.

- B. As the balance reactions develop in the maturing infant the upper limbs become emancipated from their function as props to support the body and to increase the size of the base. This emancipation occurs as ability to react to displacements of the centre of gravity, or of the base, or of both together, becomes more sophisticated.

Children improve their balance reactions through practice in precarious situations which endanger equilibrium, e.g. riding a bicycle, sliding on ice, running along narrow and uneven parapets. Conversely, desophistication of balance reactions occurs naturally as part of the ageing process. It becomes a necessity rather than a courtesy for older people to be offered a seat on a bus: they are less able to cope with the base moving under them and their centre of gravity wobbling rapidly in directions which cannot be anticipated. In this respect, it is not surprising that some elderly patients sit down on the floor of a ward when they are being helped to walk. Although they unbalance their assistants, they probably feel that their own balance is compromised. Like infants who are learning to walk, they regain a feeling of stability and safety by lowering their centre of gravity and enlarging their base.

Both Fugl-Meyer (1975) and Bobath (1977) have commented on the relationship between the hemiplegic patient's postural situation and his ability to perform selective muscle work. A protocol based on the above principles would bear a clear relationship to two basic observations. Firstly, the severely impaired hemiplegic patient is bedridden or confined to sitting in a chair with support to ensure that he does not overbalance. Secondly, the more recovered patient is able to walk and to carry out activities independently. The steps between these two states are not defined, but they may be identified if patients in the process of recovering are observed. Alternatively and despite the beliefs of physiotherapists, it may be shown that there is no orderly sequence to restoration of patterns of movement and functional abilities, and that recovery and progress cannot be represented by a scale of such items.

2. The judgment made by assessors: One advantage of the proposed type of protocol is that assessors would not be required to grade the patient's performance of each item: only to judge whether or not the patient is able to perform each item.

Holsti (1969) has advised that requiring judges to discriminate between subcategories often results in a high level of disagreement. Evidence for this is provided by the possible ambiguities in assessments which grade performances as "totally dependent", "partially dependent" and "totally independent" (cf., e.g. Benjamin, 1976). For example, a person who walks with a stick might be graded "totally independent" because he is independent of the assistance of another person or "partially dependent" because he uses a stick. One solution lies in the

careful and lengthy description of each grade. Alternatively, classification of performances using "pass" and "fail" categories should guard against such disagreements.

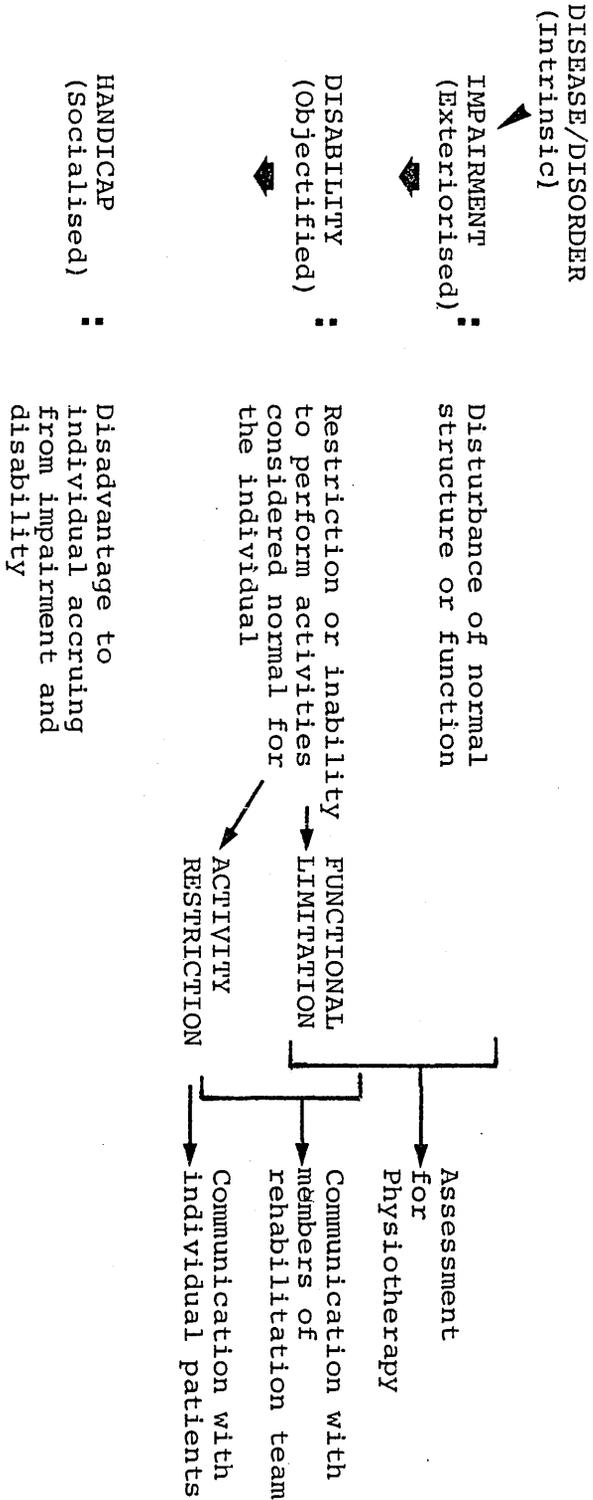
In practice, this dichotomy into "pass" and "fail" categories requires description of the "pass" performance only; performances which do not qualify are automatically classed as "fail" performances. The description of the "pass" category could be based on the clinical definition of an acceptable performance. More specifically, a "pass" would be recorded when the patient is judged to require no further treatment to improve his performance of a particular item.

This procedure also offers a way of generating a logical plan of treatment: an item which is failed would indicate where further treatment might be aimed. It might also show that different grades of performance are not subcategories of the same item: they may be independent items with their own location along the scale of recovery.

3. The extent to which treatment may invalidate data: It would not be ethical to withdraw treatment from hemiplegic patients for the purposes of this project. Consequently, the validity of identifying a sequence of motor recovery using data provided by patients who are receiving treatment might be questioned. Several factors need to be considered: Firstly, there is no confirmatory evidence that physiotherapy affects the natural process of recovery. Secondly, if physiotherapy does enhance recovery, all patients who provide data will be receiving physiotherapy. Thirdly, there is no evidence that one approach

or method of physiotherapy is more efficacious than another. Fourthly, the effects of independent variables on a patient's potential for recovery have not been ascertained. It might also be argued that, in case of differential effects in treatment, controls are needed for all variables which can be reasonably matched. However, while age, sex and side of CVA might be controlled, other important variables which directly affect the patient's potential to benefit from treatment cannot be controlled. The influences of variables such as the patient's motivation and the nature and extent of sensory disturbances are difficult to evaluate currently. The argument is necessarily circular: a standardised, valid, reliable assessment is needed in order to gather data, and valid and reliable data are needed for the development of such an assessment. It appears as if research should proceed in stages, with development of the assessment preceding the investigation of the research phenomena. In reality, research is an oscillating process, and an imperfect assessment may have to be used to collect data which can be the means of its own improvement (Phillips, 1976).

FIGURE 9
THE WHO'S DEFINITIONS OF IMPAIRMENT, DISABILITY AND HANDICAP RELATED TO
PHYSIOTHERAPEUTIC ASSESSMENT OF HEMIPLEGIA



2.5.2 Description of the procedure and findings of the assessment

In order to fulfil the criteria drawn up according to the needs of physiotherapists, two factors need to be accommodated in the description of the procedure for use of the assessment and in the presentation of the findings:

1. A valid vocabulary is needed which relates the pathological patterns of movement, which physiotherapists will treat, and the patient's functional activities, on which the rehabilitation team will base decisions about his future care.
2. Discrimination is required between the patient's ability in the more or less ideal conditions of the assessment room and his typical performance in his living environment.
3. The record of the findings should recognise that patients and practitioners of different professions have varying aims and expectations.

1. A valid vocabulary: The Classification of Impairments, Disabilities and Handicaps published by the World Health Organisation (1980) offers standardised definitions which can be used to describe the role of physiotherapy in rehabilitation (Figure 9).

For each patient, the rehabilitation team has the general aim of returning him home from hospital by enabling him both to take care of himself and to undertake other activities commensurate with his life-style. This aim is equatable with reduction of disability. Within the WHO definition of disability two separate dimensions have been identified, called "functional limitation" and "activity restriction" (Wood and Badley, 1978). For example, the rehabilitation team would need to know if the patient is capable of getting out of bed. Restriction of such

activity is a starting point for the generation of a logical plan of physiotherapy. The next step, in the case of getting out of bed, is to identify whether the limitation of function is inability to move from lying in bed to sitting on the side of the bed, or inability to stand up or to transfer to a chair, or both. The crucial assessment for physiotherapy is not assessment of the disability itself, but assessment of the impairment: i.e. those abnormalities of neuromuscular function which need to be treated in order to resolve the limitation of function.

An assessment based on the WHO's definitions could be recorded on a chart which would accommodate, under resolution of impairment, the physiotherapists' need for a description of the quality of their patient's movements. It should also demonstrate the link between improvement in quality of movement and increase in functional ability by recording them in parallel. This assessment could be interpreted for the patient and for members of the rehabilitation team as activities which he is capable of performing.

The third dimension of the WHO's classification, that of handicap, would be difficult to accommodate in such an assessment. Handicap has generally been assessed and described in terms of the individual's performance of activities of a personal and domestic nature, and of other practical activities such as being employed in a wage-earning capacity (Sainsbury, 1973). Using the WHO's definition, handicap is always of a precise individual nature because normality is descriptive of the state of each person. Some disabled people do not perceive themselves to be handicapped; a state in which one person is

able to perform to the extent of his normal limits may impose a handicap on another person. This disadvantage may extend beyond the individual and affect the life of the family. Such a definition of handicap incorporates social and psychological experiences of disability. Although this will influence therapists' approaches to individuals, it is not within the scope of a motor assessment of hemiplegia to measure and record it.

2. Discrimination between ability and typical performance: When Kelman and Willner (1962) discussed the validity and reliability of assessments they focussed on discrepancies between judgements of performances in "test" and "non-test" situations, such as the assessment room and the patient's living environment. Jeffreys, Millard, Hyman and Warren (1969), whose assessment for a prevalence study was standardised and reproducible, found that stability was unsatisfactory because disabled people perform differently at different times and in different situations. "Normal" as well as disabled people also experience variations in the quality of their performances.

Kelman and Willner's concern was to differentiate deductions of capacities for performance made at assessments from actual performance in other situations in which the hemiplegic person must integrate physical, social and psychological demands of the environment. This describes a valid difference between assessment of limitation of function and assessment of restriction of activity proposed for the optimal assessment.

Firstly, the optimal assessment would describe the patient's ability, or what he could perform in a controlled environment such as the physiotherapy department, and the quality of that performance.

Secondly, it would include an assessment of his capability to perform various associated activities by investigating his typical performance in the ward or at home.

3. Perceptions of progress acquired by practitioners and patients: Kelman and Willner also described discrepant observations of the same individuals by different observers: assessors of different health care professions use different criteria of assessment. From his study of practitioners' perceptions of progress in rehabilitation, Tamerin (1964) concluded that perception of change in the patient is related to a practitioner's role in treatment and assessment. These results show that practitioners of different professions have different aims and expectations: therefore, records of all assessments should allow users with different aims easy access to the information they need.

Evans (1981) has written that information about the pattern of recovery from stroke might be used to form more constructive rehabilitation programmes with full collaboration between disciplines. He also says that it is very damaging to rehabilitation if treatment rationales are not made clear both to other practitioners and to the patient and his relatives. Belcher, Clowers and Cabanayan (1978) suggest that practitioners perceive the needs of stroke patients and translate them into normative descriptions according to their personal skills and their ability to apply them. They also

recommend the patient as the expert in the "rehabilitation needs" of his own life. Successful rehabilitation is said to depend on the patient's active cooperation and participation in treatment, and on his recruitment as a collaborator (Nichols, 1971). Stroke patients may not be able to respond to treatment effectively, because of their reactions to the sudden and drastic deterioration of the body. Enhancement of a patient's motivation to participate in his own treatment is an essential aspect of the therapeutic relationship. To achieve this, successful communication needs consideration of alternative ways of presenting information to patients to allow them access to the information they need and want.

2.5.3 Communication and assessment

The task of describing an assessment involves two main areas:

- A. Design of the instructions for carrying out the assessment and recording the findings.
- B. Design of the record to facilitate both the recording of findings and retrieval and feedback of information.

Communication is the function which is basic to both areas. Several descriptions of communication have been used. In the literature of social psychology, communication is said to involve the totality of a person's behavioural and verbal responses (Argyle, 1972; Gahagan, 1975). Mackay (1972) has argued that communication has occurred only when information has been transferred from one person to another. Fox's description of communication in relation to a teacher of physical education teaching pupils "how to do something" (Fox, 1980) probably comes nearest to describing the skills which physiotherapists use to teach hemiplegic patients how to move and to inform them and other practitioners about their progress in treatment. These skills include learned social techniques to influence others. Skills of communication must also be used by the originator of an assessment to instruct assessors how they should use it. However many skills and processes are involved in any interaction, authors as diverse as graphic designers (Garland, 1966), psychologists (Hartley, 1980) and ergonomists (Wright and Barnard, 1975) subscribe to the view that the function of communication is to convey correct meaning.

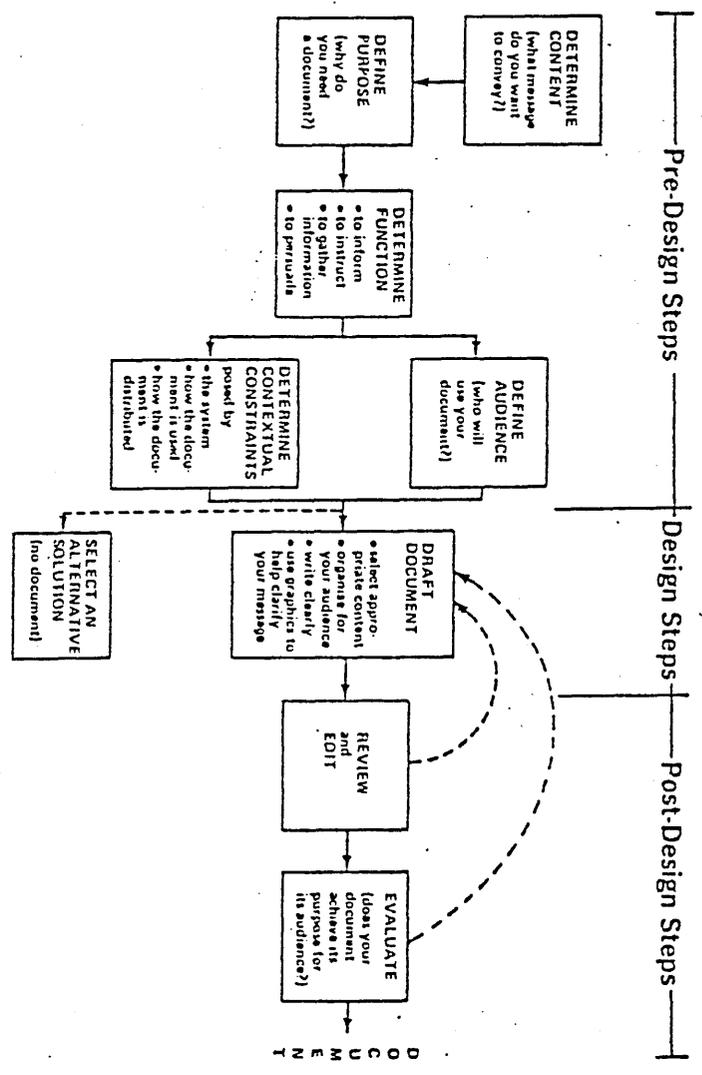
Every perceptive individual is aware how difficult it can be to

convey correct meaning. Sometimes readers or listeners have difficulty in grasping what writers or speakers intend to convey. At other times they think they have understood the intended meaning but find it difficult to apply whatever is in hand. In either case, communication is unsuccessful although information has been transferred. A writer or speaker may consider the fault to lie with the recipient, but he must still express himself more clearly and more comprehensibly for the communication to become successful. Therefore, the basic function of instructions and records as a means of communication must be to convey correct meaning to assessors and to users of the record.

Within the literature about assessments, it seems to be assumed that unsuccessful communication of instructions is revealed by tests of inter-observer reliability. More specifically, if the findings of an assessment are not reproducible then the items of assessment need to be re-written: otherwise they are satisfactory. Scant attention appears to have been given to the importance of writing clear and concise descriptions of each item and the procedure required. Simon and Hayes (1976) have written that understanding and complying with instructions are amongst the most difficult tasks of comprehension encountered in everyday life; and there is no reason to assume that health care practitioners find them easier than do other people.

One difficulty which confronts anyone who wants to use research about presentation of information is that many of the findings on graphic communication are

FIGURE 10
 A MODEL OF THE PROCESS OF DESIGN OF INSTRUCTIONS AND PERFORMAE FOR RECORDS



Source: D B FELKER (1980) Instructions Research, in, Document Design: a review of relevant research. Washington, D C: American Institute for Research, Documents Design Project.

"ad hoc, in the sense that they do not build into any single theoretical framework."

(Wright, 1981)

Fowler (1926), Partridge (1957) and Gowers (1977) have given prescriptions for writing well, but there is very little information of practical significance about the design of instructional manuals and records. Wright (1981) has specified the ingredients of adequate instructions on the basis of the problems consumers have with instructions accompanying various products and domestic appliances. In particular, they should be accurate, understandable and clearly structured. She adds that the major problem is knowing how to meet the specifications.

Adequate content, presentation and structure are also basic to the good record of an assessment, although the detailed issues may differ. For example, the first issue concerns the intended recipients (Hartley, 1980). Whereas the instructions accompanying a physiotherapeutic assessment will be written for the physiotherapist-assessor, the record will need to present some of the findings to the patient and to other practitioners.

The model of the process of design of instructions proposed by Felker (1980) is reproduced in Figure 10. The development of a clinical assessment requires several circuits of this model in the form of field tests of evolving versions of the assessment in order to explore the users' need for information and to achieve adequate presentation of that information.

2.5.4 Presentation of information

There are few absolute rules for the presentation of instructions; but there are ideas for making them clear, comprehensible and understandable and for presenting both instructions and findings effectively and simply (Neurath, 1974; Hartley and Burnhill, 1977; Wright, 1981).

All information must be changed into a form suitable for transmission. Waller (1979) presented textual transformation in terms of three functions:

- A. The "enabling function" which provides a clear channel of information.
- B. The "aesthetic function" which provides an attractive reading environment.
- C. The "access function" which identifies and structures particular aspects of the text.

Basically, it is a question of how users with different aims can be enabled to gain access to the information they want. There is no simple answer to this question; but, in addition to exploration of the users' need for information, characteristics of the assessors and other users must be identified.

Use of technical language: Loftus, Freedman and Loftus (1970) have shown that people find it easier to read and to remember familiar words. One difficulty with such words is that they may not have universally consistent meaning. Although it might be assumed that health care practitioners share a common "medical language", each profession uses language in a way which may appear idiosyncratic to another profession. For example, the

language of physiotherapy includes such terms as "diagonal patterns" and "quality of movement" which are used in conventional senses known only to those whom Gowers (1977) called "parties to the convention". The terms are unambiguous shorthand for physiotherapists, but they may be unintelligible to outsiders to whom they have not been explained.

There is no objection to the use of technical words and phrases among physiotherapists. Physiotherapeutic language is appropriate to the instructional manual accompanying a physiotherapeutic assessment: physiotherapists must eventually learn and remember the items and the procedure, and familiar words and terms will make learning and remembering easier (Charrow and Redish, 1980). However, if the record is expected to convey information to a variety of people, it should be readily understandable by all of them.

Presentation of instructional information: To facilitate learning of an assessment, a basic pattern is needed which imposes uniformity on all of the items but avoids omissions and caters for physiotherapists of different levels of skill and experience. The task is similar to that which faces a computer programmer: to relate the information required by the user to her behaviour (Green, Sime and Fitter, 1980; Stewart, 1980). Information which might introduce constraints is withheld, and users are enabled to apply their own experience to enter a program and to use their skills. The instructional manual for a physiotherapeutic assessment must allow the physiotherapist to use the items of assessment and record her findings sensibly.

The work of Marcel and Barnard (1979) suggests that the format of instructions for use of domestic appliances may influence users' compliance with them. They found that when people read instructions they may attend to every element and understand them. When they apply them, their reading pattern changes: they may ignore some of the elements and misuse the appliance. Clark and Clark (1968) showed that comprehension is aided when the order of instructional elements matches the temporal order in which they are carried out. In particular, Dixon (1981) suggest that instructions are easier to understand if the description of what to do precedes the statement about when to do it. These findings raise two implications for an assessment which is described according to the assessors' sequence of tasks:

- A. The order of items of assessment: There is a conflict between convenience for the patient and convenience for the physiotherapist in the order in which items are assessed. It would be convenient for the physiotherapist to use the order in which items appear on the record. In order to assist her, the patient might be required to change position frequently, between lying and sitting or sitting and standing. This would be tiring for him, and physiotherapists usually test all appropriate items in a position before changing it. Thus, the conflict of convenience is resolved in favour of the patient; and it should be reflected by the order in which items are presented in the instructional manual.

- B. The order of elements of each item: The assessors' task can be facilitated by the order of presentation of the elements, i.e. the movement to be assessed; the description of the required performance; its location on the record. Therefore, assessors should be observed and questioned about the direction of their attention at particular times so that the sequence of

tasks can be identified. The layout of items in the manual can be based on these observations.

Graphic codes for recording and displaying information: The record of an assessment may be referred to by a wide variety of practitioners and it may be shown to the patient. All of these people may want different information from it, but their common need is to retrieve accurate and unequivocal information swiftly and easily. At a superficial level, the record should have visual impact: the patient's relative stage of recovery and his progress between assessments should be immediately apparent. Additionally, each item should be displayed in a way that makes more detailed information readily accessible to those who need it.

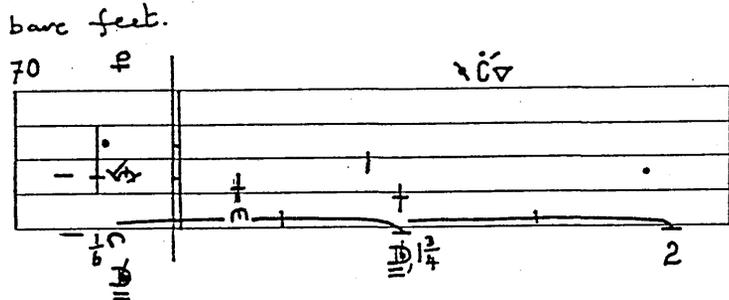
Text and graphic codes, such as pictographs and signs, may be juxtaposed on a display to help different users. Selection of alternative ways of communicating a particular item of information may be based on consideration of the cognitive processing required to comprehend them (Wright, 1981) and the space available (Garland, 1966). Several studies have been concerned with pictorial or diagrammatic representation of short instructional sequences (Szlichcinski, 1979a, b) or safety signs (Easterby and Hakiel, 1981); but none has investigated the clinical use of graphic signs.

Invented alphabets, such as Morse Code, and "sign systems", such as those used to direct traffic, have been called "codes for conveying meaning" (Garland, 1966). An invented alphabet can convey as wide arrange of meaning as languages with a traditional

FIGURE 11

AN EXAMPLE OF HEMIPLEGIC GAIT WRITTEN IN BENESH MOVEMENT NOTATION

Right hemiplegic gait



c Benesh Movement Notation

Transcript:

STARTING POSTURE (before bar):

Right hip slightly flexed and right shoulder retracted; these two factors are retained throughout the gait.

Right upper limb: elbow flexed; wrist flexed and radially deviated; fingers clenched; hand touching front of body.

Right lower limb: internally rotated; slight plantarflexion; heel just off ground.

Left upper limb: hanging by side.

Left lower limb: in normal position.

Weightbearing: through both feet; feet slightly apart.

GAIT:

Speed: 70 steps per minute in bare feet; right a quarter short of left.

Right lower limb, swing phase: foot clears ground with ankle plantarflexed; toes stroke ground first.

Right lower limb, stance phase: Heel moves towards ground but does not bear weight; knee flexed until one third of the way through swing of left lower limb, jerks into extension.

Upper limbs: left upper limb swings in normal reciprocal pattern; right upper limb held in starting position

Left lower limb: normal swing and stance phases.

By courtesy of
J McGuiness-Scott

alphabet, and a sign system serves a particular purpose in circumstances which rule out the use of alphabets. In each case, conveyance of correct meaning cannot be guaranteed.

Chinese ideograms and musical notation are sign systems which may be considered more successful than alphabets because they can be read and comprehended by people who cannot understand each other's spoken language. Benesh Movement Notation (McGuinness-Scott, 1981/82) is a clinical example of a sign system which transcends spoken language. It is adapted from Benesh Notation used to record the choreography of ballet (Benesh and Benesh, 1977); and it can be used to record gait and other patterns of movement of neurologically impaired patients. A stave recording a typical hemiplegic gait is reproduced in Figure 11. The "key" is too lengthy for reproduction here; but it is available in articles published in the journal "Physiotherapy" (McGuinness-Scott, 1981/82). The author has provided a transcription below the stave which is comparatively lengthy, and she has commented:

"... the written word cannot describe adequately the movement patterns written in Benesh Notation."

(McGuinness-Scott, personal letter)

Unfortunately, Benesh Movement Notation has limited application because it requires a great deal of learning. Few physiotherapists, and even fewer members of other health care professions, are trained to use it; and it does not offer a means of interdisciplinary communication at present.

Precise definition has also been achieved by simpler graphic codes. At the simplest level, directional arrows are very effective. Simple descriptive signs are also used by lay people

FIGURE 12
 THE RECORD CARD OF THE RIDING FOR THE DISABLED SCHEME

Name.....		Riding for the Disabled RECORD CARD	
Age.....		starting riding.....	
△	stiff	↷	curvature
○	deformed	*	painful
≡	spastic	⋯	poor sensation
∕	flaccid	∪	appliance
□	normal	?	mental handicap
Points to work on			
RIDING FOR THE DISABLED - Claire Austin			

and practitioners involved in the Riding for the Disabled scheme which gives disabled children the experience of horse riding for recreational-cum-therapeutic purposes (Figure 12). At a more complex level, a standardised, international sign system for assessment and recording of common problems of vertebral joints is already used by physiotherapists (Maitland, 1979; Grieve, 1981).

Effectiveness of different types of signs: There are few published evaluations of the effectiveness of different types of signs.

In order to determine the influence of different elements of a sign, Easterby and Hakiel (1977) proposed a vocabulary to describe them. For example, they used "image" to describe the element which specifies the message carried by a particular sign. They found that comprehension is primarily influenced by the form of the image, independent of its colour or the colour of the background. They could not determine the influence of the shape of the enclosure, whether square, circular or rectangular. They also investigated descriptive signs, signs which specify a course of action and signs which are prohibitive. While there is a tendency for descriptive signs to be understood best, as long as the sign is visually clear, comprehension depends primarily on the image itself (Easterby and Hakiel, 1981).

Taylor (1971) described three types of images which he called "symbols". They are explained by reference to the record card of the Riding for the Disabled assessment (Figure 12):

- A. An "image-related" symbol is a pictograph which is related to the subject in a particular context, i.e. the manikin.
- B. A "concept-related" symbol retains characteristics of the subject, e.g. the curved arrow to indicate curvature.
- C. An "arbitrary" symbol has no visual reference, e.g. the circle to indicate deformity and the square to indicate normality.

Following Easterby and Hakiel's conventions, signs developed for an assessment of hemiplegia will be primarily descriptive. Each sign will describe either an ability, if a "pass" is recorded, or an inability. The whole system of signs will describe the patient's status at any given time. A sign might also specify the physiotherapist's and the patient's performance. For example, a sign might describe balance in sitting position. When the physiotherapist has learned the assessment, it might also prescribe the test of balance written in the instructional manual. Other signs might specify or prohibit the use of a walking aid.

Comprehension of signs: Wright (1970) and Easterby and Hakiel (1981) have also shown that an individual's experience and familiarity with specific signs, or with similar signs, influences the likelihood of correct comprehension.

Physiotherapists are likely to be more familiar with the movement specified by an image than are other practitioners who refer to the record. They would also gain more experience with the signs because they would use them to administer the assessment and to record their findings, as well as to retrieve information. If other practitioners find the signs of a

physiotherapeutic assessment less easy to understand and comprehend than physiotherapists do, the signs may be even less meaningful to elderly hemiplegic patients. The patients may need written descriptions rather than signs, because retired people have less experience with signs than younger members of the population and find them less comprehensible (Easterby and Hakiel, 1981).

Potential use of signs on the display of the optimal assessment:

A sign system provides a means of conveying a large amount of information in a small space, such as an assessment chart printed on a single sheet. The chart needs to accommodate the occasional user, who might refer to it for information "at-a-glance", as well as the assessor who uses it regularly. The studies reported here suggest that correct meaning may be conveyed to different users in different graphic forms:

Firstly, signs may be meaningless if the user has little experience with them.

Secondly, the clear image-related descriptive sign is more immediately comprehensible and effective.

Thirdly, the concept-related sign requires the user to have attained the concept already; or the originator must incorporate a key or instruct users formally or informally in order for the sign to convey correct meaning (Easterby and Hakiel, 1981)

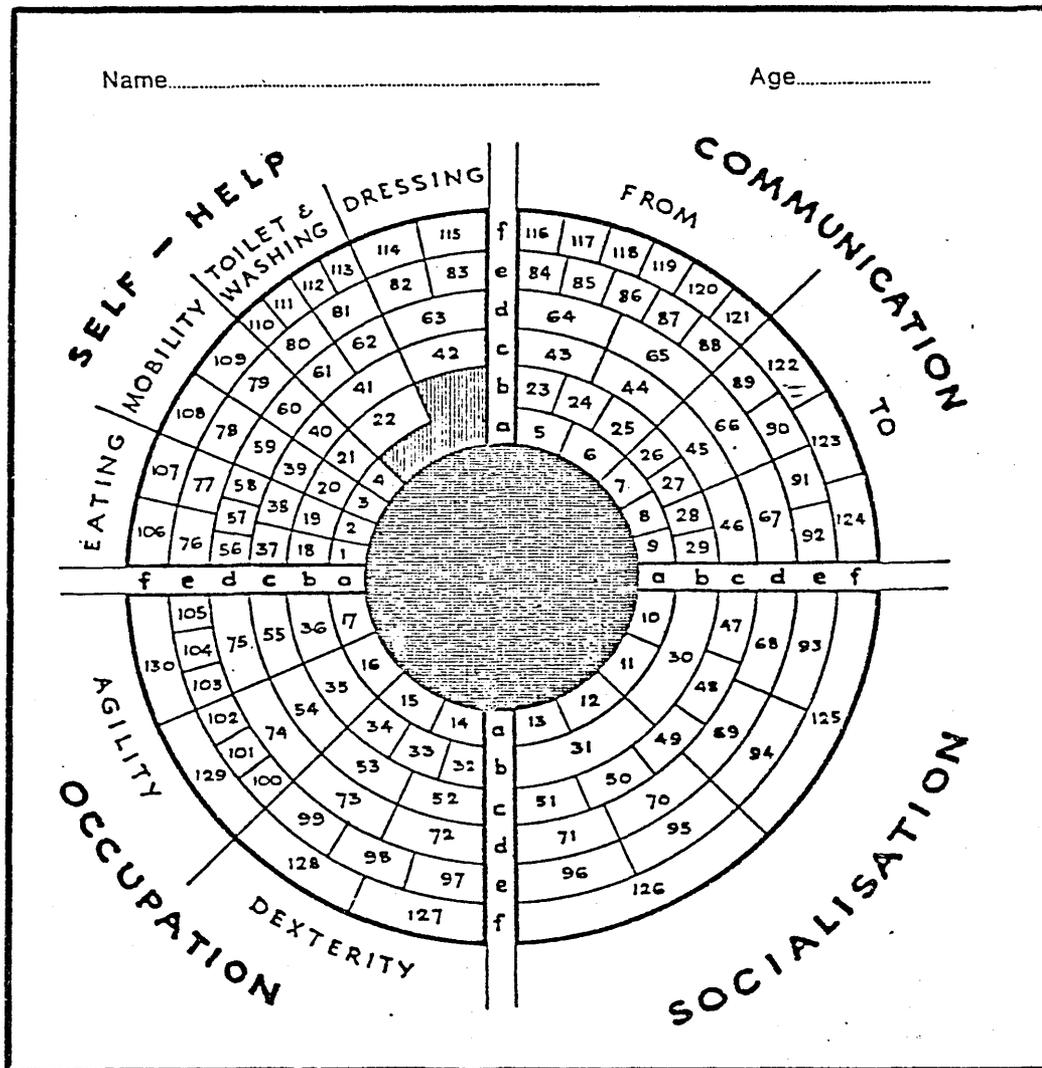
Fourthly, the lack of visual reference makes the arbitrary sign more difficult to learn and to remember: but once it is understood it is very effective.

The display should be designed to accommodate the needs of all potential users taking account of the above factors:

- A. The information which is used by elderly patients may need to be presented as written statements, e.g. items recording activities such as walking from place to place.

FIGURE 13

THE DISPLAY OF THE PRIMARY PROGRESS EVALUATION INDEX



Example from protocol:

Agility (Gross Motor Control)

16.	Tries to reach objects with hands but overshoots	....	....	....	....	a
17.	Manipulates objects	....	....	....	....	a
35.	Reaches for objects by leaning forward	....	....	....	....	b
36.	Throws objects to floor	....	....	....	....	b
54.	Looks for fallen objects by bending over	....	....	....	....	c
55.	Aligns two or more cubes or bricks	....	....	....	....	c
74.	Can kick ball without falling	....	....	....	....	d
75.	Throws ball intentionally without falling	....	....	....	....	d
100.	Picks up objects without falling	....	....	....	....	e
101.	Can jump with both feet	....	....	....	....	e
102.	Opens doors	....	....	....	....	e
103.	Climbs on chair and can stand on it	....	....	....	....	e
104.	Seats himself at table	....	....	....	....	e
105.	Takes lid off and puts it back on a box	....	....	....	....	e
129.	Jumps with both feet off bottom step without requiring support	....	....	....	....	f
130.	Stands on one foot for short periods	....	....	....	....	f

c 1969 H C GUNZBURG

- B. Information which is used by all members of the rehabilitation team may be presented as a system of clear image-related signs, e.g. items recording functional abilities such as transferring from the side of the bed to a chair.
- C. Information which cannot be represented by a clear image, and which may have a uniquely physiotherapeutic function, can be represented by arbitrary signs, e.g. "quality of movement" items which record resolution of impairment.

The overall shape of the display enclosing the signs and the text: Whatever graphic code is used and however valid the sequence of items for recording recovery, successful communication of the patient's status and progress will be affected by the pattern which is created as successive assessments are recorded.

Intuitively, patterns which develop outwards and upwards are interpreted as growth and progress and patterns which collapse inwards and downwards as decay or regression. The creation of a pattern which develops upwards and outwards on the display of an assessment might provide the same immediate insight into a patient's progress and current status. Closer inspection of individual items of the pattern can also be allowed.

Easterby and Hakiel (1981) were unable to tell if comprehension was affected by a square, circular or triangular "image enclosure". Any influence which these shapes have may also be pertinent to the enclosure of data on a display; but there is no information about preferences for rectilinear or curvilinear designs. The target-like display of the Primary Progress Evaluation Index (Gunzburg, 1969) provides an attractive record of a handicapped child's achievements (Figure 13). The pattern

of progress in each sector is meaningful to the child's parents and to practitioners of all disciplines. Closer inspection of sectors and items is also allowed. A similar design for a physiotherapeutic assessment of hemiplegia might possess the desirable qualities for easy accessibility for all users. Immediately prior to the inception of this project, a draft based on this design was proposed to the Motor Club of the Ridgway Group of ergonomists, neurophysiologists and health care professionals interested in hemiplegia (Mitchell, 1978; confidential document to Ridgway Group).

SUMMARY

Published assessments have not been found to fulfil the criteria for an optimal physiotherapeutic assessment, and a new approach to selection, description, and judgment of items of assessment is required. It seems appropriate for hemiplegic patients to generate the items themselves. The items can be described on the basis of increasingly sophisticated control of movement and balance; and, to avoid discrepancies in "grey areas" of judgment, assessors can make a categorical judgment to record whether or not a patient is able to perform each item.

The international classification of impairments, disabilities and handicaps (WHO, 1980) provides a framework for describing the optimal assessment, and for distinguishing between the objectives of physiotherapy for hemiplegia and those of rehabilitation of stroke. A physiotherapeutic assessment which is intended to communicate each patient's status to other practitioners in the rehabilitation team must also acknowledge: (A) that the patient's typical performance in his living environment, in the ward or at home, may not be equal to the ability he demonstrates in the assessment room; and (B) that practitioners of different professions may perceive progress in different ways and may need access to different kinds of information from the record.

The first need is for a clear channel of information. Findings of research on communication suggest that physiotherapists, other members of rehabilitation teams and patients may need information to be presented to them in different graphic forms. For example, the technical language of physiotherapy can be used for instructional information for assessors, because they will find it easier to learn and to remember. Additionally, to facilitate administration of the assessment, the order in which each element of the procedure is presented should follow the temporal order of tasks undertaken by assessors.

A graphic code of descriptive signs can be used to confine a large volume of information to a small space such as a record on a single sheet; but the selection of graphic forms should take account of the varying characteristics of potential users which may affect their comprehension. Their use of available information is also likely to be influenced by the attractiveness of the record. A circular target-like shape is a possible design which might possess desirable qualities by providing a clear channel of information in an attractive way.

A "sign system" developed for the record or display of an assessment might also be an attractive way of overcoming idiosyncracies of professional language. It may also be the means of teaching practitioners how to observe hemiplegic patients and their progress in a particular way. By its means, both the communication of rationales of treatment and the setting of realistic levels of expectation might be materially affected. More specifically, if a consistent sequence of resolution of motor dysfunction could be represented by a sign system, it might avoid the problem of teaching to, or requesting

of, a patient an activity or movement which is too sophisticated for him to perform at that time. Not only would practitioners' expectations of the patient be influenced, but doctors' and nurses' expectations of what the physiotherapist might achieve with a patient at any given time would also be affected.

2.6 MEASUREMENT AND SCALING

2.6.1 Reliability and validity

Two mutually dependent qualities of an assessment which have been referred to earlier in discussion constantly recur in literature about research methodology (Duverger, 1964; Holsti, 1969; Cronbach, 1970; Miller, 1975; Phillips, 1976; Mayntz, Holm and Hoebner, 1976):

Reliability, or the extent to which the assessment can be depended on to provide consistent and accurate information.

Validity, or the appropriateness of the assessment for its intended purpose.

These attributes have been confirmed for very few of the published assessments of hemiplegia and stroke. Confirmation of them for the optimal assessment will demonstrate that it can be depended on to provide information which will contribute to the growth of understanding about resolution of hemiplegia and physiotherapy to effect it.

Reliability: The items of assessment are reliable to the extent that they are reproducible and stable:

- A. The same procedure used by different assessors at the same time should yield the same findings from each assessor (reproducibility or inter-observer reliability).
- B. The same procedure used on successive occasions by the same assessors should yield the same findings on each occasion (stability or test-retest reliability).

It is not possible to repeat results if the subject of the assessment is progressing or regressing. Consequently, a test of the stability of an assessment of hemiplegia requires the patient's condition to be completely static. The test may be made with patients who are considered to have reached the limit

of their potential for recovery but not with patients who are still receiving treatment.

Validity: Fundamentally, the validity of an assessment concerns its cogency: users must be convinced of its usefulness. This will involve judgement of the extent to which the assessment corresponds with their notions of a comprehensive and appropriate assessment. Currently, it is not possible to measure with total accuracy the extent of such a correspondence. Consequently, "validation by experts" or face judgement is not considered to provide convincing evidence of validity for any scientific evaluation in association with tests of reliability (Mayntz et al, 1976).

The users' judgement can be supported by evidence of the usefulness of the assessment. For example, an assessment of hemiplegia which was shown to be valid for prediction of behaviour would fulfil needs of physiotherapists, other members of rehabilitation teams, planners and policy makers:

Firstly, if the items were ordered in a sequence from "least recovered" to "most recovered", then, from knowledge of the highest ranked item the patient had passed, it would be possible to predict his performance of other items. That is, he would be able to pass lower ranked items but would fail higher ranked items. The scale of items would discriminate between patients at different levels of recovery and describe the progress between assessments made by each patient.

Secondly, a more far-reaching predictive function would allow practitioners to predict the extent of the patient's recovery from the results of assessments made in the early weeks of treatment. Valid and cogent predictors of potential for recovery would contribute to more efficient use of physiotherapists' skills and would allow rehabilitation teams to plan for patients' discharge.

This "predictive validity" would also provide evidence that the order of the items makes good theoretical sense. More

specifically, if the order or scale of items is valid for describing recovery from hemiplegia, it will represent the sequence of restoration of normal movement truthfully. Conversely, if the scale of items is invalid, it will not discriminate between individuals at different stages of recovery, it will not demonstrate a patient's progress faithfully and it will not be able to predict his abilities.

Predictive validity is particularly difficult to establish unless mathematics can be applied to the data (Madge, 1953). This emphasises one of the problems confronting the developer of a "recovery scale". The physical scientist deals in quantitative data and has precise measurements which improve predictive ability. Assessment of hemiplegia deals with the results of pathological changes plus the process of ageing and other factors which do not have numerical properties - yet the advantages of mathematics need to be utilised to create scales and to conduct formal tests of validity.

2.6.2 Scales of measurement and the ordering of items of assessment

At present, there is no standard against which a patient's recovery from hemiplegia can be judged. The measures which are used are largely qualitative and understood by rehabilitation teams in particular locations or by members of particular professions; and they lack universality. Numerous attempts to create quantitative scales have resulted in unsatisfactory measures because they have taken an invalid step by trying to treat qualitative data as quantitative data.

Data may be described using one or other of four scales of measurement (Senders, 1958):

The nominal scale differentiates between categories (B is different from A).

The ordinal scale differentiates and compares so that classes can be ordered by rank (B is greater than A).

The interval scale differentiates and makes quantified comparisons (B is n units greater than A).

The ratio scale makes comparisons by direct proportion because absolute zero exists (B is n times greater than A).

Interval and ratio scales are distinguished by their use of standard units of measurement. Quantities of such variables as length, time and mass can be measured accurately and manipulated arithmetically. Data which are describable on qualitative continua (e.g. short/long) may be ordered (e.g. short/medium/long); but, taking a mathematically strict approach, they are excluded from certain arithmetical and statistical manipulations which are valid for quantitative data.

It may be possible to raise qualitative data to the level of standardised measurement in the gradual way in which measures of length were made more reliable. For example, the yardstick was more accurate and reliable than the personally variable distance from the nose to the end of the middle finger. Over the centuries, scientists have developed standard units of time and mass as well as length. However, although science has natural units of length and time as standards, a standard of mass cannot yet be defined with sufficient precision in terms of atomic quantities. Therefore, scientists maintain an operational approach and use the standard kilogram.

Recovery from hemiplegia must also be defined operationally, but there are greater barriers to the achievement of this definition: there is no "standard hemiplegic patient"; each unit in the sequence of recovery does not have a measurable length; and the process of recovery does not have a repeating, regular and countable pattern.

It is suggested here that the process of restitution of normal movement in hemiplegia conforms to an ordinal scale with irregular distances between each step. The order might be demonstrated through subjecting observations of recovering patients to a scaling technique which would be a way of creating a yardstick for measuring recovery.

Summating Rating Scales: One approach to creation of such a scale - that of assessment of ADL - has already been introduced in section 2.4.4 above. The properties of number are imparted

to criteria of assessment so that the patient's status and abilities can be summarised with an absolute number which can be manipulated arithmetically and used as a basis for inference.

Summated rating scales have been widely used in sociological surveys to score people's attitudes towards a variety of statements. They have been used to probe the goals and beliefs of individuals and the values and norms of groups. The Likert scale (Likert, 1932) is the most elaborate, and the scales used in assessments of stroke and hemiplegia are simpler versions. Two illustrations are taken from the literature:

- A. Fugl-Meyer et al (1975) describe thirty movements of the upper limb and fourteen movements of the lower limb which are scored:

- 0: not performed
- 1: partly performed
- 2: completely performed

Together with speed and balance tests, fifty items are assessed and a summated score of 100 is possible.

- B. Benjamin (1976) scores seventeen activities of daily living:

- 1: totally independent
- 2: partially independent
- 3: totally dependent

The best possible score is 17 and the highest score, 51, indicates "total or gross disability".

These scales, and the four point scale proposed by Ashburn (1982) demonstrate a pragmatic approach to scaling rather than one which obeys the rules of mathematics. It is not

appropriate to sum the patient's "score" for each item since:
(A) the numbers used to symbolise the grades are as qualitative as the level of performance they represent; and (B) neither the scales of grades nor the scales of items have the properties of an interval scale, i.e.,

"Equidistant intervals with uniform change from one scale point to the next."

(Senders, 1958)

The precision and treatment of interval scales is attractive to scale developers, and summated rating scales are relatively easy to devise. However, developers of assessments of stroke and hemiplegia should consider the validity of a quantitative scale for their underlying variable which does not have the inherent mensurable properties of variables such as length. Objectivity will have been sacrificed if it is not apparent to what extent the data collected on the scale are a function of recovery from hemiplegia or stroke. It was said previously that an absolute number does not describe the patient adequately. Additionally, a summated rating scale is not able to discriminate between individuals at different levels of recovery: individuals with the same totals may not have achieved the same level of performance on every item; and all items are weighted equally. In order to describe recovery and progress items need to be arranged along a continuum from "least recovered" to "most recovered".

Ordinal scaling in clinical assessment: Fundamentally, clinicians classify their observations into one of two mutually exclusive categories according to the appearance or non-appearance of certain attributes (seen/not seen; able/

FIGURE 14

THE MEDICAL RESEARCH COUNCIL SCALE OF MUSCLE POWER

- 0 : No contraction
- 1 : Flicker or trace of contraction
- 2 : Active movement with gravity eliminated
- 3 : Active movement against gravity
- 4 : Active movement against gravity and resistance
- 5 : Normal power

Source: MEDICAL RESEARCH COUNCIL (1943) War Memorandum
No 7: Aids to the Investigation of Peripheral
Nerve Injuries (Reprinted 1963). London:
Her Majesty's Stationery Office

not able). This same principle of common sense differentiation is carried forward to the idea of simple order for which uniform increase in magnitude between items is unnecessary.

The achievement of an ordinal scale for physiotherapeutic assessment of hemiplegia is necessary if the process of resolution of impairment and disability is to be demonstrated.

The verification of such a scale poses three questions:

- A. How reliable are qualitative assessments made by clinicians?
- B. Can they be standardised?
- C. Are the standardised observations valid as indicators of resolution of impairment and disability in hemiplegia?

The idea of a valid and reliable qualitative scale is not new to physiotherapy and medicine. The Medical Research Council scale of muscle power (MRC, 1943) demonstrates objectivity and standardisation (Figure 14). Each item classifies muscle power in one of two categories ("at this grade" and "not at this grade"); and the items form a cumulative scale which describes muscle power with increasing force by each successive item or grade passed. It is an example of a perfect ordinal scale: no person who can pass 5 cannot also pass 4, 3, 2 and 1; and no person who fails 4 can pass five. The same transitional relationships hold true for all items. Consequently, the scale will predict the patient's performance of higher and lower ranked items from knowledge of one item which is passed or failed. For example, if a patient cannot pass grade 3, it will be correctly predicted that he cannot pass grades 4 and 5. Alternatively, if he can pass grade 3, it will be correctly predicted that he can also pass grades 1 and 2.

The MRC scale has also been shown to possess the ability to predict a patient's future status in special circumstances. Huckstep (1964) suggested a "rough but useful guide" to estimation of the final grade of power which would be recovered by individual muscles affected by poliomyelitis. The author of this thesis used it at a children's polio clinic in Kenya and found it to be empirically valid. However, recovery from polio is not equatable with recovery from hemiplegia due to CVA because polio affects the motor fibres of the peripheral nervous system directly. In polio, recovery may be due to regeneration of nerve fibres, which is well documented (Seddon, 1954), and to hypertrophy of innervated muscle fibres. The MRC scale of muscle power records recovery of power in isolated muscles, rather than recovery of co-ordinated activity of muscles in patterns of movement. The scale is used here to illustrate the argument that a valid qualitative yardstick to measure resolution of impairment can be standardised, can have predictive validity and can discriminate between different levels of recovery.

The first task in the development of a physiotherapeutic assessment of hemiplegia is seen as the development of an ordinal and cumulative scale from a set of qualitative items which describe resolution of hemiplegia. The reliability of the items will depend on the formulation of each one so that competent assessors will agree which performances belong in the "acceptable/pass" category and which do not (Schultz, 1958).

2.6.3 Selection of an appropriate method of scaling

The texts of Torgerson (1958) and Maranell (1974) discuss methods of achieving order with qualitative data which have been developed by behavioural scientists. There are no unequivocal criteria for classification of these scales in the way nominal, ordinal interval and ratio scales are distinguished. Therefore, in order to apply a scale to assessment of hemiplegia, it is necessary to select a method of scaling in which the underlying premises are theoretically appropriate both to the function of clinical assessment and to the nature of recovery from hemiplegia.

A logical choice can be made by deduction according to three propositions:

1. The relationship of the subject to the item.
2. The nature of the subject's response.
3. The correspondence of the scale to the available data.

1. The relationship of the subject to the item: The first choice is between response methods and judgment methods.

Response methods relate the item to the subject. It seems obvious and bathotic to say that an item of assessment would assess the patient. However, judgment methods, such as Thurstone's Judgement Scaling Model (Thurstone and Chave, 1929) require the subject to evaluate the item with respect to some attribute it possesses. Therefore, response methods are more appropriate to clinical assessment.

2. The nature of the subject's response: The second choice is between categorical responses and comparative responses.

A categorical response requires the subject to endorse the item and to be characterised in some way by it. Consequently, subjects will be classed in mutually exclusive categories of the item. The alternative comparative response, such as that required by the Coombes Model for Comparative Response (Coombes, 1954), requires the subject to prefer one item over another.

Therefore, a method for categorical responses is appropriate because a hemiplegic patient would be able or unable to perform an item. Consequently, he would both endorse its position on a scale of "least recovered" to "most recovered" items and be characterised as passing or failing the item.

3. The correspondence of the scale to the available data:

The final choice is between a deterministic model and a latent distance model.

A deterministic model is stated in terms of an ideal which is not expected to hold true exactly with real data but to provide a very close approximation to them. Response is determined by the individual relationship of each subject and each item to the variable underlying the scale. Alternatively, in Lazarsfeld's Latent Distance Model (Lazarsfeld and Barton, 1951) the parameters associated with the subject and the item determine the probability of the subject responding in a given way.

Therefore, a deterministic method which states an ideal model is appropriate to physiotherapeutic assessment of hemiplegia. As required, each patient and each item of assessment would be related to resolution of hemiplegia. It would not be necessary for the progress of every patient to conform to the order of the items in every respect as long as the order approximates very closely to the sequence of recovery displayed by hemiplegic patients as a whole. Therefore, it would accommodate deviations due to various as yet undefined independent variables. However, this method also presents three central problems:

- A. Deciding whether recovery from hemiplegia or resolution of impairment and disability can be presented as an ordinal scale of items of assessment.
- B. Establishing the rank order of items and patients in respect of resolution of hemiplegia.
- C. Demonstrating that the scale is an adequate approximation to the data collected from any sample of patients and is appropriate to all hemiplegic patients.

Guttman (1941) proposed a technique for tackling such problems which has been widely investigated (cf., e.g. Goodenough, 1944; Festinger, 1947; Stouffer, 1954; Edwards, 1957; Williams, 1979).

2.6.4 The Guttman Scalogram Technique

Guttman's scalogram technique (Guttman, 1941; 1947; 1950; 1974) seeks to derive a scale of qualitative characteristics using techniques of calibration which are comparable to those employed in physical measurements. He developed the technique to locate items on a scale which denotes their respective positions in a sequence with undefined intervals between them. Each item should have the nominal scalar characteristic of classifying subjects in mutually exclusive categories, such as "agree/disagree" or "pass/fail".

Guttman's principle is that an infinite number of items pertaining to any attribute or variable can be represented by a selection which form a homogeneous and measurable dimension. Thus subjects can be ranked by competence, or the number of items they pass; and items can be ranked by difficulty, or the number of subjects passing each one. The technique will create a cumulative scale which describes increasing resolution of hemiplegia with each successive item a patient passes. Guttman and successive developers of the technique (cf., e.g. White and Saltz, 1974) have incorporated procedures for testing both the ordinality of any set of items and their validity for the underlying variable.

The procedure for selecting items: The procedure is not stereotyped. Selection is determined by the knowledge and ideas of the developer of a scale, whom Guttman sees as an active creator of data rather than a mere passive observer, collector and user. Consequently, the most important task in the scaling

process is conceptual (Guttman, 1950): the selected items should represent a concept that is enmeshed in a system of relationships with other important concepts. In this case, the concept of "physiotherapy to effect resolution of impairment and disability in hemiplegia" is seen to be enmeshed within concepts of "rehabilitation for stroke". Eventually, the scale developer's construct may not be verified: initially at least, it is this construct, rather than an established theoretical principle, which must be satisfactorily stated and demonstrated.

Guttman also pointed out that the more clear-cut the scale developer's assumptions are, the easier it is to construct a meaningful set of scalable items. Consequently the first step towards formulation of theory in scientific terms may be the application of unsubstantiated empirical beliefs which are, nonetheless, clear-cut assumptions. This characteristic recommends the technique to disciplines like physiotherapy which are in the process of formulating their own theory but, as yet, possess little scientific confirmation of observational and experiential data.

The perfect Guttman scale: This is a theoretical possibility in which all recorded observations form a matrix which conforms to the optimal pattern shown in Figure 15. It shows no passes (x) outside the upper left section and no fails (o) within it. Such appearances are counted as errors.

The technique of achieving order: Basically, the items are ordered according to the number of subjects passing each of

them, and the individuals are ordered according to the number of items they pass. On the principle of minimising the number of errors, Guttman (1947) described a pencil-and-paper technique to overcome the problem of deciding the positions of individuals with tied frequency counts of passes. A scalogram board (Guttman 1950) was the first technological transformation. More recently, scalogram processing has been developed for computers (Nie, Bent and Hull, 1970).

While computer processing is convenient and easy to use, its major disadvantage is that print-outs are restricted by the number of columns which it is possible to print across a page. Consequently, computer programs do not include sub-programs to print the whole matrix for inspection. Conversely, the major disadvantage of the paper-and-pencil technique is its extreme laboriousness: but its major advantage is its display of the total graphic matrix which can allow hypotheses to be tested to confirm validity. For example, assuming that a particular scale will discriminate effectively between hemiplegic patients at different stages of recovery: because the items and individuals can be ordered to construct the matrix, it will be readily apparent by inspection whether or not an hypothesis concerning discrimination is verified, and therefore whether or not the scale is valid.

Mathematical principles: A particular advantage of the Guttman scalogram technique is that the axioms of simple order¹ are

1. These axioms are:

1. If x and y are distinct points of a scale then $x > y$ or $y > x$.
2. If $x > y$ the x and y are distinct.
3. If $x > y$ and $y > z$ the $x > z$.

(cf. Senders, 1958)

FIGURE 16

PATTERN OF RESPONSES FOR GUTTMAN SCALING

Subject	A	B	C	D	E	F	Cumulative Item Frequency
Item							
1	1	1	1	1	1	1	6
2	1	1	1	1	1		5
3	1	1	1	1			4
4	1	1	1				3
5	1	1					2
6	1						1
Cumulative Frequency	6	5	4	3	2	1	21
Putative Cumulative Percentage	10%	15%	25%	45%	75%	100%	

satisfied by the individuals who are assessed. Figure 16 illustrates proof of the third axiom. All subjects who are able to pass an item are assigned a score of 1. Assuming that the items are in the correct order for scaling resolution/recovery, person A is more recovered than person B because only person A is able to pass item 6. Therefore, if he can pass all other items, A is most recovered and F is least recovered.

The deductive proof is obtained by calculating the proportions of persons in a large sample who pass each item. To demonstrate this, putative cumulative percentages are also given in Figure 16. Thus, if more individuals can pass item 5 than can pass item 6, B is less recovered than is A. Similarly, in this ideal model, none can pass 6 who cannot pass 5; and all who cannot pass item 5 cannot pass item 6 also. Therefore, B logically precedes A. The same is true for the B/C comparison and for the A/C comparison, because there are none who can pass item 6 who cannot pass item 4. This is verified all along the line of subjects.

The first and second axioms of simple order are also satisfied if the third is satisfied, since the individuals are distinguished and a relationship of precedence occurs between any given pair.

The scaling procedure: As stated previously, a Guttman scale is an ideal model which collected data are not expected to fit exactly. The "degree of fit" is ascertained by counting each "error", or deviation from the expected pattern of findings;

then, by calculation of coefficients which describe the homogeneity and validity of the scale.

According to Guttman's theoretical postulates, this scaling procedure does not test the appropriateness of the scale simply to the sample which provides that data: but rather it tests the appropriateness of all possible items which could be formulated to deal with the topic to the whole population of subjects - in this case, all hemiplegic patients. The scale developer's knowledge and experience are the only criteria for the formulation and selection of items. Consequently, it is usual for more items than are needed to be described; and items associated with most errors are discarded. Two coefficients are calculated to describe the validity of the scale:

The coefficient of reproducibility¹ expresses the proportion of errors to the total number of recorded items and describes the correspondence between the expected distribution of the "ideal model" and the distribution of the collected data.

The coefficient of scalability² partly reflects the proportion of people "able" under each item, and describes the cumulative nature of the scale: when a cumulative scale exists, the proportion "passing" each item should decrease progressively - as shown in Figure 16.

A scale is said to be valid, unidimensional and cumulative if the CR of each item is above 0.85, the CR of the scale is above 0.9, and the CS is above 0.7. Then, the entire response pattern of "passes" and "fails" can be predicted for any subject from knowledge of the rank of the "highest" item he

Hereafter, the following conventional abbreviation will be used:

1. Coefficient of reproducibility will be referred to as CR.
2. Coefficient of scalability will be referred to as CS.

has passed (Festinger, 1947). For example, if it were known that a hemiplegic patient had passed the seventh item of a scale of ten items, it would be predicted that he had also passed the first to sixth items but had failed the eighth, ninth and tenth items.

Alternatively, if the patient had passed only three items, it would be predicted that he had passed the first, second and third items. Consequently, the Guttman scalogram technique would appear to offer a means of achieving predictive validity in assessments, which would be of great potential value to the clinical physiotherapist.

Several authors have discussed auxiliary criteria which are designed to ensure that, in establishing the validity of the scale, advantage is not taken of chance variability (cf., e.g. Ford, 1950; Torgerson, 1958; Oppenheim, 1966; Mayntz et al, 1976). Guttman (1974) specified that a scale should consist of at least ten items which are dichotomous - i.e. which classify subjects in either of two mutually exclusive categories, such as "pass" or "fail". Many scales have been reduced to four or five items by the scaling procedure has been completed (cf., e.g. Lyle, 1980). However, several authors support Guttman's requirement (cf., e.g. Torgerson, 1958; Mayntz et al, 1976); although Stouffer (1954) considered that:

"... a ten or twelve item cumulative-type scale is easier to talk about than to accomplish."

The numerical details of the coefficients of Guttman scales and details of the auxiliary criteria will be found in Appendix I.2.

2.6.5 Application of the Guttman technique in rehabilitation

Numerous studies suggest that disability would fit Guttman's cumulative model (Carroll, 1962; Katz, Ford, Moskowitz, Jackson and Jaffe, 1963; Katz, Downs, Cash and Grotz, 1970; Harris et al, 1971). Williams et al (1976) found that the individuals could be assigned to a cumulative scale of disadvantage which avoided intuitive comparisons between different disorders or diagnoses. They also suggested that the Guttman procedure was likely to be successful in any area which is characterised by progression or regression or both.

The scalogram technique has been used in several studies. Kohen-Raz (1967) used it to organise the items of the Bayley Scale of Mental Development (Bayley, 1969) in five scales which demonstrate how one competence or response pattern grows out of another. He also showed that an assessment made at one stage in a child's development could be used to predict ability at a later stage with a high degree of accuracy. Lyle, Stone, Neill and Stewart (1979) arranged seventy-five items into twelve Guttman scales for an ADL assessment of hemiplegia. These scales are said to be "functional groupings of items" and they range from four items to twelve items in length. Coefficients of reproducibility and scalability are given for each scale; but the validity of those scales which contain less than ten items must be doubted. There is no evidence in this paper, or in Lyle's doctoral thesis on functional treatment of the upper limb in hemiplegia (Lyle, 1980), that attention was paid to any auxiliary criteria.

Whiting and Lincoln (1980) also used Guttman's technique to scale items of ADL for an assessment for occupational therapy; and Lincoln and Leadbitter (1979) used it to order the items on three separate scales for an assessment of hemiplegia. For the latter assessment, association is shown between each scale and recovery from hemiplegia; but no association is shown either among the scales, or between all three scales considered as a single continuum and rate or level of recovery.

In the present study, it is proposed to use the Guttman technique to order items which describe motor recovery from hemiplegia in order to create a physiotherapeutic assessment. The items will be recorded on parallel scales, demonstrating resolution of impairment and resolution of disability serially, in order to show how functional ability improves as the patient's muscle tone and patterns of movement become more normal. Hopefully, these scales will also allow findings of physiotherapeutic assessments to contribute more effectively to decision-making by rehabilitation teams.

An index of rate of progress: The mathematical assumptions for ordinal scales underlying the Guttman scale are very simple in comparison with those of interval, and especially ratio, scales. However, the Guttman technique is a means of quantifying qualitative data and it does permit the researcher to incorporate mathematical properties into his or her scale. It would seem possible to utilise these properties to develop an interval scale, and possibly even a ratio scale of measurement of recovery from hemiplegia.

Some inhibition is caused by the need to maintain objectivity. Construction of a clinical scale requires a mathematically strict approach, to ensure that the data recorded at assessment are a function of hemiplegia: and nominal or ordinal scales are valid for these data.

However, if the Guttman technique of ordinal scaling is used to ensure the objectivity of the clinical assessment, other techniques might be used to convert the Guttman scale into a quantitative scale. Hamblin, Buckholdt, Ferritor and Kosloff (1971) have developed "magnitude estimation" to construct ratio scales of status based on questions such as: If a graduate has 100 units of status, how much status has a plumber? a caretaker? a physiotherapist? a doctoral candidate? a professor? and so on. This technique could be of considerable significance in the devising of a clinical scale of recovery - for example, instead of using summated rating scales in order to summarise a patient's recovery status it would appear feasible to describe a ratio scale which does take account of rate of progress as well as the amount of recovery. The technique could be extended to include other factors at a later date.

Although Hamblin and his co-workers believe it to be possible for almost everyone to learn to "think in ratio terms", the method is not yet practicable for the construction of a clinical scale of recovery status. The training of observers is so vital that the authors have been compelled to write complex instructions for the setting up of an elaborate associated training scheme.

It would certainly seem more feasible to create a clinical index of recovery by taking advantage of the cumulative property of a Guttman scale and defining each additional item a patient achieves as an "improvement". Here two factors would need to be taken into account:

Firstly, some patients have a more severe hemiplegia than others at entry to treatment.

Secondly, patients progress at variable rates for many reasons, some of which are not yet clearly defined.

Therefore, an index might be expressed on the basis of the number of "improvements", or items, the patient must achieve to reach the top of the scale; the number recorded at each assessment; and the time taken in weeks after the CVA and the inauguration of physiotherapy.

The feasibility of such an index can be investigated when a valid and reliable clinical assessment is available.

SUMMARY

In order to develop a sign system to represent the sequence of recovery from hemiplegia, the assessment itself must be valid and reliable. Measurement can often be reduced to comparison of whatever is of interest with an agreed standard known by everyone with whom the user wishes to communicate. At present there is no universally accepted standard (A) by which recovery from hemiplegia might be measured, or (B) upon which an assessment and sign system could be based.

Methods of scaling ordinal data have been described by behavioural scientists. They may be adapted to establish points on a recovery continuum which can be used to describe both resolution of impairment and reacquisition of functional abilities. The Guttman scalogram technique appears to be valid for description of recovery from hemiplegia.

Each item of a Guttman scale classes subjects in mutually exclusive and exhaustive categories which are characteristic of qualitative data. These categories can be used to classify positive and negative observations, or "passes" and "fails" in performances of items of assessment. Frequency counts of passes allow subjects and items to be ordered in such a way that any individual's pass or fail performance of each item can be accounted for by the order of all items. Thus, a scale can be said to be dependent on a single, if complex, variable. In accordance with the axioms of number theory, it is the variable which is scalable. Scalability implies that an individual's response to every item can be predicted from knowledge of the highest ranked item, or the number of items, he has passed.

Thus, the order of items would describe resolution of hemiplegia. Knowledge of the highest ranked item the patient had passed would also describe his abilities and his inabilities; and his motor status and progress would be described relative to all other hemiplegic patients who were assessed in the same way.

Guttman scaling is a technique for ordinal scale data. The mathematical assumptions of ordinal scales are very simple in comparison with those of interval scales, and especially those of ratio scales. It is very difficult to achieve interval scales with qualitative, descriptive data: and the achievement of ratio scales, which would allow the full power of mathematics to be used, does not seem likely to be successful. However, the Guttman technique is a means of quantifying qualitative data; and it may be possible to develop a valid and reliable Guttman scale into an index which measures such factors as the patient's rate of progress.

2.7 COLLECTION AND ANALYSIS OF DATA TO INVESTIGATE THE VALIDITY OF THE ASSESSMENT

Several sets of data are needed for the development and evaluation of a physiotherapeutic assessment of hemiplegia which would chart the process of motor recovery and have potential to communicate the findings to a wide variety of people. Descriptions and prescription of the items of assessment; devising and testing the scale to which they are assigned; and related evaluation of the reliability of the resulting assessment are all areas requiring empirical investigation to which reference has already been made. This section is principally concerned with collection and analysis of data for evaluation of the assessment's validity for routine clinical use. Data are required for:

- A. Estimation of the appropriateness and adequacy of the recovery scale for describing all hemiplegic patients;
- B. Evaluation of the compatibility of the assessment with physiotherapists' working methods;
- C. Identification, in the interactions occurring between physiotherapists and other practitioners, of critical issues which may affect the assessment's potential to contribute to multidisciplinary rehabilitation of stroke patients.

Similar data, both for description of and validation of the items of assessment, is required both from hemiplegic patients and from physiotherapists. Consequently, identification of the sequence of recovery will also be referred to in the discussion of methods of collection of data and sampling of populations. Discussion of methods of analysis is directly concerned with data collected to investigate the clinical usefulness of the assessment.

2.7.1 The survey approach to collection of data

To a certain extent, the sources of the required data determine the methods and techniques used to collect them. There is no single classification of methods of research in the literature about its design (cf., e.g. Brown and Ghiselli, 1955; Fox, 1976; Mayntz et al, 1976; Phillips, 1976). Three approaches to collecting data can be identified: here they are called the archival approach; the survey approach, and the experimental approach. Each uses particular techniques and each contains differing assumptions concerning the source and type of the data concerned.

In the archival approach the data have already been generated and are available in publications, papers and other documents.

Survey data are not available in documents, but they are available for generation in existing circumstances.

Finally, in the experimental approach the data are available neither from documents nor from contemporaneous survey, but they can be obtained if a new and very specific situation is created.

Thus, in a research programme such as that presently proposed, the archival approach acquaints the researcher with completed studies, illuminates the problems which he may encounter, and allows the research and the findings to be placed in the context of current professional knowledge. It is the experimental approach which motivates the researcher to invent a solution, such as a motor assessment chart, which requires explanation and verification. However, the data required for the development and evaluation of the assessment are available only from the hemiplegic patients and from the practitioners; and these data need to be generated by the methods of the survey.

The survey is the most widely used approach to collecting data. Generically, it includes methods of observation as well as questioning (Goode and Hatt, 1952; Selltitz, Jahoda, Deutsch and Cook, 1959; Weisberg and Bowen, 1977). Its techniques enable researchers not only to gather factual data, but also to explore goals and beliefs, and to collect information about patterns of interaction and other forms of observable behaviour. This approach to data-collection is more flexible than the archival approach used for reviews of literature or major retrospective research. The archival researcher must accept data in the form in which they have been gathered and are presented, whereas the survey approach allows the researcher great freedom both to generate data and to determine the form in which they will be collected. This facility also opens the survey approach to abuse; and it makes the data vulnerable to criticism of their nature, form and amount. The aim here is to identify techniques which are most appropriate to the data required for this study.

Observation and questioning: The choice between these methods might be forced by practical considerations: questioning is less time-consuming. However, questioning might be seen only as a means of gathering questionable factual data and opinion; and a poor alternative to observation for gathering data about interactions between practitioners in rehabilitation teams and other relevant behaviour. For example, questioning physiotherapists about the sequence of resolution of hemiplegia would be a poor substitute for data obtained by observation of hemiplegic patients: since respondents are subject to forgetfulness and data obtained by questioning can be taken only as indicators of relevant fact (Mayntz et al, 1976). However, in other circumstances, questioning

gives access to data which cannot be observed. Whilst current interactions between practitioners might be observed, information about past behaviour can be gained only by questioning.

Both methods are subject to distortion of data. The reliability of data collected by questioning is dependent on the honesty, comprehension and objectivity of respondents; and the person who is observed may display atypical behaviour. Distorted data is not likely to be provided by hemiplegic patients because clinical observation is a continuous process which the patient is more or less aware of at particular times. During a formal assessment he is instructed and is particularly aware that his performance is being observed and recorded. He may be unaware of informal assessments at other times although the practitioner may note differences between the two performances.

Other comparisons between observation and questioning involve ethical considerations for researchers:

Firstly, the researcher may feel that the purpose of the research cannot be made explicit to providers of data without prejudicing the data.

Secondly, while people may refuse to respond to questioning they may be quite unaware that they are being observed, and the researcher may not ask permission to observe them in case it initiates atypical behaviour.

Researchers are concerned about the reliability and validity of their data; but they cannot ignore the ethical implications of keeping their intent covert and of not obtaining the informed consent of providers of data. It is relatively easy to collect data for the overt purpose of clinical assessment without telling patients that they will also be used for research.

Although it appears unlikely that patients would object to the data being used for research, it is desirable to allow them the opportunity to refuse to participate in the same way as practitioners can choose or refuse to participate in a project. The corollary to this proposition is that providers of data should be able to benefit from their participation. Practitioners can be kept informed during the development and evaluation of an assessment, but individual hemiplegic patients will progress, or may regress, beyond their own ability to profit. Therefore, the aim must be to enable succeeding generations of patients to benefit.

Direct and indirect techniques: Both methods may be used directly or indirectly by the researcher. Using direct techniques, the researcher may make and record observations or may administer an interview schedule. Inevitably, these techniques are costly in researcher-time, for travel to the location as well as for collecting the data. It would be very difficult for one researcher successfully to observe twenty hemiplegic patients in different locations throughout two or three months of their recovery; but data can be collected from a larger number of patients in a wider range of treatment centres by the physiotherapists who see them every day. Generally, larger numbers of people can be surveyed by comparatively less expensive indirect techniques, such as by providing collaborators with a form on which to record their observations, or with a self-administered questionnaire.

A further consideration affecting the choice of indirect observation as a method in the development of a physiotherapeutic

assessment is that the physiotherapist-assessor is always a participant observer. For some studies participant observers may be required to play the participant role as authentically as possible, in order to identify with it and to lose sight of the theoretical or methodological frame of reference of the observation (Mayntz et al, 1976). Physiotherapists who are cast in the role of observers for research are primarily "real" participants. Their relationships with patients are very important in ensuring the validity of the data.

Questionnaires and interview schedules: At an informal level, non-directive questioning is an integral part of the process of research (Fox, 1976; Mayntz et al, 1976). It can range freely through topics associated with the research with requests for clarification and detail interpolated by the researcher. It is a necessary and continuous activity which allows the researcher to gather opinion and to estimate reactions to developments in the research programme. The self-administered questionnaire and the researcher-administered interview schedule are used to gather data which can be subjected to analysis.

Questionnaires are said to be useful for seeking information (Goode and Hatt, 1952; Oppenheim, 1966). The specification for a good questionnaire might describe it as easily understood, and as producing accurate and relevant information which is easily processed by the researcher. Necessarily, questionnaires are explicit and spontaneity is limited because questions are usually closed-ended, with responses restricted to pre-considered categories which allow quick tabulation of data. Consequently, respondents' choices are often forced between "agree/disagree"

and "yes/no" types of category. They can thus indicate the intensity of their opinion only by choosing between fixed alternative categories. Questions which are intended to probe in depth may be included; but, because the researcher does not supervise responses, these may be made superficially for a variety of reasons which may be unconnected with the research itself. For discussion of specific issues related to the design and administration of questionnaires and interview schedules, see Appendix II.1.

Factors affecting choice of methods: Open-ended questions which give respondents freedom to frame their responses may be used in questionnaires. In general, they are a feature of researcher-administrated interview schedules. Interviewing is said to be more appropriate to investigation of attitudes and behaviour, and to determination of influences on them (Hyman, Hart, Cobb, Feldman & Stember, 1954). At the turn of the century, social scientists used the qualitative interview almost exclusively (Goode and Hatt, 1952). They are said to have held instructured, probing conversations and to have had no concern for reliability of the data. More recently, the pendulum has swung to the highly structured interview, with depth sacrificed for standardisation. The middle path uses prepared interview schedules to semi-standardise the questioning and to prohibit discussion or explanation of topics which might invalidate the data. The interviewer is allowed to re-phrase questions from the schedule and to follow up spontaneous remarks, and respondents can ask for clarification of questions.

Three broad factors are of importance here:

A. In order to describe the items of assessment and to validate the "recovery scale" against data from larger numbers of patients, it is necessary to use indirect methods of observation.

Advantage can be taken of the daily contact which physiotherapists have with their patients: improvements can be recorded as and when they occur, rather than at assessments at intervals dictated by the researcher, so that the sequence of restoration of normal movement may be charted more accurately.

B. The same physiotherapist-observers will also be available, and well-qualified, to respond to questions concerning the correspondence of the assessment to their notions of a valid assessment and its compatibility with their working methods. This information can be gathered on a self-administered questionnaire.

C. The researcher-administered interview schedule is more appropriate to investigation of interactions within multi-disciplinary teams than is the questionnaire. The researcher can direct respondents to topics in order to identify the critical issues which may either contribute to, or detract from, the use of the record of the assessment as an aid to communication.

2.7.2 Selection of samples for observation and questioning

One of the major aims of the survey is to select samples which will provide data representative of the population about which the researcher wishes to make general statements and inferences. In order to make their studies more sensitive to various effects, sociologists often survey hundreds or even thousands of people. This is because the effects of random errors will tend to cancel each other out but the effects of particular variables will be aggregated over all subjects.

Probability sampling: In this type of sampling, each member of the population has a known probability of being included. It is used to select samples so that results can be applied as widely as possible beyond the specific context of the researcher (Mayntz et al, 1976; Phillips, 1976).

The simple random sample, in which each member of the population has an equal chance of being selected, is the most widely used of the procedures of probability sampling. More elaborate procedures are also used. For example, a stratified sample may be drawn by dividing the population into strata which are meaningful to the research. A simple random sample may be drawn from each stratum; or quotas, which are proportional to the numbers in specific groups in the whole population, may be randomly drawn. Whatever method is used, the aim of this type of sampling is to calculate the probability that the result from the data provided by the sample differs from a result based on a survey of the whole population.

Like all statistical tests and the methods of scaling discussed previously, certain underlying assumptions need to be met for a method to be valid. For probability sampling, the main assumption is that the population is distributed normally and is completely characterised by its mean and standard deviation (Blalock, 1974). The normal distribution is a theoretical curve which is symmetrical about its mean. Although an opinion or an ability or any other variable may be distributed normally in very large populations, such as all physiotherapists or all hemiplegic patients in the world, a normal distribution cannot be assumed for any smaller population under study (Senders, 1958).

For some surveys, data from censuses of populations can be used to test if the results obtained from one or more sub-samples differ significantly. Data of this type is not available from hemiplegic patients or from the physiotherapists who treat them. Therefore, each member of these populations cannot have an equal chance, or known probability, of being represented in the sample; and no calculation can be made to test if results obtained from samples of them differ from results based on censuses or surveys of them.

The extent to which results can be generalised is evaluated by the statistic of sampling error (Weisberg and Bowen, 1977). Researchers who are concerned about this "external validity" use large samples in order to minimise sampling error. However, large samples may create problems with "internal validity", or the extent to which the data apply to the phenomenon under study. For example, if probability is being trusted to provide a random sample in which the significant variations in the populations

of hemiplegic patients and physiotherapists would be represented, less may be known by the researcher about variables such as the method of treatment used by each physiotherapist and the setting in which each patient is treated. Consequently, internal validity might be doubtful, and it would be worthless to try to generalise from the data and the findings. Phillips (1976) considers that external validity becomes important after useful internally valid results have been obtained.

Non-probability sampling: The problem with large samples is that internal validity could be compromised: the problem with small samples, or samples for which the statistic of sampling error cannot be calculated, is a question of the worth of research for which the extent of external validity cannot be estimated. Fortunately, non-parametric statistical tests for samples as small as six members do not specify conditions about the parameters of the population from which the sample is drawn (Siegel, 1956; Daniel, 1978).

Firstly, they can be used to detect relationships among variables, e.g. the compatibility of an assessment with the different methods of physiotherapy.

Secondly, theoretical distributions of test statistics allow probability statements to be made about numerical values which may be calculated from the data provided by the samples.

Therefore, in some circumstances, it may be more appropriate to use non-probability sampling which allows the researcher to select samples having particular characteristics. Inferences and general statements based on the findings might be considered less valid than those based on probability samples; but lack of a statistic of sampling error may be offset by a gain in internal

validity. Consequently, inferences based on data from non-probability samples may be equally or more valid than inferences made when the extent to which the findings can be generalised is vested in the precision of external validity.

A final comparison between probability and non-probability sampling may be based on the use of random selection to minimise potential bias of the researcher. Conversely, it can be argued, especially when there is no alternative, that non-probability sampling raises these biases to the surface in the criteria used to select the samples. In this way, characteristics are demonstrated which may be important when inferences and general statements are made.

Biased samples: A non-probability sample may also result when data are collected from only a proportion of a designated probability sample. It is inevitable that some members of a selected sample of either type will not respond to a postal survey. Consequently, the structure of the responding sample can be a major problem (Reuss, 1943). A low rate of response is almost certain to produce a biased sample, but a high rate of response is not proof that no bias exists. Specific groups may have responded; and lack of response from specific groups may affect the representativeness of the samples and the validity of the findings of the research.

Researchers in the social sciences have been criticised for reporting results when respondents have represented only a small proportion of the selected sample. Fifty per cent is suggested as the lower limit of acceptability, and a proportion

less than sixty per cent of the selected sample is said to produce "fragile data" (Fox, 1976). Goode and Hatt (1952) suggest that non-responding members of selected samples should be interviewed to determine the direction of their biases; to allow a clear picture of them to emerge; and to investigate whether lack of response is due to dissatisfaction with, say, the physio-therapeutic assessment or to other factors. It would appear more feasible to try to follow up these people with letters of enquiry if the sample is drawn from all over the United Kingdom, and overseas, as is possible for the proposed project.

2.7.3 Analysis of data which has been collected by questioning

Analysis of data from questionnaires and interviews can serve several purposes. Firstly, analysis of responses from individuals and from groups can provide valuable information about their prejudices and biases. Secondly, analysis of responses to specific questions can be used to determine their relative difficulty, as in techniques of attitude scaling or item analysis. Principally, analysis is used to summarise and manipulate the data. This third purpose poses difficult problems because a great deal of the data from questioning is likely to be categorical and qualitative.

Quantitative analysis: Questionnaires are usually designed so that data are collected in a way that will make them amenable to quick tabulation, quantification and quantitative analysis. The concept of levels of measurement and the admissible mathematical operations at different levels was discussed with regard to methods of scaling. The same principles apply to data collected on questionnaires.

The simplest statistical analyses involve straightforward frequency counts of responses. Tests of association compare the proportions in each response category or group. They allow calculations to be made of the probability that a difference as great or greater than that obtained could have arisen by chance; and, therefore, whether or not it is significant. The choice of statistical tests is critical for data forming ranking or rating scales which are collected in response to fixed alternative questions (Huff, 1973). Any statistical test which involves

calculation of the mean (\bar{x}) assumes data at the level of interval or ratio scales. In general, the simpler assumptions required by non-parametric tests (Siegel, 1956; Daniel, 1978) make them more appropriate to data from questionnaires. These data are usually in the form of proportions or percentages or, at best, they may be ordinally scaled.

Quantitative analysis of interview data is concerned with the semantic content of the material: the frequency of occurrence of words, assertions, symbols and themes in transcriptions and written records. This concern implies that frequency is the valid index of concern, intensity and the like. However, although statistical procedures may be used to indicate the likelihood of generalisations from the sample data being valid or not, enumeration carries with it a bias in the selection of problems to be investigated (Holsti, 1969). This makes the procedure appropriate to analysis of data from questionnaires which have been pre-coded by the choice of responses offered. It is less appropriate to analysis of data from interviews, where emphasis is in the direction of the significance of a problem or assertion rather than the assertion itself. The use of quantitative methods in these circumstances poses problems such as:

Should the number of interviews in which each assertion is made be tabulated?

Or should the number of times an assertion is made in each interview be tabulated?

Or should both be tabulated?

The frequency of occurrence of an assertion may not necessarily be related to its importance because the non-appearance of an assertion may be highly significant also. In this respect, and

particularly if respondents are well-educated and have an extensive vocabulary, it might be more valuable to tabulate the terms which are used in reference to particular assertions rather than the frequency of the assertions themselves.

Qualitative analysis: This method of analysis (Schutz, 1958; Webb et al, 1966) suggests that researchers participate in the construction of the data they gather by probing their own fundamental assumptions instead of setting them up as boundaries to the investigation.

Instead of using a preconceived scheme for coding data, the researcher reads the record of each interview or the transcript to get "a feel for" the data. He allows critical categories for analysis to emerge from them. Such a process requires protection against idiosyncratic interpretation or misinterpretation of data because of the potential for exercise of bias by the researcher. Analysis might easily go beyond the manifest issues communicated by respondents to more latent aspects, and the researcher may infer what was implied or meant in order to create categories (Holsti, 1969).

Choice of methods of analysis: A methodological controversy exists between quantitative methods and qualitative methods. The former methods are more controlled and they offer greater reproducibility. Therefore, the data are likely to be thought more reliable and the results to have more extended application. However, although quantitative analysis has been assisted by increasingly sophisticated techniques, it is not necessarily

considered to have been accompanied by a growth of understanding (Phillips, 1976). This may be because, essentially, both quantitative and qualitative methods depend upon the researcher's ability to select the most appropriate method, technique or test, and on the advice he or she receives to assist that choice. Computer programs for quantitative analysis (cf., e.g. Nie et al, 1970) are facile, quick and all-too-easy to use. Brigham (1975) has warned that such programs may not offer the optimal analysis for the data concerned, nor may they perform the most appropriate statistical tests.

Conversely, qualitative or descriptive analytic methods are vulnerable to criticism concerning their supposed lack of objectivity. Consequently, inferences or general statements based on them are commonly supposed to be less well-founded than those based on the results of quantitative analysis. However, Phillips (1976) has written that learning gained by all research methods is a basis for improving scientific method in general because all methods are "merely human construction" and are subject to continuing change.

Lazarsfeld and Barton (1951) and Goode and Hatt (1952) have stressed that concepts of qualitative and quantitative are not dichotomous but constitute a continuum. There is a quantitative element to qualitative analysis, if only because the researcher uses two classes of data ("asserted/not asserted") in order to determine the significance of assertions.

While quantitative analysis is appropriate to data from questionnaires and qualitative analysis is appropriate to

data from interviews, Tukey's point is pertinent

He emphasised that analysis of data must progress by approximate answers, because knowledge of what is really the problem will, at best, be approximate also.

"Far better an approximate answer to the right question, which is often vague, than an exact answer to the wrong question, which can always be made more precise."

(Tukey, 1962)

SUMMARY

In order to develop a physiotherapeutic assessment which incorporates all of the desirable qualities which have been discussed, several sets of data must be collected, including data from clinicians which can be used to confirm the clinical acceptability of the assessment.

Techniques of the survey approach can overcome the temporal limitations of both the archival approach and the experimental approach to collection of data. Although remembrances of the past and ideas about the future are easily distorted to meet the needs of the present, researchers can learn about on-going processes from retrospective and prospective questioning using self-administered questionnaires or researcher-administrated interview schedules.

The interview should be used to collect data which cannot be requested on paper. Therefore, questionnaires are considered more appropriate to collection of relatively uncomplicated facts and opinions: conversely, interviews are more appropriate to collection of data concerning complex individual experiences, relationships or behaviour. The latter data may form a pattern over many interviews, yielding emergent issues during analysis which are inaccessible to the "vertical sampling" of questionnaires.

CONCLUSIONS

There is a need for a standardised physiotherapeutic assessment of hemiplegia of confirmed reliability and validity for clinical use. Such an assessment would possess the potential to increase effective knowledge of physiotherapy for hemiplegia and rehabilitation of stroke patients. Specifications for the performance and appearance of the assessment lie in four main areas:

- A. Construction of a scale of items of assessment to describe recovery from hemiplegia.

The assessment should provide information about the sequence of motor recovery and have potential to provide cogent predictors of outcome from physiotherapy and rehabilitation.

- B. Presentation of the findings of the assessment on a record which offers potential users ready access to the information they want.

The record should display both specific information which physiotherapists need about the patient's control of movement and posture and general information about his functional ability. It should aid communication of rationales of treatment also by displaying his motor status and his progress in a readily-understood manner.

- C. Validation of the appropriateness of the assessment for physiotherapy for hemiplegia.

The assessment should fulfil the normative and felt needs of physiotherapists for an assessment which will aid planning, monitoring and evaluation of their treatment of individual patients.

- D. Investigation of the potential of the assessment to contribute to multidisciplinary rehabilitation of stroke patients.

The assessment should enhance collaboration both between physiotherapists and patients and between physiotherapists and practitioners of other health care professions in rehabilitation teams.

A valid Guttman scale would demonstrate the sequence of recovery; and, because it is unidimensional and cumulative, it might enable practitioners to predict outcomes from physiotherapy and rehabilitation. Therefore, an assessment based upon it would also improve the efficiency of physiotherapeutic assessment, and enable physiotherapists to plan and monitor their treatment more effectively. It might also influence the expectations of other practitioners regarding individual patients at specific times during their treatment.

Organisation of the findings of the assessment according to the international classification of impairments, disabilities and handicaps (WHO, 1980) is seen as a means of distinguishing those aims of physiotherapy which are concerned with the resolution of impairment from those aims of rehabilitation of stroke which are concerned with resolution of disability. It would also be a means of demonstrating the compatibility of these two sets of aims. Descriptions of relative status on Guttman scales of impairment and disability would give the assessment considerable potential for use, both in evaluative studies of functional and neurophysiological methods of physiotherapy for hemiplegia, and in related studies of the role of physiotherapy in rehabilitation of stroke.

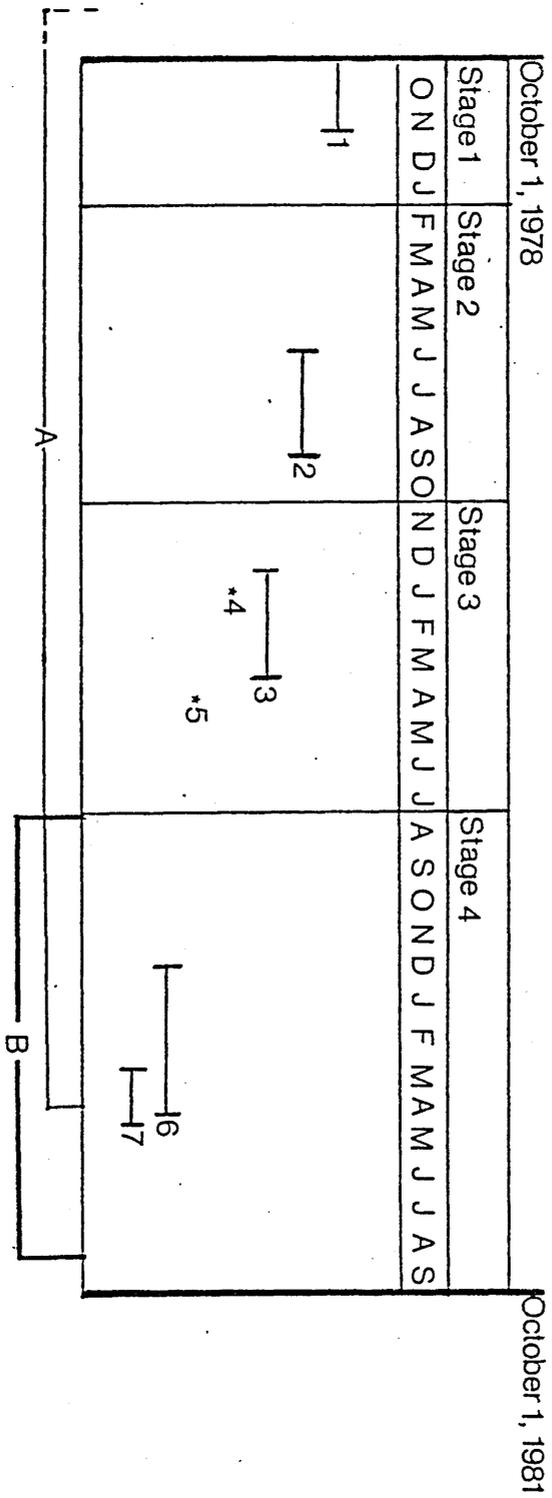
A sign system might overcome problems of language and improve communication between physiotherapists and other practitioners. However, it is recognised that meaning may be conveyed more successfully by verbal descriptions to patients who are likely to be elderly and unused to signs.

It is proposed that such an assessment can be developed by:

1. Observing hemiplegic patients in all stages of recovery;
2. Subjecting the collected data to the Guttman scalogram technique to demonstrate a "recovery scale";
3. Describing items of assessment according to the points of the recovery scale;
4. Presenting the record of the assessment on a single sheet graphic display which uses a sign system to represent the recovery sequence and verbal descriptions to communicate with patients.

FIGURE 17

THE TIME SCALE OF THE RESEARCH



A: Development and evaluation of physiotherapeutic assessment

B: Investigation of SMAC's use in rehabilitation of stroke

- 1 Pilot study of prototype chart
- 2 Field test of preliminary chart
- 3 Field test of interim chart
- 4 Survey using postal questionnaire

- 5 Study day, inter-observer test of reliability and survey.
- 6 Interviews with practitioners and patients
- 7 Inter-observer test of reliability of final chart

3. ORIGINAL OBSERVATIONS DURING THE DEVELOPMENT AND EVALUATION OF THE SHEFFIELD MOTOR ASSESSMENT CHART

3.1 INTRODUCTION

Administratively, the project was divided into two parts

(Figure 17):

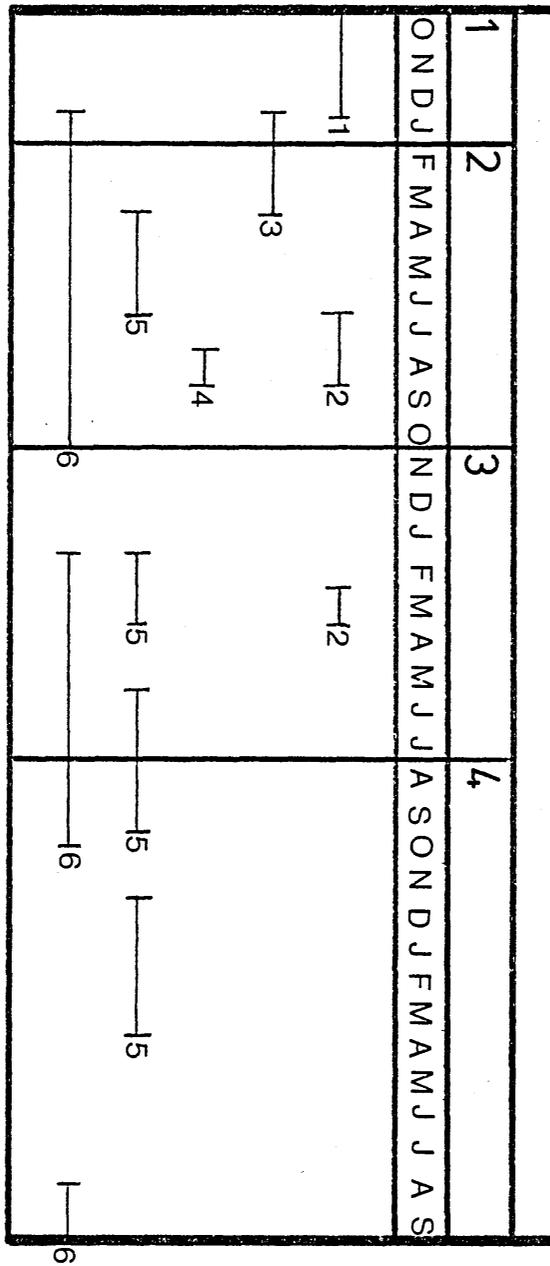
- A. Development and evaluation of the physiotherapeutic motor assessment of hemiplegic patients (Years 1 and 2).
- B. Investigation of the potential of the final version of the Sheffield Motor Assessment Chart¹ to contribute to multidisciplinary collaboration in the rehabilitation of the stroke patients (Year 3).

In reality, the division was not so clear-cut. Informal preliminary investigations of the chart's ability to communicate with patients and practitioners were made during Part A; and inter-observer tests of reliability were repeated with the final version during Part B.

Stages 1, 2 and 3 of the project were defined by the preparation and testing of the prototype, preliminary and interim versions of SMAC respectively. These stages also included analyses of data and revision of each version to the succeeding version (see Figure 19). The final format of SMAC was used for studies in Stage 4. This stage is defined by preparation and administration of interview schedules, and collation and analysis of responses.

1. Hereafter, the Sheffield Motor Assessment Chart may be referred to as "the chart" or by its acronym, SMAC.

FIGURE 18
ACTIVITIES ASSOCIATED WITH DEVELOPMENT OF SMAC



- 1 Computer programming course
- 2 Writing & revision of programs
- 3 Research methodology course

- 4 Videotaping for test of reliability
- 5 Consultations with physiotherapists & developers of assessments
- 6 Talks to physiotherapists & other interested practitioners

Associated activities which were undertaken during the course of the project are shown in Figure 18. The authorities on physiotherapy for hemiplegia and the developers of physiotherapeutic assessments who were consulted are listed in Appendix III.

This foreword is concerned, in particular, with the selection of samples of patients and physiotherapists for each field test (section 3.1.1). The order in which the results are presented is also discussed (section 3.1.2).

3.1.1 Selection of samples of patients and practitioners

The samples of patients who provided data

Samples of twenty to thirty patients and one hundred patients were proposed for the first and second field tests respectively.¹ These were "non-probability samples" and prospective: Many members would suffer their CVAs during a field test, of just before it, and after the samples of physiotherapists had been drawn. These samples were also subject to uncontrollable variables, such as the service provided in different areas of the country and the place in which the CVA occurred (Brocklehurst, Andrews and Morris, 1978).

Consequently, collection of data from any hemiplegic person was dependent on the participation of the physiotherapist who treated him, in the first instance, rather than on his own willingness to cooperate. In terms of such variables as the method of physiotherapy received and the range of ages, the representativeness of these samples was also dependent on the selection of physiotherapists.

TABLE 2

SIZES OF SAMPLES REQUIRED FOR FIELD TESTS

	Number of patients	Number of physiotherapists (at 2-3 patients per physio.)
First Field Test	20 - 30	7 - 15
Second Field Test	100	35 - 50

1. Research Proposals and Budget submitted to DHSS, 1978.

The samples of physiotherapists who produced the data

It was necessary to estimate the number of physiotherapists needed to produce data from the required numbers of patients. It was felt that asking them to assess more than three patients using evolving versions of the chart might create a conflict between their clinical commitments and their participation in the project. Senior and superintendent physiotherapists who participated in the pilot study (cf. Section 3.2.1) advised that assessment and reassessment of two patients might be the maximum that could be readily accommodated, because participants were asked to judge each item and the procedure. Therefore, fifteen physiotherapists might be needed to produce data from twenty to thirty patients in the first field test, and up to fifty might be needed for the second field test (cf. Table 2, p 147).

Additionally, to assess and evaluate opinions of the assessment and the reproducibility of records made by physiotherapists of different levels of skills and experience, three different samples of physiotherapists were required:

The first sample (A) would participate in both the first and the second field tests;

the second sample (B) would participate in only the second field test.

and the third sample (C) would not use the chart in a field test but would take part in the test of inter-observer reliability.

Therefore, three factors needed to be taken into account:

Firstly, sample A, in particular, needed to be sustained throughout a long development period.

Secondly, the methods of physiotherapy used by members of the samples should be representative of methods being used in the United Kingdom.

Thirdly, members should be drawn from the wide variety of settings in which hemiplegic patients are treated so that data would be collected from patients of all ages and at all stages of recovery.

Potential participants: To achieve representative samples, an invitation to participate was extended through the correspondence columns of the journal of the Chartered Society of Physiotherapy¹. Consequently, potential participants were a self-selected sample of physiotherapists who were interested in developing a standardised physiotherapeutic assessment. This was expected to aid maintenance of a working group, even when members might have little or no direct contact with the researcher. It was also expected to demonstrate unacceptability of the assessment, if self-motivated physiotherapists terminated their participation.

Sixty-two physiotherapists were available for selection for Sample A. They were surveyed for information about the methods of physiotherapy they used; the type of setting they worked in; their experience with hemiplegic patients; and the range of their patients' ages. These data showed that many different combinations of these factors may occur in one hospital or health district.

1. Physiotherapy, December 10th, 1978.

Characteristics of sample drawn for first field test: A

"non-probability sample" was selected. All physiotherapists who treat hemiplegic patients were considered to be the population. This is an unknown proportion of the physiotherapists working in the National Health Service¹, plus physiotherapists in private practice. Physiotherapists who reported particular characteristics were deliberately chosen. Three characteristics were considered to contain elements which were crucial to the project:

1. The setting of physiotherapy: SMAC should be usable in any situation in which physiotherapists treat hemiplegic patients.
2. The method of physiotherapy: SMAC should be compatible with current British practice of physiotherapy and be usable with methods of treatment of hemiplegia used by British physiotherapists.
3. The skill of the physiotherapist: SMAC should be usable by physiotherapists of all levels of skill and experience.

Selections were made to ensure that experienced and relatively inexperienced physiotherapists in all the major types of treatment centre were included.

No British physiotherapist reported using Brunnstrom's method of treatment. Only one said that she used "functional physiotherapy" exclusively; she was included. A small minority reported using Bobath's method exclusively; but the majority could be described as "Bobath/eclectic" for professing Bobath's method in combination with other techniques (See Section 3.4.4).

Five physiotherapists who worked overseas were included in the sample: one Australian and one Swiss who used Bobath's method; one American who used Brunnstrom's method; one Australian who used both Bobath's and Brunnstrom's methods; and one Canadian who was interested

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1. Council for the Professions Supplementary to Medicine, Computer statistic, August 12th, 1981: 14,957 physiotherapists qualified in the United Kingdom and overseas, registered and eligible for employment in the NHS. The absolute number working in the NHS is unknown.

in adapting a physiotherapeutic assessment of hemiplegia for computerised "problem-orientated medical records".

Table 3 shows that thirty-nine physiotherapists were selected for Sample A, and twenty-seven of them produced data during the first field test.

TABLE 3

NUMBERS OF PHYSIOTHERAPISTS IN SAMPLE A AND SAMPLE B

	Sample A	Sample B	Totals
Number of volunteers	62	41	103
Transferred from A to B	13	13	
Withdrew before field test	10	15	25
Number in selected sample	39	39	78
Non-responding group	12	14	28
Data-producing group	27	25	

Selection of Sample B for the second field test: Table 3 also shows that Sample B could be selected from forty-one new volunteers and thirteen of the original volunteers who had not been selected for Sample A. Before sampling was undertaken, two factors were considered:

1. Ten volunteers had withdrawn before the first field test, for domestic reasons such as pregnancy, or because of occupational changes. Some were promoted to managerial posts. Principally, junior staff, who were gaining experience in different specialities, were moved to specialities which were inappropriate to SMAC.
2. Three members of Sample A had withdrawn from the second field test for similar reasons.

It was expected that potential members of Sample B would be similarly affected. To ensure that the sample would be adequate, no volunteer was excluded from participation in Sample B. In

the event, fifteen withdrew before the start of the second field test (Table 3).

TABLE 4

THE SAMPLES OF PHYSIOTHERAPISTS

Version of Chart	Volunteers	Sample of Data Collectors	Number of Data-Collectors	Number of Data-Collectors	Data-Producers as Proportion of Data Collectors	Number of Non-Respondents
Prototype Pilot Study	6	6	6	6	100%	0
Preliminary 1st Field Test A	62*	39 ^a	27	27	69.2%	12 ^d
Interim A	27	24 ^b	22	22	91.6%	2 ^e
Second Field Test B	54	39 ^c	25	25	64.1%	14 ^f
A + B	78	63	47	47	74.6%	16

KEY

- a,b,c: Withdrawals due to domestic and occupational changes before the start of the Field Tests, (a = 10; b = 3; c = 15) = 28
- d: Displays stolen with contents of car=1; Unsuited for adaptation to POMR = 1; Unsuited for Brunstrom's method = 1; Insufficient time to participate = 2; Displays said to be lost in transit = 3; Reasons not given = 3 Total = 12
- e: Participant temporarily overseas = 1; Unsuited for Brunstrom's method = 1 Total = 2
- f: No hemiplegic patients referred during Field Test = 8; Unsuited for Brunstrom's method = 1; Reason not given = 5. Total = 14
- * 56 respondents to invite plus 6 participants in Pilot Study.

Attrition of selected samples of physiotherapists

Table 4 shows that the proportions of both Sample A and Sample B who produced data were above 60 per cent. The reasons for attrition of the samples are given as footnotes to this table.

Identification of significant groups who did not produce data:

It was necessary to determine if those who had not produced data had withdrawn for reasons antagonistic to SMAC or to some aspect of its development. The members of samples A and B who did not produce data from the second field test were tabulated in parallel with those who did not respond to the postal questionnaire which was sent out at the beginning of that field test. Table 5 shows that some responded to the postal questionnaire or attended the study day, or did both, even though they did not produce data from the field test. Similarly, some produced data from the field test or attended the study day, but did not respond to the postal questionnaire.

There are two significant groups amongst those who did not produce data from the field test or respond to the questionnaire. They are likely to hold opinions of SMAC which are different to those held by respondents to the postal questionnaire (Section 3.4):

1. Two physiotherapists withdrew because they found SMAC unsuitable for use with Brunnstrom's method. Two physiotherapists had withdrawn from the first field test for the same reason.

These four physiotherapists were from North America.

Brunnstrom's method appears to be rarely used in the United Kingdom (see section 3.4.4) Therefore their withdrawal does not affect the acceptability of SMAC to British physiotherapists.

TABLE 5

TABULATIONS OF LOSSES FROM SECOND FIELD TEST AND POSTAL SURVEY

SECOND FIELD TEST	POSTAL QUESTIONNAIRE DURING SECOND FIELD TEST
Selected Samples A and B = 63	Number surveyed A & B = 63
Data producers = 47 ^{a,b}	Respondents = 44 ^{a,c}
	Number who did not respond = <u>19</u>
Number who did not produce data = <u>16</u>	Produced Field Test data and attended Study Day = 3** (16)
Responded to questionnaire = 3++	Produced Field Test Data = 3
Attended Study Day = 5	Attended Study Day = 5
Enquired later = 1	Enquired later = 1
Used Brunnstrom's method, withdrew = 2	Used Brunnstrom's method, withdrew = 2
Number not traced = <u>5</u>	Number not traced = <u>5</u>

Key:

- a: Includes one Norwegian and one Swiss participant
- b: Includes three participants who did not return the Postal Questionnaire but attended the Study Day
(Asterisked ** on Postal Questionnaire Table)
- c: Includes three participants who did not produce data from the Field Test.
(Marked ++ on Field Test Table)

2. Five members were not traced. Three members of Sample A were also untraced after the first field test (cf. Table 4, d: reasons not given).

These eight volunteers did not respond to letters of enquiry, and it may be assumed that they withdrew because they found the chart unacceptable. There may be other reasons. For example, one member of Sample A who did not produce data from the second field test was not traced for fifteen months, until she returned from overseas and enquired about the development of the chart.

TABLE 6

ANALYSIS OF RESPONSE TO THE FIELD TESTS AND THE POSTAL QUESTIONNAIRE

<u>First Field Test</u>			
$N_1 = 39$	$n_1 = 28^*$	$p = .72$	
	$n_2 = 11$	$q = .28$	
			$\hat{n} = 25$
<u>Second Field Test</u>			
$N_2 = 63$	$n_1 = 47$	$p = .75$	
	$n_2 = 16$	$q = .25$	
			$\hat{n} = 21$
<u>Postal Questionnaire</u>			
$N_3 = 63$	$n_1 = 44$	$p = .7$	
	$n_2 = 19$	$q = .3$	
			$\hat{n} = 27 (27.4)$

* Includes one peripatetic physiotherapist who collected data which was stolen with the contents of her car.

Where \hat{n} = the estimated size of the responding sample for 95% confidence in the data.

p = the proportion of the sample who collected data or responded to the questionnaire.

q = the proportion of the sample who did not respond for reasons known to be or might be assumed to be associated with the chart and the project.

N = the size of the sample.

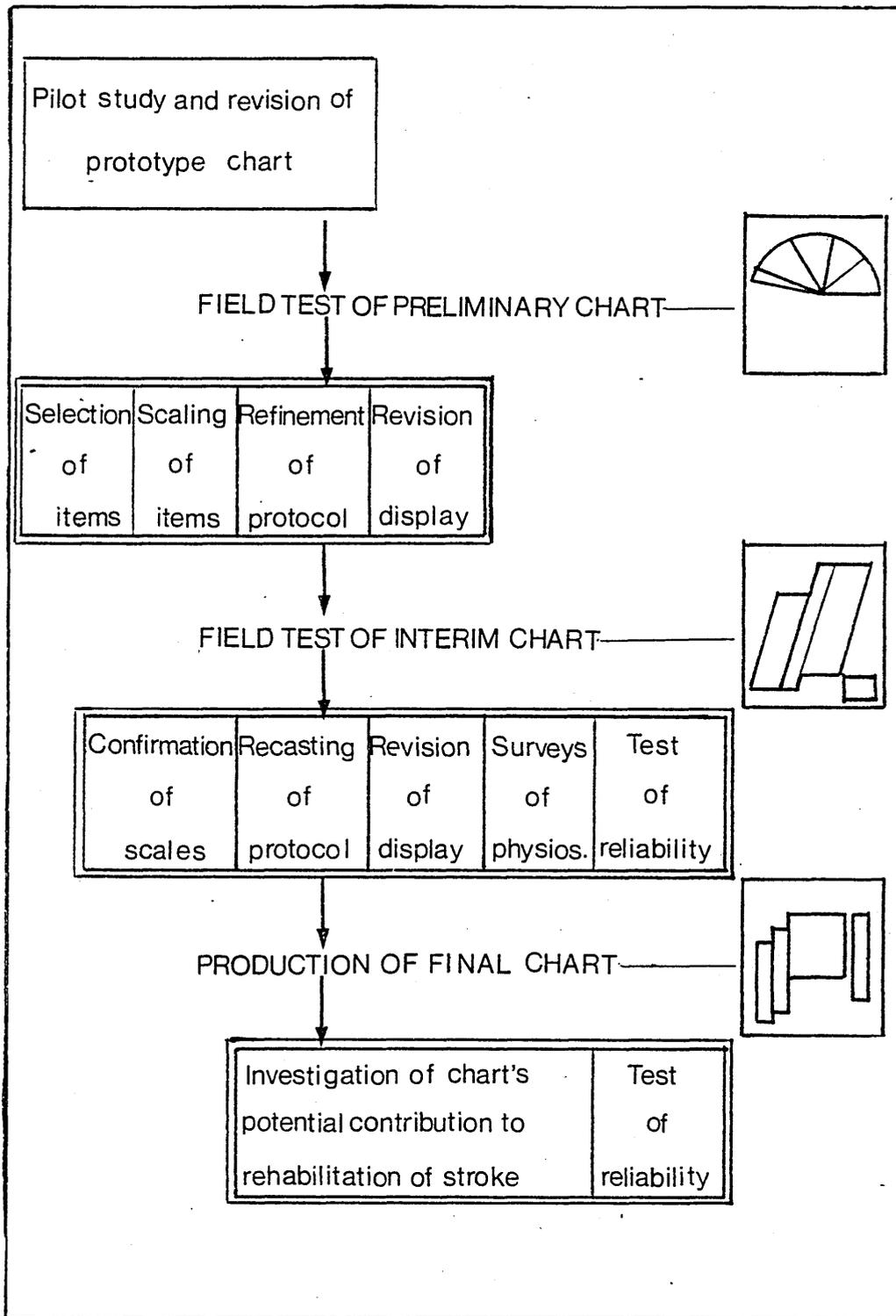
64 is the binomial variable for 95% confidence.

Confidence in the data on which SMAC is founded

In order to be confident that revisions and evaluations of SMAC were not based on fragile data (cf. section 2.7.2), estimates of the required sizes of responding samples were calculated from the rates of response to both field tests and to the postal questionnaire (Table 6: N_1 , N_2 , N_3). In each case, the number of respondents is greater than the estimate (\hat{n}), to the extent that the responding sample can be considered representative at a level of confidence better than 95 per cent.

FIGURE 19

DIAGRAMMATIC REPRESENTATION OF THE DEVELOPMENT OF SMAC



3.1.2 Presentation of data

The chronological order of events is shown in Figure 19, with a replica of the shape of each display of the findings of the assessment as it evolved. The procedures, tests and results are presented in four sections:

- 3.2: Development of the protocol of items of assessment
- 3.3: Development of the display
- 3.4: Evaluation of the chart's acceptability to physiotherapists
- 3.5: Evaluation of the chart's potential contribution to rehabilitation of stroke patients.

This order of presentation is related to fulfilment of specifications for the performance and appearance of SMAC. These are drawn up on the basis of (A) criteria of clinical and scientific acceptability of an optimal assessment identified in section 2.4.3; and (B) factors identified during discussion of procedures for satisfying these criteria in sections 2.5, 2.6 and 2.7. The specifications are as follows:

1. The assessment should be brief and easy to administer.
2. The protocol of items should be an adequate and comprehensive description of recovery from hemiplegia.
3. The items should assess degrees of resolution of impairment and disability.
4. The items should form an ordinal and cumulative scale.
5. Each item should require assessors to make a categorical judgment of "pass" or "fail", or "able" or "not able".
6. Each item should be reproducible.
7. The chart should display the patient's status and his progress between assessments.
8. The display should assist planning and monitoring of physiotherapy.

FIGURE 20

SUMMARY OF TECHNIQUES USED TO COLLECT DATA

PURPOSE FOR WHICH DATA WAS REQUIRED	PROVIDERS OF DATA	TECHNIQUE OF COLLECTION	INSTRUMENT OF COLLECTION
Selection and scaling of items of assessment	Patients	Observation	Preliminary SMAC
Confirmation of validity of scale(s)	Patients	Observation	Interim SMAC
Evaluation of chart's acceptability to physiotherapists	Physiotherapists	Questioning	Questionnaire
Testing of reproducibility and stability	Physiotherapists	Observation	Interim SMAC and Final SMAC
Investigation of chart's potential contribution to rehabilitation of stroke patients	Patients	Questioning and Observation	Interview schedules and Final SMAC
	Practitioners		

9. The display should demonstrate the relationship between resolution of impairment and resolution of disability.
10. The display should discriminate between a patient's ability in the assessment room, or physiotherapy department, and his typical performance elsewhere.
11. The display should assist communication of physiotherapeutic rationales of treatment, relative to realistic expectations of the patient's performance at a given time.
12. The display should give users with different aims ready access to information they want and need.

With regard to Wright's comment concerning the specifications for good instructions accompanying consumer products, which were discussed in section 2.5.3, the major problem concerning the design of an assessment also is "knowing how to meet the specifications" (Wright, 1981). Following a search of the literature to identify existing assessments, techniques of the survey approach to collection of data were most appropriate to collection to the type of data which were required. These are summarised in Figure 20 (cf. Section 2.7).

3.2 DEVELOPMENT OF THE PROTOCOL OF ITEMS OF ASSESSMENT

Fundamentally, the development of the protocol followed a process of reduction. More precisely, in order to consider and describe physiotherapy for hemiplegia it was necessary, first of all, to reduce an extremely complex subject to a series of comparatively few critical and significant issues, the items of assessment. While hemiplegic patients were intended to generate items (cf. section 2.5.1), selection of specific items for the protocol of SMAC was grounded in the needs and requirements of physiotherapists.

A small group of experienced physiotherapists used the prototype assessment in the pilot study. The majority of participants contributed to field tests and revisions of the preliminary and interim versions. Additionally, they discussed their requirements and preferences at a study day which was held end of the field test of the interim version. Inter-observer reliability¹ of the items was also tested at this meeting.

In order to meet specifications for the performance of the assessment, several aims were described for the development of the protocol

1. Description of a protocol of items to assess the motor function of hemiplegic patients
2. Arrangement of the items along an ordinal scale from "least recovered" to "most recovered".

1. Commonly, the term "reproducibility" is used to describe the extent to which the same results are obtained from different assessors who use an assessment at the same time. Here, this quality is called "inter-observer reliability" in order to avoid ambiguity. "Reproducibility" is used only to describe one of the characteristics of a Guttman scale, in the sense of the coefficient of reproducibility.

3. Estimation of the validity of the scale for representing recovery from hemiplegia.
4. Refinement of the protocol so that resolution of impairment and resolution of disability are assessed independently.
5. Testing the inter-observer reliability of the items of assessment.
6. Presentation of the items in a manner which utilises the assessors' sequence of tasks.

These aims were fulfilled during two years of tests and revisions which are presented under the following headings:

- 3.2.1 The prototype protocol
- 3.2.2 The preliminary protocol
- 3.2.3 The interim protocol
- 3.2.4 Tests of inter-observer reliability
- 3.2.5 The items of assessment of function of the upper limb
- 3.2.6 Presentation of items of the final SMAC
- 3.2.7 The SMAC index of rate of recovery

FIGURE 21

THE PROTOTYPE PROTOCOL*

CHART PROTOCOL: Note that only NORMAL postures and patterns of movement should be recorded.					
	SIDE LYING	SITTING	STANDING	WALKING	
Can maintain NORMAL POSTURE with SUPPORT at:	4 Trunk, arm, leg, head. 3 Arm, leg, head. 2 Arm, head. 1 None needed.	4 Both sides: back, arm, head. 3 Back, arm, head. 2 Arm, head. 1 Supporting seat only.	4 BOTH sides: arms, trunk, AFFECTED knee 3 AFFECTED side: arm, trunk, knee. 2 AFFECTED arm. 1 None needed.	4 Both sides: Zimmer frame 3 Affectd side: physio/ndpwr 2 Affectd side: stick 1 None needed	
Can TRANSFER WEIGHT in relation to base	X	3 Anteroposteriorly 2 ON AFFECTED buttock 1 ON UNAFFECTED buttock	3 ON AFFECTED foot 2 ON UNAFFECTED foot 1 Anteroposteriorly in step	3 Forward step 2 Backward step 1 Side step a) Unaffected b) affected	
Can move segments SEQUENTIALLY	TO SUPINE 4 Shoulders leading 3 Hips leading TO PRONE 2 Shoulders leading 1 Hips leading	2 To turn to UNAFFECTED side 1 To turn to AFFECTED side	2 To turn to UNAFFECTED side 1 To turn to AFFECTED side	5 Flexes knee with hip extended 4 Clears ground with toes dorsiflexed 3 Strikes heel with positive support. 2 Rotates hips for weightbearing 1 Swings arm contralaterally	
Can ISOLATE movements segmentally	3 Head turning 2 Trunk rotation a) shoulders against hips b) hips against shoulders 1 Limbs against trunk a) arm b) leg	3 Head turning 2 Trunk rotation a) shoulders against hips b) hips against shoulders (twisting) 1 Limbs against trunk a) AFFECTED arm b) across AFFECTED leg over unaffected	3 Head movements 2 Trunk rotation a) shoulders against hips b) hips against shoulders 1 Limbs against trunk: (arm swinging)	3 Strikes heel with positive support. 2 Rotates hips for weightbearing 1 Swings arm contralaterally	
Can BEAR WEIGHT	2 ON AFFECTED ELBOW 1 ON EXTENDED AFFECTED ARM (To Side Sitting)	Bears weight 2 ON AFFECTED ELBOW 1 ON EXTENDED AFFECTED ARM (12 & 11)	Takes weight on BOTH FEET	Takes weight through AFFECTED leg and TRANSFERS WEIGHT on each foot	EQUAL stance phases on each foot
Can CHANGE POSTURE	ROLLS 1 Prone to supine 2 Supine to prone	SIDE SITS on floor SITS on SIDE OF BED	a) over UNAFFECTED arm b) over AFFECTED arm	Takes weight through AFFECTED leg and TRANSFERS WEIGHT on each foot	a) sideways b) single steps forwards c) cyclically

*Reduced from A4 format

3.2.1 The prototype protocol

Introduction:

The aim at this initial stage was radical and complex. That is, the pivotal precept was that hemiplegic patients should generate items for their own assessment. Consequently, items had to be listed which would allow data to be collected in an amenable form.

Seventy-four items of assessment were described according to the principles discussed in section 2.5.1:

- A. The position in which the patient would perform each item.
- B. The degree of control of movement required.

The items were listed in columns, from left to right, according to positions requiring increasingly finer control of balance; and in rows, from top to bottom of the page, requiring increasing control of voluntary movement (Figure 21).

Assessors were required to judge the patient as "able" or "not able" to perform each item on the basis of whether his performance was acceptable as normal or was considered to require further treatment. For convenience, items were referred to as "passed" or "failed".

Methods:

The researcher pre-tested the protocol by assessing four patients. Six experienced physiotherapists, of Senior I or Superintendent grades, each assessed and reassessed two patients during a pilot study lasting two months. They also recommended revisions for the production of the preliminary version.

Results:

The physiotherapists found that the procedure was compatible with their working methods; and that aims of treatment which could be formulated from a "failed" item were compatible with their subjective assessments. They were dissatisfied with items performed in side lying position. In general they found that administration and recording of items took an inordinate length of time.

Discussion:

The main problem was encountered by the researcher as well as the physiotherapists: the assessment was time-consuming to administer and to record. The main difficulty lay in identification of each item on the protocol and then in locating it on the record. Although the physiotherapists' comments were dated, it was not possible to estimate the extent to which unfamiliarity contributed to the problem.

Firstly, a new assessment needs expenditure of time.

Secondly, there were too many items to be remembered easily.

Thirdly, it was felt that, because only two patients were assessed by each physiotherapist, the interval between each use of the chart was too long to enable assessors to become familiar with the assessment.

Inevitably and necessarily, attention was concentrated on these shortcomings of the prototype protocol so that appropriate revision could be carried out. However, the results also indicated that the assessment had some advantages over published assessments, such as formulation of aims from "failed" items. These factors suggested that the protocol might be refined to create the type of protocol at which the investigation was aimed.

Recommendations:

1. In order to reduce the time it takes to make an assessment, a smaller number of items should be identified which describe the process of motor recovery unequivocally.
2. In order to give assessors easier access to items, items should be numbered consecutively in columns.
3. In order to avoid confusion between the protocol of items and the record of the findings, items performed in side lying should be recast as items performed in supine. (This topic is discussed in section 3.3: The development of the display.)
4. In order to avoid conflict between physiotherapists' clinical commitments and their participation in the field test of the preliminary assessment, physiotherapists should not be asked to assess more than two patients.

FIGURE 22

THE PRELIMINARY PROTOCOL *

Protocol:



	SUPINE LYING	SITTING	STANDING	WALKING
SUPPORT	1. Trunk, arm, leg, head. 2. Arm, leg, head. 3. Arm and/or head. 4. None needed.	1. Both sides, back, arm, head. 2. Back, arm, head. 3. Arm and/or head. 4. Supporting seat only.	1. Both sides, arm, trunk, associated arm. 2. AFFECTED side, arm, trunk, knee. 3. AFFECTED arm. 4. None needed.	1. Both sides, head, trunk, knee. 2. AFFECTED side, wrist. 3. UNaffected side, wrist. 4. None needed.
TRANSFER OF WEIGHT		5. OFF AFFECTED buttock. 6. OFF UNaffected buttock. 7. Anteroposteriorly.	1. foot level. 2. OFF AFFECTED foot. 3. OFF UNaffected foot. 4. Onto AFFECTED leg, forwards in step.	Forward step, backward step. Side step 5"/2", with UNaffected leg. 6"/10", with AFFECTED leg.
SEGMENTAL MOVEMENT	Turns Head! 5. To UNaffected side. 6. To AFFECTED side. Rotates Trunk! 7. To UNaffected side. 8. To AFFECTED side. 9. Rotates pelvis (bridged). 10. Places AFFECTED hand on opposite shoulder. 11. Lower AFFECTED arm from elevation and returns it. 12. Places AFFECTED arm from elevation 13. Extends AFFECTED leg.	Turns Head! 8. To UNaffected side. 9. To AFFECTED side. Rotates Trunk! 10. To UNaffected side. 11. To AFFECTED side. 12. Knees forward/backwards in chair. 13. Places AFFECTED hand on opposite shoulder. 14. Lower AFFECTED arm from elevation and returns it. 15. Crosses AFFECTED leg over unaffected	Turns Head! 8. To UNaffected side. 9. To AFFECTED side. Rotates trunk! 10. To UNaffected side. 11. To AFFECTED side. 12. Places AFFECTED hand on opposite shoulder. 13. Lower AFFECTED arm from elevation and returns it. 15. Crosses AFFECTED leg over unaffected	11. Rotates knee with hip extended 12. Foot clear, ground with toes horizontal. 13. Strides 1-1. 14. Rotates hips for weight-bearing. 15. Swing's arm contralateral.
BEARS WEIGHT		16. Bears weight on AFFECTED elbow. 17. On EXTENDED AFFECTED arm.	14. Takes weight equally on both feet.	16. Walks reactively.
CHANGES POSTURE	Rolls over UNaffected side. 15. To prone. 16. To supine. Rolls over AFFECTED side. 17. To prone 18. To supine	Slide side on bed side. 18. Over UNaffected side. 19. Over AFFECTED side. 20. Transfers to chair.	15. Slides up with help. 16. Slides up unaided.	17. Slides up and down.

* Reduced from A4 format

3.2.2 The preliminary protocol

Introduction:

Following the pilot study, a preliminary protocol of seventy items was produced when the items performed in side lying were recast as items performed in supine (Figure 22). It was aimed to select thirty to forty of these items for the interim chart and to arrange them in a cumulative scale to describe recovery from hemiplegia.

Methods:

A sample of physiotherapists was selected by the non-probability method of sampling described in section 3.1.1. Each physiotherapist received a "trial pack" containing copies of the protocol and the display, and a set of instructions.

So that both the items and their order could be based on the recovery of hemiplegic patients, participants were asked to assess at least two patients: one patient who suffered a CVA during the field test, or immediately before it, and one patient who was recovering. Assessors were instructed to make re-assessments at intervals they considered appropriate to the progress of each person. They were also asked to write down and date their comments as they made assessments.

So that assessors could contribute to selection of items, they were asked to mark one copy of the protocol:

- A. with two asterisks against up to twenty items which they considered to be essential;
- B. with one asterisk against up to ten items which they considered to be "highly desirable";

- C. by deleting items which they considered to be repetitive or otherwise redundant

They were also asked to:

- D. identify ambiguous items, and to clarify them, if possible, by writing alternative descriptions;
- E. list other items which they thought should be included in the protocol.

Participants in South Yorkshire were each visited once during the field test. The researcher used these visits to assess four patients independently. On two occasions she observed assessments, recorded her judgments and compared her record with the assessor's.

TABLE 7

NUMBER OF CATEGORICAL DATA FOR ANALYSIS FROM FIELD TEST OF PRELIMINARY PROTOCOL

Number of hemiplegic patients assessed	n = 61
Number of items of assessment categorised "passed" or "failed"	k = 70
Data for analysis	nk = 4270

Analyses:

The data were collated and analysed in five steps:

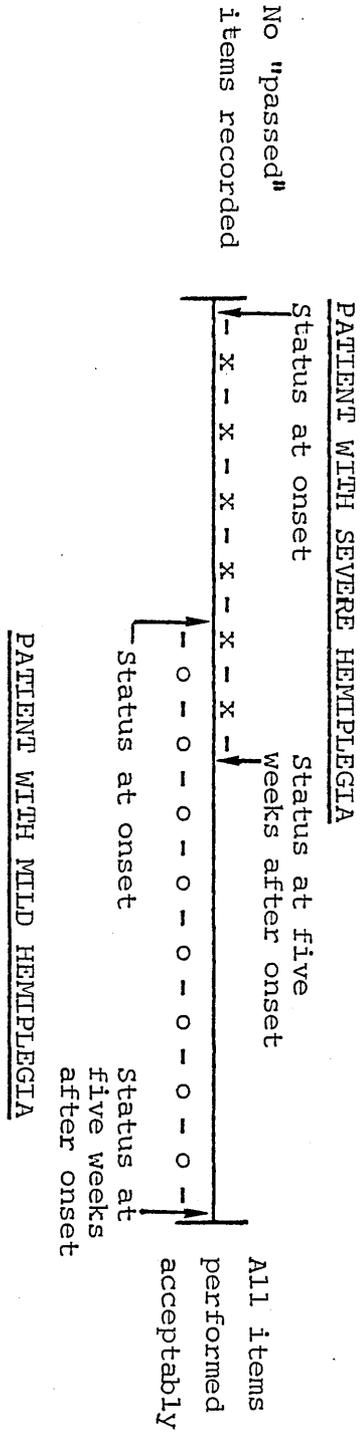
1. An informal mutivariate analysis was made to investigate the ordinality of items.
2. A taxonomic study was made of clusters of items which were identified during the multivariate analysis, in order to identify items which had an ordinal relationship with each other.

3. Identified items were subjected to Guttman scalogram analysis.
4. The homogeneity of the Guttman scale of items was tested.
5. The protocol of items was refined in preparation for the production of the interim assessment.

Results are reported in the above order, with a brief description of the analysis at the head of each report. Detailed analyses will be found in Appendix I.3.

FIGURE 23

THE APPARENT "RECOVERY CONTINUUM"



Results:

1. The informal multivariate analysis

The records were analysed (A) according to the intervals between each patient's CVA and the dates of his assessments; and (B) according to each patient's apparent level of recovery from inspection of the record.

This analysis demonstrated a continuum from onset of hemiplegia to recovery with items of assessment clustered along it. This orderly sequence represented the status and progress of patients who were "least recovered" as well as those who were "most recovered". More specifically, a patient with mild hemiplegia could perform items at his first assessment made within a week of his CVA which a severely affected patient could not perform until his second or third assessment, three, four, or five weeks after his CVA. Both mildly affected patients and severely affected patients appeared to progress along the continuum in the same sequence of restitution of control of movement and balance (Figure 23).

2. Taxonomic study of clusters of items

The clusters of items which had been identified at the multivariate analysis were reviewed in conjunction with frequency counts of items which participants had asterisked or deleted.

Twenty-nine items were identified which had an ordinal and predictable relationship with each other. These items are listed in Table 8. Thirty-two redundant or variable items were eliminated. Thirteen items had special characteristics, as follows:

Items assessing function of the upper limb:

Only one of these items had a fairly constant, ordinal relationship with other items (Table 8, item 15). This item assessed a patient's ability to bear weight through his affected arm. This ability is directly related to his ability to move from lying in bed to sitting on the side of the bed on his affected side (item 17).

The remaining items which assessed function of the upper limb were unpredictable. They could not be arranged in a scale with the selected twenty-nine items. Seven of them, which held the most constant relationships with each other, were selected for a scale assessing "Arm Function" for the interim protocol.

Pairs of associated items:

Two pairs of items were identified in which the members of each pair were closely associated with each other.

1. "Flexion of the lower limb" and "extension of the lower limb" in supine:

Both of these items held the same rank. They were combined into

one item to assess whether or not a patient moved his lower limb in pathological patterns of total extension or total flexion, or elements of them. The new item could also be used to assess if muscle tone was below normal (item 7).

2. "Transference of weight off affected buttock" and "transference of weight off unaffected buttock" in sitting:

Transference of weight from buttock to buttock in sitting is a component of balance of the trunk in sitting. It is also used to move the buttocks on a seat to reach a suitable position from which to stand up. Hemiplegic patients bear most of their weight, sometimes all of their weight, through the unaffected side. Therefore, transference of weight from the unaffected buttock on to the affected buttock is the most important item of this pair. They were recast as one item (item 10).

Recasting of the final item of the scale:

The assessors identified the item "steps up and down" as recording a patient's ability to step down onto his unaffected leg. That is, hemiplegic patients are able (A) to step up onto either leg, and (B) to step down onto the affected leg, before they are able (C) to step down onto the unaffected leg. Stepping down requires muscles to "pay out", or to work as they are lengthening, in order to control flexion of the standing leg and to lower the body down. Therefore, the item holding the final rank in the scale was taken to represent "stepping down onto the unaffected leg" (item 29).

TABLE 8

THE SCALE OF TWENTY-NINE ITEMS AND THEIR COEFFICIENTS OF REPRODUCIBILITY

Rank	Description	CR
1	Lies in normal posture: supine	1.00
2	Turns shoulders to <u>affected</u> side: supine	0.91
3	Turns shoulders to <u>unaffected</u> side: supine	0.94
4	Turns shoulders to <u>unaffected</u> side: sitting	0.94
5	Turns shoulders to <u>affected</u> side: sitting	0.97
6	Rolls to <u>affected</u> side-independently	0.91
7	Flexes and extends <u>affected</u> leg	0.91
8	Bridges	0.91
9	Rolls to <u>unaffected</u> side-independently	0.94
10	Transfers weight from buttock to buttock	0.94
11	Transfers weight anteroposteriorly: sitting	0.94
12	Has sitting balance	0.88
13	Stands up from sitting-with assistance	0.94
14	Crosses <u>affected</u> leg over unaffected: sitting	0.97
15	Bears weight through <u>affected</u> forearm: sitting	0.85
16	Turns shoulders to <u>affected</u> side: standing	0.98
17	Sits up from lying over <u>unaffected</u> side - indep.	0.88
18	Turns shoulders to <u>unaffected</u> side: standing	0.98
19	Sits up from lying over <u>affected</u> side - indep.	0.98
20	Transfers from seat to seat - independently	1.00
21	Walks - with assistance	0.94
22	Taps <u>unaffected</u> foot: standing	1.00
23	Steps with <u>unaffected</u> leg	1.00
24	Stands up from sitting - independently	0.98
25	Walks - independently with aid	0.98
26	Releases <u>affected</u> knee: standing	0.98
27	Steps forward onto <u>affected</u> leg	1.00
28	Walks - unaided	1.00
29	Steps down onto <u>unaffected</u> leg	0.98

Unless otherwise stated, items are performed without help from an assistant or aid

3. The Guttman scalogram analyses

A matrix was constructed using (A) the postulated scale of twenty-nine items identified during the taxonomic study and (B) data collected from patients who had been assessed within twenty-eight days of their CVAs. The extent of the correspondence between the postulated scale and the data was estimated by calculation of Guttman scale coefficients. (cf. Appendix I.2)

From inspection of the matrix it was apparent that the scale was able to discriminate between more severely affected patients and less severely affected patients throughout the process of recovery.

Co-efficients of reproducibility:

This coefficient expresses the proportion of "errors", or incorrect predictions, to the total number of "passed" and "failed" items. Conventionally, a coefficient which is equal to or greater than 0.9 confirms the existence of a unidimensional scale which has "construct validity". That is, the scale makes good theoretical sense and will truthfully represent, in this case, recovery from hemiplegia. This statistic was readily attained: CR = 0.946 (Table 9, column 1).

Additionally, the coefficient of each item should be equal to or above 0.85. The coefficients of reproducibility calculated for each item are given in Table 8.

For twenty-six out of the twenty-nine items, the coefficients are above 0.9; and for six of them, perfect correspondence was achieved (items 1, 20, 22, 23 27 and 28).

The minimum coefficient was obtained for item 15. This is the item of assessment of the upper limb which was identified as the only one which could be included in the main scale.

TABLE 9

COEFFICIENTS OF REPRODUCIBILITY AND SCALABILITY CALCULATED FOR
THE SCALE OF TWENTY-NINE ITEMS AND ARBITRARY SUB-SCALES

Type of Data	1	A*	B*
n	32	25**	25**
k	29	14	14
Σ MM	634	238	248
Σ E	50	25	19
<u>CR</u>	0.946	0.93	0.946
MMR	0.68	0.68	0.709
%IMP	0.26	0.25	0.24
<u>CS</u>	0.83	0.78	0.814

Key:

n: number of subjects

k: number of items

Σ MM: sum of maximum marginal frequencies

Σ E: sum of errors

CR: coefficient of reproducibility

MMR: minimum marginal reproducibility

%IMP: percentage improvement

CS: coefficient of scalability

* Correlation between scales A and B: $r_s = 0.987$

** Seven patients who could pass only item 1 were excluded when this item was excluded.

Coefficient of scalability:

If this coefficient is calculated to be well above 0.6 a scale is said to be cumulative and to have "predictive validity". That is, the scale can be used to predict performances for which evidence is not immediately available. For this scale, the coefficient of scalability was 0.83 (Table 9, column 1: CS).

Table 9, columns "A" and "B", gives the Guttman coefficients which were calculated for two arbitrary sub-scales used in the test of homogeneity (4). Excluding item 1, one scale contained fourteen even-numbered items and the other contained fourteen odd-numbered items. As a further test of reproducibility and scalability, the coefficients obtained for each scale are well above minimum acceptable levels.

4. Homogeneity of the scale

The extent of homogeneity was tested using the "split-half" technique for estimating internal consistency. Alternate items were cast into two arbitrary scales; and the correlation between the two scales was calculated using the Spearman Rank Order test for non-parametric data (Appendix I.1)

In order to use the Spearman Rank Order test for non-parametric data, which requires an even number of items, item 1 was excluded. This item was chosen because it was the lowest item of the scale, it was passed by all patients, and it did not affect the ability of the scale to discriminate between individuals.

Correlation was calculated between two arbitrary scales of fourteen odd-numbered items and fourteen even-numbered items: Spearman's rho (r_s) was calculated to be 0.987, which is significant at the 0.01 level. This confirmed that the whole scale had internal consistency and was homogeneous.

5. Refinement of the protocol of items

Two sub-scales were identified which assessed resolution of impairment and resolution of disability respectively. These scales were also tested using the Guttman technique.

The twenty-eight items which were used to confirm the homogeneity of the scale readily divided into two unequal clinical scales:

A scale of seventeen items was seen to assess resolution of impairment. This scale was called "The Physiotherapy Items".

A scale of eleven items assessed resolution of disability, and they were called "The Gross Functional Items".

Matrices were constructed for each of these scales; and coefficients of reproducibility and scalability were calculated for each of them (Table 10). The coefficients confirmed that each scale was cumulative and unidimensional, and that, respectively, they represented resolution of impairment and resolution of disability truthfully.

1. Please note: The international classification of impairments, disabilities and handicaps (WHO, 1980) had not been published at this stage of the research.

TABLE 10

COEFFICIENTS OF REPRODUCIBILITY AND SCALABILITY CALCULATED FOR
THE SCALES OF "PHYSIOTHERAPY ITEMS" AND "GROSS FUNCTIONAL ITEMS"

Type of Data	"Physiotherapy Items"	"Gross Functional Items"
n	25	25
k	17	11
ΣMM	303	193
ΣE	25	16
<u>CR</u>	0.94	0.94
MTR	0.713	0.702
%IMP	0.23	0.24
<u>CS</u>	0.795	0.804

Key: See Table 9

Discussion

The aim of the field test of the preliminary protocol was to select thirty to forty items which could be arranged in a cumulative scale to describe resolution of hemiplegia.

Two methods of gathering data about patients and medical conditions have been described: the "sponge mode" and the "search mode" (DeGroot and Siegler, 1979). The "sponge mode" is said to provide voluminous information which may smother relevant data and divert attention from it. The "search mode" is presented as a method of collecting clinically significant data which is particularly relevant to the patient's current treatment and his eventual outcome from it.

The Sheffield Motor Assessment Chart is intended to employ the "search mode" of enquiry into each patient's motor status and progress towards recovery. Consequently, if a small number of items could be identified which (A) are significant in the process of recovery from hemiplegia and (B) are constellatory in the information they convey to physiotherapists, the assessment would be both less fatiguing for a patient to undergo and less time-consuming for a physiotherapist to administer. The findings might also be more readily communicated to other practitioners in the rehabilitation team.

The characteristics of a Guttman scale:

The analyses suggest that the preliminary protocol of seventy items could be reduced to a main scale of twenty-nine items. The Guttman scale coefficients calculated for this scale, and for four sub-scales, confirmed that the "recovery scale" had

"construct validity" and "predictive validity". The items which assess function of the upper limb needed further investigation.

The predictive function is the most important implication of a valid Guttman scale. It confers special characteristics on a physiotherapy assessment which is intended to record change during a period of time. The obtained coefficients were sufficiently high to permit prediction of a patient's achievement (A) on the postulated "recovery scale" and (B) on the sub-scales of "Physiotherapy Items" and "Gross Functional Items".

1. Taking a "passed" item of any rank on the main scale or on a sub-scale: if the two preceding items had been passed, it could be predicted that all precedent items had been passed.
2. Taking a "failed" item of any rank on the main scale or on a sub-scale: if the two succeeding items had also been failed, it could be predicted that all subsequent items would be failed.

This predictive validity has important implications for the conduct and termination of all assessments. For example, if, as is common, a patient is met when he is sitting in a chair, and he is able to "pass" appropriate items in sitting, it would be unnecessary to assess precedent items performed in supine. This would reduce the number of items the patient would need to perform and, consequently, the time it takes a physiotherapist to conduct an assessment. Alternatively, if the assessment was progressing from items performed in supine, and the patient could not perform items further up the scale, the physiotherapist would have an accurate indication of when to terminate the assessment without underestimating his ability. Consequently,

a patient would not be required to attempt more items than were absolutely necessary. The record would also inform other practitioners whether or not their expectations of the patient were unrealistic at that time. Walking is probably the most obvious example, because so many self-care activities are vested in the ability to walk: but the record might show that walking was beyond the patient's capacity at that time.

This predictive ability was not implemented during revision of the preliminary protocol. Rather, it was set aside until it had been confirmed with fresh data. If the data from the field test of the preliminary protocol had been misapprehended, such an alteration in the procedure of the assessment would have jeopardised the data from the field test of the interim assessment.

Scaling and the needs of practitioners:

The aim of Guttman scaling is to select about ten dichotomous items which are related to the fewest number of errors. However, this aim may not be consistent with specifications for the performance of the assessment. These specifications are concerned with conveyance of meaning in a readily understandable manner. Although communication is most obviously concerned with the display of the findings, it needed to be taken into account when the protocol was revised. In particular, the adequacy of the scale of eleven "Gross Functional Items" needed to be improved.

For example, the ability to transfer from one chair to another was assessed only once in the Guttman scale of Gross Functional

Items (Table 8, item 20). From its rank, it could be inferred that the item assessed the independent performance of patients who assisted themselves by leaning on the arms of a chair or another aid.

Physiotherapists could be expected to have attained concepts of posture, balance and movement in order to make such inferences, However, the cognitive processing needed to comprehend and integrate information contained in items ranked higher and lower than item 20 was unlikely to assist other users to gain access to the information they want. Nor would it help the communication of rationales of treatment.

Therefore, the scale of Gross Functional items was extended, both to inform possible assistants and to demonstrate even small steps of progress to the patient. The participants advised that two classes of performances should be used:

- A. a class of performances which are assisted by another person;
- B. a class of independent performances which the patient might make "with aid" (such as walking stick) or "without aid", and "to the affected side" or "to the unaffected side".

Two items were also added to the scale of Physiotherapy Items:

1. An item labelled "steps up onto affected leg" was added because the final item had been interpreted as stepping down on to the unaffected leg.
2. Normal gait requires flexion of the knee joint while the hip is extended, and flexion of the hip joint while the knee extends. This is a more complex, or more recovered, pattern of movement than that required in item 7. Therefore, a new item was described to assess the normalisation of muscle tone and the "break up" of pathological patterns of total flexion and total extension.

FIGURE 24

THE PROTOCOL OF ITEMS DESCRIBED FOR THE INTERIM ASSESSMENT

The Physiotherapy Items

1. Turning to affected side: supine
2. Turning to unaffected side: supine
3. Turning to unaffected side: sitting
4. Turning to affected side: sitting
5. Flexion and extension of affected leg: supine
6. Bridging
7. Weight transference from buttock to buttock: sitting
8. Weight transference anteroposteriorly: sitting
- *9. Affected leg over bedside and return: supine
10. Crossing affected leg over unaffected thigh: sitting
11. Weight bearing through affected forearm: sitting
12. Turning to unaffected side: standing
13. Turning to affected side: standing
14. Tapping unaffected foot on ground: standing
15. Stepping with unaffected leg
16. Releasing affected knee: standing
17. Stepping forward onto affected leg
- *18. Stepping up onto affected leg
19. Stepping down onto unaffected leg

The Gross Functional Items

- *A. Rolling: with assistance
- B. Rolling to affected side: independently
- C. Rolling to unaffected side: independently
- *D. Moving from lying to sitting: with assistance
- E. Balancing without support in sitting
- F. Standing up from sitting and sitting down: with assistance
- G. Moving from lying to sitting over unaffected side: independently
- H. Moving from lying to sitting over affected side: independently
- *I. Transferring from seat to seat: with assistance
- *J. Standing up from sitting, and sitting down: independently with aid
- K. Transferring from seat to seat: independently with aid
- L. Standing up from sitting, and sitting down: independently of all aid and assistance
- M. Standing up from sitting, and sitting down: independently of all aid and assistance
- *N. Transferring from seat to seat: independently of all aid and assistance
- O. Walking: independently with aid
- *P. Climbing and descending stairs: independently with aid
- Q. Walking: independently of all aid and assistance
- *R. Climbing and descending stairs: independently of all aid and assistance

* Items marked with an asterisk were added at the request of participants or to complete the classes of the scale of Gross Functional Items.

Conclusions

At this stage, the general aim for the development of the preliminary protocol had been fulfilled: the number of items had been reduced, and the selected items had been arranged in a cumulative scale. Consequently, two of the main aims for the development of the protocol had also been satisfied:

1. A protocol of items to assess the motor function of hemiplegic patients had been described.
2. The items had been arranged in an ordinal scale from "least recovered" to "most recovered".

Additionally, the third and fourth aims were partially fulfilled:

3. The validity of the scale for representing recovery from hemiplegia needed to be reconfirmed against fresh data.
4. The protocol had been refined so that resolution of impairment and resolution of disability were assessed independently; but the validity of the scales of Physiotherapy Items and Gross Functional Items needed to be tested.

The protocol of the interim assessment is listed in Figure 24.

It reflects the items listed in Table 8 very closely.

Items which are asterisked were included in order to meet specifications for the performance of the assessment.

FIGURE 25
HEADINGS USED TO STANDARDISE THE PHYSIOTHERAPY ITEMS IN THE MANUAL

HEADINGS	ASPECTS OF ASSESSMENT
Starting position:	Described according to the fundamental and derived starting positions of exercise therapy ¹ .
Instruction:	Performance to be assessed expressed as an instruction to the patient ² .
Disqualifiers:	Pathological components of each performance which, if observed, disqualify a performance from being recorded.
Remark:	Additional information for assessor.
Demonstrates:	Description of abilities which the performance demonstrated.
Precedes:	List of Gross Functional Items which succeeded the Physiotherapy Item on the Guttman scale.

1. For example, close standing; see Gardiner (1960).
2. The patient should perform independently and the assessor should not provide proprioceptive or cutaneous input to facilitate a movement.
3. Disqualifiers and remarks were listed principally for the information of less experienced physiotherapists to assist their judgment.

3.2.3 The interim protocol

Introduction:

The Physiotherapy Items were standardised using the headings shown in Figure 25 and an instructional manual was produced for the field test of the interim assessment (Appendix IV). The interim protocol was field tested for three months with the general aim of reconfirming (A) the validity of the postulated scales of Physiotherapy Items and Gross Functional Items, and (B) that they belong to the same uniform scale of recovery.

Methods:

Copies of the interim assessment, an instructional manual and a poster (Appendix IV) were sent to participating physiotherapists in a "trial pack". Each physiotherapist was asked to assess at least two patients, and to reassess them at intervals appropriate to the progress of the individual patient during three months.

Forty seven participants, seventy-five per cent of those who were sent trial packs, returned a total of one hundred and thirty-three records. Reasons for which twenty-five per cent did not produce data have been given as footnotes to Table 3.

All one hundred and thirty-three charts could not be used in analyses. Three charts were discarded immediately, because the assessor had used an idiosyncratic method of recording her findings. Of the remaining one hundred and thirty charts, no Physiotherapy Items were recorded on nine of them and no independently performed Gross Functional Items were recorded on forty-one charts.

The data were analysed in the light of information provided in writing by participants in the field tests and during discussion by physiotherapists who attended the study day.

Analyses

Six analyses were undertaken:

1. Review of participants' comments and their recommendations.
2. Estimation of the reproducibility and scalability of the postulated scale of Physiotherapy Items.
3. Estimation of the reproducibility and scalability of the postulated scale of Gross Functional Items.
4. Estimation of the reproducibility and scalability of the unified scale of Physiotherapy Items and Gross Functional Items.
5. Estimation of the correspondence between achievement and progress on the scale of Physiotherapy Items and on the scale of Gross Functional Items.
6. Evaluation of the ability of the scale of Physiotherapy Items to predict the results of patients' performances.

Results are reported in the above order, with a brief description of the analysis at the head of each report. Detailed analysis can be found in Appendix I.4.

Results:

1. Participants' comments and recommendations concerning specific items

Comments which were written during the field test and on the postal questionnaire were collated. Specific items were identified and were discussed with physiotherapists who attended the study day.

The Physiotherapy Items:

Participants considered that four of the Physiotherapy Items were redundant (cf. Figure 24):

- Item 5 : "Flexion and extension of the affected leg", because the movement was assessed by Item 9.
- Item 6 : "Bridging". This was a highly controversial item. Some participants considered it highly undesirable; others used the movement in treatment and thought it highly desirable item of assessment.
- Item 7 : "Transference of weight from buttock to buttock: sitting" was considered to be assessed with items 3 and 4: "Turning to the unaffected side/affected side: sitting". Items 3 and 4 are performed with the arms in forward reach position and weight is transferred as the body is turned.
- Item 14: "Tapping unaffected foot". This item assessed a patient's ability to bear weight through his affected leg; which was also assessed by item 13: "Turning to the affected side: standing". Again, weight is transferred onto the affected leg as the trunk and arms are turned to the affected side. Secondly, weight transference was assessed more dynamically by item 15; "Stepping with the unaffected leg".

Participants also recommended that item 11: "Weight-bearing through the affected forearm: sitting", should be transferred to the assessment of the upper limb to extend that scale (See section 3.2.5)

The Gross Functional Items

To ensure the safety of patients, assessors had been asked to exercise clinical judgement when recording the Gross Functional Items. At the study day, some assessors said that they had screened their assessments before recording them. That is, those who had used the display to communicate information about the status and progress of their patients to other practitioners had made recordings according to the known or expected skill of likely assistants. Other assessors had not offered the display of the findings of their assessments to other practitioners but had recorded performances which they had assisted.

Consequently, if the skill of the assistant had been considered imperative for a patient's safety, some assessors had not recorded a patient's ability to perform an item of the assisted class of Gross Functional Items until minimal assistance was required.

This problem had not arisen in the field test of the preliminary protocol: all assessors had recorded performances which they assisted because the preliminary display had not been intended to assist communication (See Section 3.3). Participants recommended that these items should be recast in a new section of the assessment which recognised the exercise of clinical judgment more specifically.

2. The reproducibility and the scalability of the postulated scale of Physiotherapy Items

Two matrices were constructed using data collected from one hundred and twenty-one patients. The scale of nineteen Physiotherapy Items listed in Figure 24 was used for the first matrix. For the second matrix, a scale of fourteen items was used, following exclusion of the five items which were recommended for elimination or transfer by the participants. The extent of the correspondence between the scale of fourteen items and the process of recorded recovery of one hundred and twenty-one patients was estimated by calculation of the Guttman scale coefficients.

The matrix of nineteen items

This matrix was constructed so that the influence could be observed of items which participants recommended for exclusion or transfer:

Items 5 and 6 were responsible for the same patterns of error in the records of more than five per cent of patients. Therefore, these items would have been excluded on the basis of an auxiliary criterion (Appendix I.2), had exclusion not been recommended by participants.

Items 7, 11 and 14 had no apparent detrimental effect on the matrix.

Consequently, item 11 was transferred to the assessment of the upper limb as requested. Items 5, 6, 7 and 14 were eliminated from the scale: Firstly, because the intention was to produce a scale of items (A) which were significant in the process of recovery, and (B) which were acceptable to all assessors. Secondly, because items 5 and 6 did not fulfil the Guttman criterion. Thirdly, because items 5 and 7 had required manipulation following the field test of the preliminary protocol.

Coefficients of reproducibility and scalability of the scale of fourteen items

The matrix constructed using these items showed that the scale was able to discriminate between individuals at different levels of recovery, or between groups of individuals where several

were at the same level. This ability was confirmed by the coefficients which were obtained (cf. Table 11: Physiotherapy Items, "All items"). They are well above the minimum acceptable levels.

Table 11 also gives the coefficients which were obtained after application of the auxiliary criterion stipulating exclusion from calculations of all items which are "passed" or "failed" by more than eighty per cent of patients (Physiotherapy Items, "Items less than 80% popular"). These coefficients confirm that the scale is a truthful representation of recovery from hemiplegia.

TABLE 11
COEFFICIENTS OF REPRODUCIBILITY AND SCALABILITY CALCULATED FOR THE POSTULATED
SCALES OF THE INTERIM ASSESSMENT

	PHYSIOTHERAPY ITEMS		GROSS FUNCTIONAL ITEMS		UNIFIED SCALE
	All items	Items less than 80% popular	All items	Items less than 80% popular	
COEFFICIENT OF REPRODUCIBILITY	0.97	0.95	0.95	0.94	0.92
COEFFICIENT OF SCALABILITY	0.87	0.83	0.82	0.82	0.75
Range of coefficients of reproducibility of individual items	0.92-1.00	0.92-0.98	0.91-1.00	0.9-0.98	0.88-0.97

3. The reproducibility and scalability of the independently performed items of the postulated scale of Gross Functional Items

Two matrices were constructed. The first matrix was constructed using data from one hundred and twenty-eight patients and the scale of eighteen Gross Functional Items listed in Figure 24. The second matrix used data from eighty-nine patients and twelve items which were performed independently by the patient. Guttman scale coefficients were calculated for the latter scale.

The matrix of eighteen items

This matrix illustrated the varying uses of the assisted class of Gross Functional Items described by assessors, which mitigated against their scalability. These items were responsible for patterns of error in more than five per cent of records. Consequently, they were excluded from the scale.

Coefficients calculated for the independently performed items

The matrix constructed using these items showed that an item which had been added when the interim protocol was drawn up needed to be relocated (Figure 24, item J). After this was done, the coefficients of reproducibility and scalability which were obtained showed a very good approximation of the postulated scale to the data (Table 11, Gross Functional Items, "All items"). When items which were "passed" or "failed" by more than eighty per cent of patients are excluded from calculations, the coefficients show that the statistics calculated for the whole scale of independently performed items are not spuriously high.

4. Reproducibility and scalability of the unified scale of
Physiotherapy Items and independently performed Gross
Functional Items

The unified "scale of recovery" was reconstituted. Guttman coefficients were calculated using those items which were "passed" or "failed" by less than eighty per cent of patients.

The coefficients, given in Table 11, "Unified Scale", confirm the existence of a single unidimensional scale. More specifically, they show that the items of the tested scales of Physiotherapy Items and independently performed Gross Functional Items are still members of the same unidimensional scale which represents recovery from hemiplegia.

5. Estimation of correspondence between progress on the scale of Physiotherapy Items and progress on the scale of Gross Functional Items

The Spearman Rank Correlation Coefficient was calculated (A) to determine the homogeneity of the unified scale, and (B) to determine the extent of the association between resolution of impairment (achievement on the scale of Physiotherapy Items) and resolution of disability (achievement on the scale of Gross Functional Items).

The statistics obtained from four samples of patients are given in Table 12. The samples are:

- A: patients assessed in less than eight days after their CVAs.
- B: patients assessed between seven and twenty-nine days after their CVAs.
- C: patients assessed between twenty-eight and eighty-five days after their CVAs.
- D: patients assessed more than eighty-four days after their CVAs.

TABLE 12

RANK ORDER CORRELATION COEFFICIENTS CALCULATED FOR INTERIM PROTOCOL

Samples	A	B	C	D
n	25	33	26	28
r_s	0.63	0.79	0.77	0.64
p <	0.001	0.001	0.001	0.001

The probability of obtaining values of the Spearman Rank Correlation Coefficient, r_s , as large as those calculated is less than 0.001. Confirmatory statistics, in terms of the student's t for all samples and Kendall's tau for sample A, are given in Appendix I:4.

These results:

- (A) confirm the homogeneity of the unified scale; and
- (B) demonstrate a direct relationship between status and progress along the scale of Physiotherapy Items and status and progress along the scale of independently performed Gross Functional Items. Consequently, the relationship between resolution of impairment and resolution of disability is also demonstrated.

6. Evaluation of the predictive ability of the scale of
Physiotherapy Items

Theoretically, because a Guttman scale is cumulative, it should be possible to use characteristics of a valid scale to make an assessment briefer and more convenient to use by reducing the number of items a patient is required to perform.

The utility of the predictive ability of SMAC was tested by estimation of the proportions of the population of hemiplegic patients for whom the order of "passed" and "failed" items would be correctly or wrongly predicted by the scale of Physiotherapy Items. The number of errors, or items which were incorrectly predicted, were counted in up to four reassessments of one hundred and twenty-one patients. Additionally, the number of assessments was counted in which two, three and four or more errors occurred in succession.

Correct predictions

There is 99 per cent confidence that the scale of Physiotherapy Items will predict "passed" and "failed" items correctly for 0.71 ± 0.1 patients who are assessed for the first time with SMAC ; and for 0.7 ± 0.14 patients assessed a second time. The samples were too small for proportions of the population to be estimated for third and fourth assessments.

Incorrect predictions

There is 99 per cent confidence also that only 0.04 ± 0.03 assessments will contain two or more incorrect predictions, and that 0.96 ± 0.034 of all assessments will contain only two or fewer incorrect predictions.

Utility

These estimates support the conclusion drawn from the test of the preliminary protocol. The procedure for use of SMAC can be described, on the probability of $p = 0.01$, that two errors are likely to occur using the scale of Physiotherapy Items.

This procedure can also be applied to the scale of independently performed Gross Functional Items, since a high level of correspondence between this scale and the scale of Physiotherapy Items has already been demonstrated.

FIGURE 26

THE RELATIONSHIP OF THE PROTOCOL TO THE WHO CLASSIFICATION OF IMPAIRMENTS,
DISABILITIES AND HANDICAPS

Classes of the Interim Protocol	WHO Classification	Classes of the Final Protocol	Place of assessment
Physiotherapy Items	Impairment	Quality of Movement	Tested in assessment room
Independently performed Gross Functional Items	Disability: Functional limitation	Functional Ability	
Gross Functional Items performed with assistance	Disability: Activity restriction	Activity Capability	Judged with regard to patient's living environment

Discussion

The scales of independently performed Physiotherapy Items and Gross Functional Items have been improved against a second set of data in a way which will make the assessment both briefer and easier to administer.

The assisted class of Gross Functional Items could not be scaled to record restitution of motor function sequentially with independently performed items, of either the scale of Physiotherapy Items or the scale of Gross Functional Items. To fulfil the needs of practitioners for information about the level of a patient's performance, these assisted items cannot be excluded from the display (see section 3.3). Therefore, an alternative means of describing them for the display is required.

The international classification of impairments, disabilities and handicaps was published at the time these data were analysed (WHO, 1980). It appeared to offer a means of presenting the items of assessment according to the needs of practitioners. The relationships between this classification and the interim and final versions of the protocol are summarised in Figure 26. The protocol which was recast according to the classification is presented in Figure 27.

Functions of the protocol:

In order to distinguish a patient's ability, or his optimum performance in the assessment room, from his typical performance in his living environment, very similar items are assessed under Functional Ability and Activity Capability. The assessment of Functional Ability restates the independently performed Gross Functional Items; whereas the assessment of Activity Capability includes the assisted class of Gross Functional Items which could not be scaled. In the second case, the assessor is asked to exercise clinical judgement to record if the patient will be safe performing alone, using a mechanical aid or entirely independently; or if he needs the assistance of another person.

Like the Physiotherapy Items and the independently performed Gross Functional Items, the assessment of Quality of Movement assesses resolution of impairment, and the assessment of Functional Ability assesses resolution of disability.

Confirmation of both direct association between these two scales and the utility of the predictive function of a valid Guttman scale permit the procedure of the assessment to be facilitated. More specifically, 92.6 to 97.4 per cent of all assessments made with SMAC are likely to contain two, one or no incorrect predictions. Therefore:

Firstly, if a patient can pass, say, item 5, and two immediately adjacent items, it is unnecessary to assess preceding items: the patient should perform them acceptably also.

Secondly, if he fails, say, item 7, and two immediately adjacent items, the assessment can be terminated: he can be expected to fail all succeeding items.

Thirdly, from knowledge of the highest item he has passed, an exact description of his status can be given, with regard to the stated items of assessment. Additionally, if he has been assessed on each occasion, the extent of his progress can be described.

Conclusions

Following the field test of the interim protocol, the third and fourth aims for the development of the protocol have been satisfied:

The validity of the "scale of recovery" for representing recovery from hemiplegia has been confirmed;

the association between resolution of impairment and resolution of disability has been tested and proven.

The protocol has been recast according to the international classification of impairments, disabilities and handicaps; and the procedure for use has been adapted to accommodate utilitarian modifications of the characteristics of a valid Guttman scale. The inter-observer reliability of each item has yet to be tested.

3.2.4 Tests of interobserver reliability

Introduction:

Two tests were carried out:

- 1 Evaluation of the inter-observer reliability of the items of the interim protocol.
- 2 Evaluation of the inter-observer reliability of items described for the final protocol.

The methods and results of each will be described separately. Detailed reports will be found in Appendix I.4.

1 The inter-observer reliability of the items of the interim protocol

Procedure:

The test was carried out at the study day for participants.

Preparatory to the test, the researcher was videotaped while assessing four hemiplegic patients:

- A: A patient whose progress had been hindered by a deep vein thrombosis, was over eighty years of age and had a left sided spastic hemiplegia following a CVA five months previously.
- B: A patient who had been confined to a wheelchair since a CVA four years earlier. He had suffered another CVA a month previously, was over 60 years of age and had a right sided spastic hemiplegia with expressive aphasia.
- C: A patient who was over seventy years of age and had a left sided hypotonic hemiplegia following a CVA less than three months previously.
- D: A patient whose date of discharge from hospital was forecast. He was over fifty years of age and had right sided hypotonic hemiplegia with expressive aphasia following a CVA less than three months previously.

Thirty-six physiotherapists watched the videotapes and recorded their assessments simultaneously. They fed their results into a micro-computer program which had been written to provide a print-out of frequency counts for discussion.

The data were retested at a later date when the Binomial Test was applied to data from the following samples of physiotherapists:

- N: All observers N = 36
- n₁: Observers who had used the preliminary and interim versions in the field tests n₁ = 8
- n₂: Observers who had used only the interim version in a field test n₂ = 15
- n₃: Observers who had not participated in a field test of either version n₃ = 13

Results:

The probability of reliable use was calculated to be highly significant for all items except those listed in Table 13. That is, where $p > 0.01$ it is assumed that an item is inadequately standardised so that assessors use it unreliably.

TABLE 13

THE PROBABILITY OF SPECIFIC ITEMS PRODUCING UNRELIABLE FINDINGS IN AN ASSESSMENT

Patient	A	B	C	D
Gross Functional A* Items (With Assistance) I		0.2	0.7	
Physiotherapy 4 8 15 Items 17 19		0.12	0.31 0.03	0.07 0.12 0.15
Gross Functional B Items (Independently) E		0.34 0.12	0.12	

*See Figure 24 for key to items

Discussion:

Simultaneous recording by thirty-six observers demonstrates accumulation of errors which might not be apparent if the data had been provided by a small sample. This could be achieved by showing videotaped assessments; because direct observation by so many observers might be intimidating for a patient, and because each observer would have a different view of the patient and the assessor. However, observation of videotapes is also unsatisfactory and, according to their responses to the study day questionnaire (section 3.4.2), observers who had participated in the field test of the interim assessment.

- A. thought that they did not understand the items of assessment as well when they were watching the tapes;
- B. found the items of assessment more difficult to remember and to apply to what they were seeing;
- C. had more difficulty recording their assessments.

The effects of the variables on the results of the test of inter-observer reliability cannot be estimated. Two sources of unreliability could be clearly identified.

1. One source of unreliability was the idiosyncratic use of the assessment by some experienced assessors. They had ignored instructions in the manual regarding the fundamental and derived starting positions for the Physiotherapy Items. They were using the assessment in a sophisticated manner, by using a patient's ability to perform the Gross Functional Items to qualify his performances of Physiotherapy Items.
2. Four of the Gross Functional Items were apparently

unreliable. Discussion focussed on the use of the display to communicate with other practitioners. Even if a patient could perform an item acceptably with the assessor's assistance or in the assessment room, it was not recorded until the assessor was satisfied that the patient would be safe with any assistant or in any situation which was likely to be more hazardous. Despite the fact that they were participating in a test of reliability, assessors said that they still screened their results as they had clinically.

Conclusions:

1. The use of Gross Functional Items to qualify assessment of Physiotherapy Items was considered to be too complicated for less experienced physiotherapists for it to be written into the procedure for use of SMAC. It was recognised that a standardised procedure might be used idiosyncratically, and that modifications by users cannot be prevented.
2. Clinical judgment or screening, should be accommodated by allowing performances of Gross Functional Items in different situations, as well as with less skilful assistants, to be recorded. The participants also wanted the context of the patient to be taken into account. For example, patients should be assessed walking from one place to another, such as bedroom to dayroom, because this would have functional significance.

3. The reliability test should be repeated with a smaller sample of physiotherapists who could observe patients directly from the same vantage point.

2. The interobserver of reliability of the items
of the final protocol

Procedure:

Six physiotherapists directly observed assessments of three patients who had been chosen by the assessor to demonstrate items which are assessed at different stages of recovery.

- A: A patient who could walk with supervision and occasional assistance.
- B: A patient who could stand up from sitting in a chair independently but could not walk without assistance.
- C: A patient who did not have control of his balance in sitting.

The quick but mathematically inelegant method of analysis described by Maxwell (1961) was used to evaluate the variances of recordings. Particular attention was paid to items which had been found to be unreliably used at the previous test (Figure 27, Items 4, 5, 11, 12 and 14 and Items A and F).

Results:

Variance is at its maximum when the proportion of assessors judging the item to be failed equals the proportion judging it to be passed. When either proportion is less than twenty per cent, the variance of an item decreases rapidly until it reaches its minimum when one proportion is zero. A significant result is obtained when variance is less than 0.21.

The results in Table 14 are acceptable for all but item 9, which is not an item which was identified at the previous test of inter-observer reliability. The variance of item 9

TABLE 14

VARIANCE OF ITEMS OF THE FINAL PROTOCOL

Items of assessment of quality of movement	Variance	Items of assessment of functional ability	Variance
1	0.00	A*	0.0475
2	0.00	B	0.00
3	0.075	C	0.00
4*	0.15	D	0.075
5*	0.075	E	0.00
6	0.00	F	0.00
7	0.00	G*	0.12
8	0.12	H	0.075
9	0.24	I	0.00
10	0.2	J	0.00
11*	0.12	K	0.12
12*	0.00	L	0.00
13	0.00	M	0.00
14*	0.00	N	0.00

* Item which was unreliably used at previous test.

See Figure 27 for key to items.

is associated with the higher than average variance of item 10 and the variance of item K. More specifically, in order to maintain her balance, the patient concerned sought occasional support from the assessor while she was performing these items. Therefore, according to the instructional manual, no pass should have been recorded.

Conclusions:

Results show that the items are reliable, if the instructions are adhered to. Variance is attributed to observers' errors, and the standardisation of the items is presumed to be adequately precise. Therefore, the fifth aim for the development of the protocol is fulfilled.

3.2.5 The reproducibility and scalability of the items assessing the function of the upper limb

Introduction:

Following multivariate analysis of data collected during the field test of the preliminary assessment, all but one of the items which assessed function of the upper limb had been excluded from the main scale of items (Section 3.2.2). A separate protocol of items, called the "Arm Function" scale, was devised for the interim assessment (Figure 28). It was aimed to test the scalability of these items and to evaluate their adequacy.

Method:

Guttman scalograms were constructed using 924 items of categorical data provided by one hundred and thirty two patients.

The scale and assessment of the upper limb in general were discussed with physiotherapists who attended the study day.

Results:

TABLE 15

COEFFICIENTS OF REPRODUCIBILITY AND SCALABILITY OBTAINED FOR ITEMS ASSESSING FUNCTION OF THE UPPER LIMB

	Data from all first assessments	Data from all first and second assessments
Coefficients of reproducibility	0.9	0.95
Coefficients of scalability	0.73	0.78

The coefficients are well above the minimum acceptable levels and the scale can be said to be homogeneous and unidimensional. However, because there are fewer than ten dichotomous items in this scale, strictly the coefficients can only be taken as indicating scalability and reproducibility. Therefore, the scalogram technique was repeated with several subsamples, and detailed analyses will be found in Appendix I.2.

Although 132 records were received, the coefficients for first assessments are based on data from only fifty-two patients: no passed items were recorded for eighty patients, or 60.6 per cent, at their first assessments. Similarly, no passed items were recorded for 54.5 per cent of patients who were assessed twice. Conversely, 14.4 per cent of patients passed all items at their first assessments.

Discussion:

Physiotherapists who attended the study day criticised this scale because it "did not start low enough" to assess a minimum level of function and because it "did not end high enough" to describe functional recovery.

Their first criticism is supported by the evidence that no passed items were recorded for 60.6 per cent of patients at their first assessments. Consequently, it was necessary to describe an item which would rank below the current first item of the scale. Such an item was described using the first and second items of the scale of Physiotherapy Items.

In order to perform items 1 and 2 of the scale of Physiotherapy Items, the patient starts in lying with his hands clasped together on his chest. Then he stretches his arms upwards and straightens

his elbows before turning towards his affected side (item 1) or his unaffected side (item 2). He is allowed to move his affected arm passively with his unaffected limb; but he will be unable to do this if the muscles of his shoulder girdle and arm are hypertonic. In that state, the spastic muscles would hold the limb in the typical hemiplegic posture (Figure 4) and would resist being stretched. Consequently, the patient would be unable to protract his shoulder and straighten his elbow passively.

This passive movement was taken as the first item of the assessment of the upper limb; and, therefore, it became the base line for the whole assessment. That is, if the patient could not protract his shoulder on the affected side, he would be unable to turn his shoulders or rotate his trunk towards the unaffected side (Figure 27, item 2). If he could not turn his shoulders, he would be unable to roll over in bed to lie on his unaffected side (Figure 27, item C).

The physiotherapists' second criticism, that the scale did not end high enough, was made because functional activities were not tested by the items of this scale. It was expected that these activities would be tested by the assessments of ADL made by occupational therapists. It was agreed that some provision should be made for physiotherapists who wish to record functional activities, or who do not work with an occupational therapist. Additionally, the small number of patients who passed all items of the interim scale, and who might recover independent movements of the fingers and thumb, should also be accommodated.

Conclusions:

The scale of items of the upper limb for the final assessment is shown in Figure 28 alongside the items of the interim

assessment. Three additional items are listed: the new items at either end of the scale, and item 11 of the scale of Physiotherapy Items which was transferred to this scale at the request of the participants.

FIGURE 28

ITEMS OF ASSESSMENT OF THE UPPER LIMB

ITEMS OF THE INTERIM CHART	ITEMS OF THE FINAL CHART
Placing in elevation	Passive movement Placing in elevation
Touch top of head	Weightbearing through forearm Touch top of head
Lowering and raising of limb	Lowering and raising of limb
Supination and pronation	Supination and pronation
Touch shoulder with palm	Touch shoulder with palm
Reaching with hand	Reaching and holding with both hands
Grasping and releasing	Grasping and releasing
	Opposition of thumb to fingers

3.2.6 Presentation of items of assessment in the instructional manual

Introduction:

General advice is available concerning both the conduct of medical and physiotherapeutic examinations (Bomford, Mason and Swash, 1976; Parry, 1980) and the content of instructional manuals (Cronbach, 1970). However, there is no information about the way in which instructional information is sought and found in a manual.

While presentation of introductory and descriptive material cannot be ignored, it is the presentation of the items of assessment which requires the greatest attention to detail. The recommendations discussed in section 2.5.4 suggest that assessors would be able to use SMAC more easily if the same basic patterns were used to describe each item of assessment. According to assessors' reports concerning the interim assessment, they found remembering the items more difficult than understanding, applying or recording them (cf. section 3.4.2). Uniformity would make items easier to remember: application and recording, as well as remembering would be facilitated if the uniform pattern were related to the assessors' behaviour. This appears to involve three areas:

- A. The way in which assessors look for information in a manual.
- B. The sequence in which the tasks of the assessment are undertaken.
- C. The way in which assessors can be enabled to use their own skills within a standardised procedure.

Therefore, before the manual to the final SMAC was drafted, these factors were investigated in order to decide what information should be given to assessors about items of assessment and how it should be presented.

Method:

In order to observe the way in which they found information they needed:

- A. Thirty-six students of physiotherapy were observed and questioned while they used for the first time the manual accompanying the interim assessment.
- B. Physiotherapists who participated in the field test of the interim assessment were observed and questioned while they were making assessments. The order in which the following tasks were carried out was noted:
 - 1. Identification of an item of assessment.
 - 2. Instruction of the patient.
 - 3. Assessment of the performance.
 - 4. Location of the item on the display.
 - 5. Recording of the judgement.

Results:

A. Use of the manual

Neither qualified physiotherapists nor students made immediate use of the table of contents. They "flipped through" the pages of the manual until they saw a relevant sign post or recognised the shape of text on a page. The students used the table of contents if a sign post, such as a heading, was not immediately evident. Firstly, they looked for the

items of assessment; secondly, they looked for a description of the display; thirdly, they read about the procedure of the assessment. Physiotherapists who had used SMAC before looked for the items of assessment only.

B. The sequence of tasks

With regard to the application of each item, a sequence of seven tasks was identified concerning:

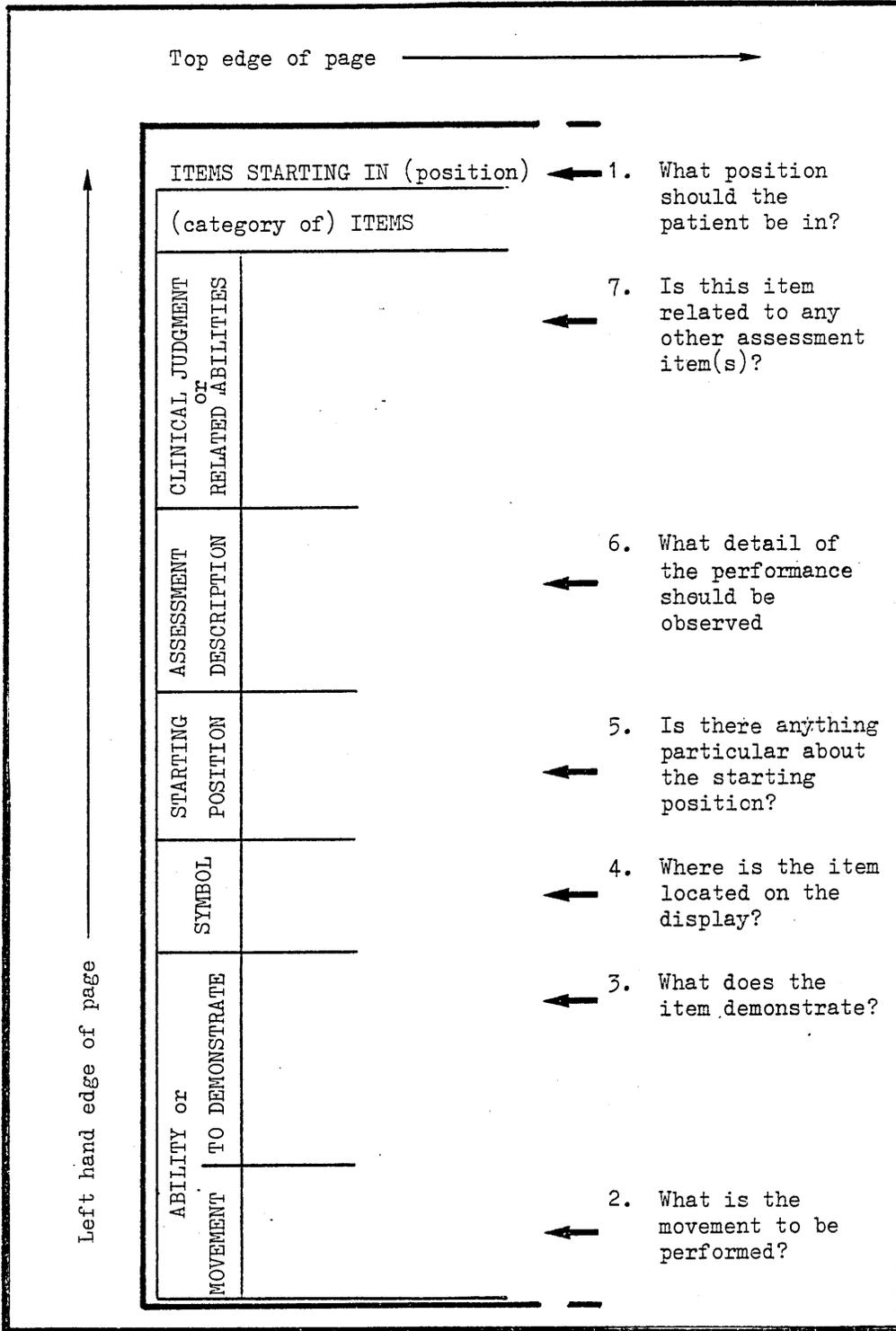
1. The position of the patient - lying, sitting, standing.
2. The basic movement to be performed, or the ability to be assessed.
3. For items assessing Quality of Movement, what the movement demonstrated.
4. The location of the item on the display.
5. The detailed starting position.
6. The detailed description of the performance.
7. Other items of assessment with which this item is associated.

C. The skills of assessors

"Disqualifiers", or pathological components of a movement which would disqualify a performance from being recorded as a "pass", were listed with each item of the interim assessment (see Figure 25). They were described on the basis of observations made by skilled and experienced assessors, and many of them were appropriate to more than one item. Therefore, in order both to allow assessors to use their own skills to apply the items and to reduce the amount of printed information, it was felt that this information should be grouped in some way, rather than listed with each item.

FIGURE 29

LAYOUT OF ITEMS IN THE MANUAL



Conclusions:

The layout of the items in the manual was organised with regard to the users' sequence of tasks. This is shown in Figure 29 in terms of the questions assessors were seeking to answer at each stage. Hence:

1. In order to assist assessors in finding the items of assessment they were printed on green paper.
2. A double page spread was allocated to all items performed in any one position; taking account of the fact that the conflict of convenience is resolved in favour of the patient (see section 2.5.4).
3. Each item was described as shown in Figures 29.
4. Disqualifiers were printed at the foot of the double-page spread.
5. Physiotherapeutic terminology was used in order to save space and a glossary was printed on the final page of this section.
6. The procedure was printed on the first page of this section.

The manual will be found in Appendix V.

3.2.7 The SMAC index of rate of improvement

Introduction:

Medical consultants who were interviewed during the last stage of the project expressed a need for a quantitative measure of patients' progress. Some physiotherapists also considered that an index might assist members of rehabilitation teams to reach decisions about the continuation or termination of a patient's treatment. Consequently, the protocol was reviewed in order to investigate the feasibility of providing such an index and to identify data which might be utilised.

Available data:

1. Fourteen items on each of the scales of Quality of Movement and Functional Ability
2. The rank of the highest item a patient passes at the first assessment and at reassessments. (Items on the Functional Ability scale can be ranked 1 to 14 for this purpose.)
3. The time elapsed from the patient's CVA to his current assessment.

Principles of the index:

1. The scales of assessment are cumulative. Therefore, each item which is passed can be called an "improvement".
2. Theoretically, no failure to pass an item should occur in a recorded sequence of passed items. Therefore, such failures are treated as random errors for the purposes of determining both the rank of the highest item at

the first assessment and the number of improvements achieved.

Method of calculating a patient's index:

- A. Calculate the number of improvements a patient needs to achieve in order to reach the top of a scale, according to his ability at his first assessment:

A = 14 - rank of highest item passed at first assessment

- B. Calculate the number of improvements he has made since his first assessment:

B = rank of highest item achieved at current assessment
- rank of highest item passed at first assessment

- C. Add up the number of weeks lapsed since his first assessment

- D. Apply the figures to the following formula:

number of improvements made since first assessment (B)	number of improvements needed at first assessment (A)
_____	x
number of weeks since first assessment (C)	

- E. "Round" the product up or down to the nearest whole number.

- F. Sum the indices of the scales of assessment of Quality of Movement and Functional Ability.

F is the SMAC Index.

Examples:

Examples are given in Table 16.

TABLE 16

EXAMPLES OF THE SMAC INDEX

Patient	Scale	Entry Level	Imps* Needed	Improvements achieved and indices					Final Index
				Week 1	Week 2	Week 3	Week 4	Week 5	
A	QM	4	10	3	4	5	9	10	20
	FA	4	10	2	4	5	8	8	16
	SMAC			50	30	33	42	36	36
B	QM	5	9	4			9	20	20
	FA	6	8	4			6	12	12
	SMAC			68			32	32	32
C	QM	5	9		4	18	7	16	16
	FA	7	7		4	14	7	12	12
	SMAC					32	28	28	28
D	QM	7	7	1	4	14	6	11	11
	FA	3	11	5	8	44	8	22	22
	SMAC			62	58		33	33	33
E	QM	9	5	3		5	8		8
	FA	11	3	2		2	2		2
	SMAC			21		10			10

* Imps = improvements; QM = Quality of Movement; FA = Functional Ability

Discussion:

The index possesses the required qualities of describing a patient's rate of progress according to (A) his status immediately after his CVA, (B) his progress along the Guttman scales, and (C) the length of time for which he has received treatment.

Table 16 has several interesting features which require further evaluation:

1. Severely affected patients appear to make comparatively rapid progress in the early weeks after their CVA, which may be overlooked because they are not yet capable of performing any or many activities.
2. The rate of improvement of each patient may vary from time to time, for reasons which may be individual or may be due to independent variables.
3. The rate of improvement of all patients appears to diminish as recovery progresses.

However, the index also presents some unsatisfactory features:

Firstly, it is necessary to manipulate the product of the calculation to produce an integer. While representation of the patient's status by an absolute number can be criticised, representation of his rate of progress by an imperfect number is also undesirable.

Secondly, the index has no base line. Of itself, this does not invalidate the index: there is no base to the Guttman coefficient of reproducibility. However, the indices calculated for each person appear to be unique; and it is not possible at present to estimate if the index has any prognostic value, or if it can be used to compare individuals.

Conclusions:

The index does not appear to be suitable for routine clinical use at present, because there is insufficient information about its behaviour. It would appear to bear evaluation using large volumes of data from patients who can be described as severely, moderately or mildly affected immediately after their CVAs, according to the number of improvements they need to achieve. It may be speculated that, during such an evaluation, trends may be observed, association between indices may be plotted or calculated, and the meaning of these trends or associations may be closely defined. When this information is available, the index could be included on the display of the findings of the assessment, and it might contribute to multidisciplinary rehabilitation of stroke patients.

3.2.8 Conclusions to the development of the protocol

The aims for the development of the protocol, which have been referred to as each version was revised, were concerned with specifications for the performance of the assessment. These specifications involve three areas: the items of assessment; the scales; and the administration.

1. The items of assessment:

In keeping with the specifications laid down in section 3.1, in order to use the items assessors are required to make categorical judgments of patients' performances. The items and the performances have been standardised and been shown to be reliable in use, as long as assessors follow the instructions and descriptions given in the manual.

2. The scales of assessment:

The items are arranged in three cumulative ordinal scales - Quality of Movement, Functional Ability, and Function of the Upper Limb. According to the Guttman coefficients of reproducibility and scalability calculated for these scales, they are valid representations of resolution of impairment, resolution of disability, and resolution of motor dysfunction of the upper limb respectively. There is a high degree of association between resolution of impairment and resolution of disability; and these two scales form a unified scale which represents recovery from hemiplegia truthfully. Basically, these scales assess motor function of the trunk and lower limb. From the available data, there is little

apparent association between them and resolution of dysfunction of the upper limb.

Decisions to include or exclude individual items from these scales were based on the opinions and requirements of physiotherapists who participated in field tests.

Therefore, all three scales might be presumed to be valid for physiotherapeutic assessment of hemiplegia. The participating physiotherapists' opinions of the adequacy and comprehensiveness of the scales and of the protocol as a whole will be presented in section 3.4.

3. The administration of the assessment:

The brevity and ease of administration of the assessment involves the use of the record as well as use of the protocol. However, these factors have been assisted substantially by reduction of the number of items of assessment and by utilisation of the predictive ability of a valid Guttman scale. Firstly, an assessment can be begun with any item which a patient can pass. If he can pass three successive items, all preceding items can be recorded as pass performances, without being assessed. Secondly, an assessment can be terminated when a patient fails three items in succession. Although these aspects of procedure were confirmed for the scale of Physiotherapy Items of the interim version, the predictive function also applies to the scales of the final version: Firstly, because there was high correlation between achievement on the scale of Physiotherapy Items and achievement on the scale of independently performed Gross Functional Items. Secondly, because the scales of the final

version are substantially the same as these two scales.

Administration has also been eased by utilisation of the assessors' sequence of tasks to present the items of assessment in the instructional manual. This is expected to allow assessors to comply with the instructions more easily.

These characteristics should make the assessment less fatiguing for patients to undergo, and less time-consuming and more convenient for physiotherapists to administer.

Finally, the specification for the appearance of the assessment which concerns resolution of impairment and resolution of disability (section 3.1.2, specification 3, requires the scales assessing Quality of Movement and Functional Ability to be displayed appropriately on the record. Similarly, specification 10, which requires a patient's typical performance in his living environment to be distinguished from his ability under optimal conditions, is also partially fulfilled by description of a group of unscalable items, called an assessment of Activity Capability. The classes of the final protocol are described according to the international classification of impairments, disabilities and handicaps, which will be reflected in the final display.

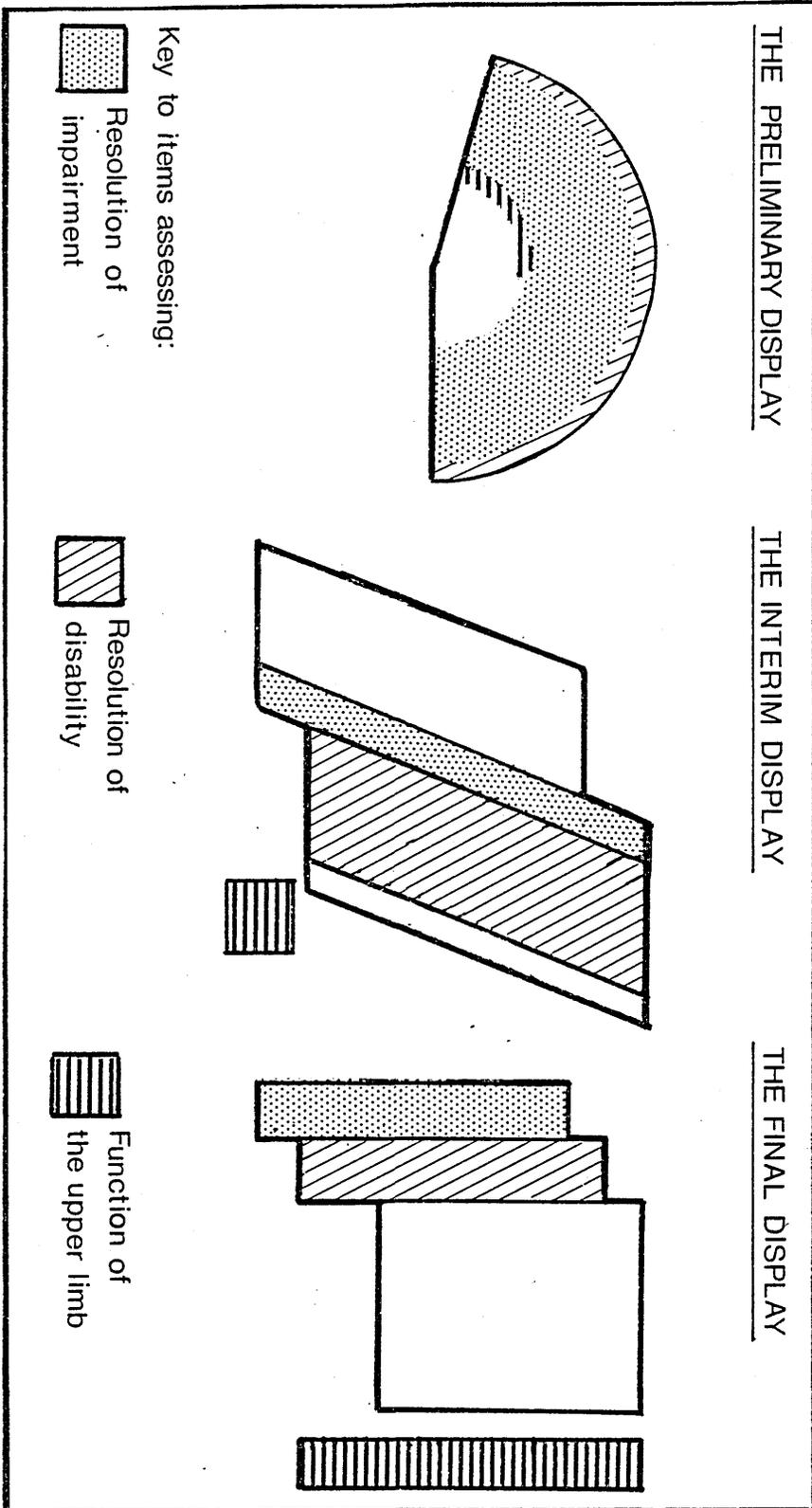
FIGURE 30

DIAGRAMMATIC REPRESENTATION OF THE EVOLUTION OF THE DISPLAY

THE PRELIMINARY DISPLAY

THE INTERIM DISPLAY

THE FINAL DISPLAY



3.3 THE DEVELOPMENT OF THE DISPLAY

In order to fulfil specifications for the performance and appearance of SMAC, it was aimed to design a single-sheet display of the findings of successive assessments which would possess the desirable attributes discussed in section 2.5.4. That is, (A) it would have visual impact; (B) it would provide clear channels of information to various users; and (C) it would convey meaning correctly.

The development of the basic shape of the display is shown in Figure 30. The changes occurred through iteration of a process of design (cf. Figure 10) during two years. Consequently, the design evolved in response both to physiotherapists' stated requirements and to changes in the protocol of items.

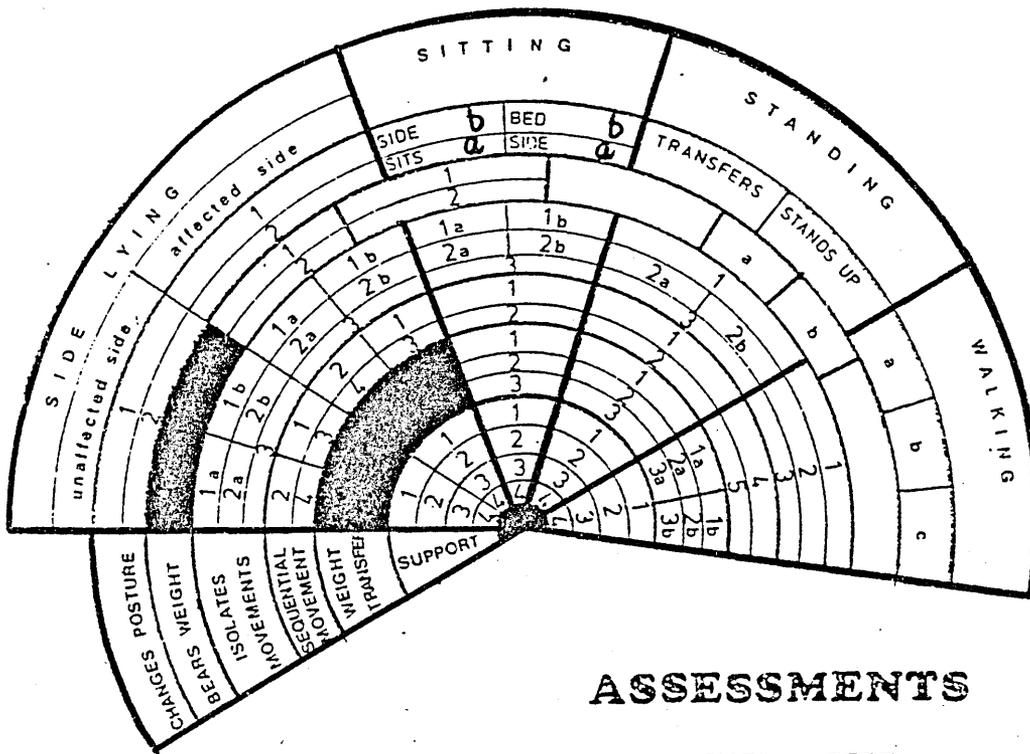
The design of each display will be discussed separately in the following sections:

- 3.3.1 The semicircular display of the prototype and preliminary assessments.
- 3.3.2 The rhomboidal display of the interim assessment.
- 3.3.3 The final display of SMAC.

FIGURE 31

THE PROTOTYPE DISPLAY

THE SHEFFIELD MOTOR ASSESSMENT CHART



ASSESSMENTS

NAME/NUMBER:

AGE:

DATE OF STROKE:

TREATMENT BEGAN:

DATE	CODE

• Reduced from A⁴ format

3.3.1 The semicircular display of the prototype and preliminary assessments

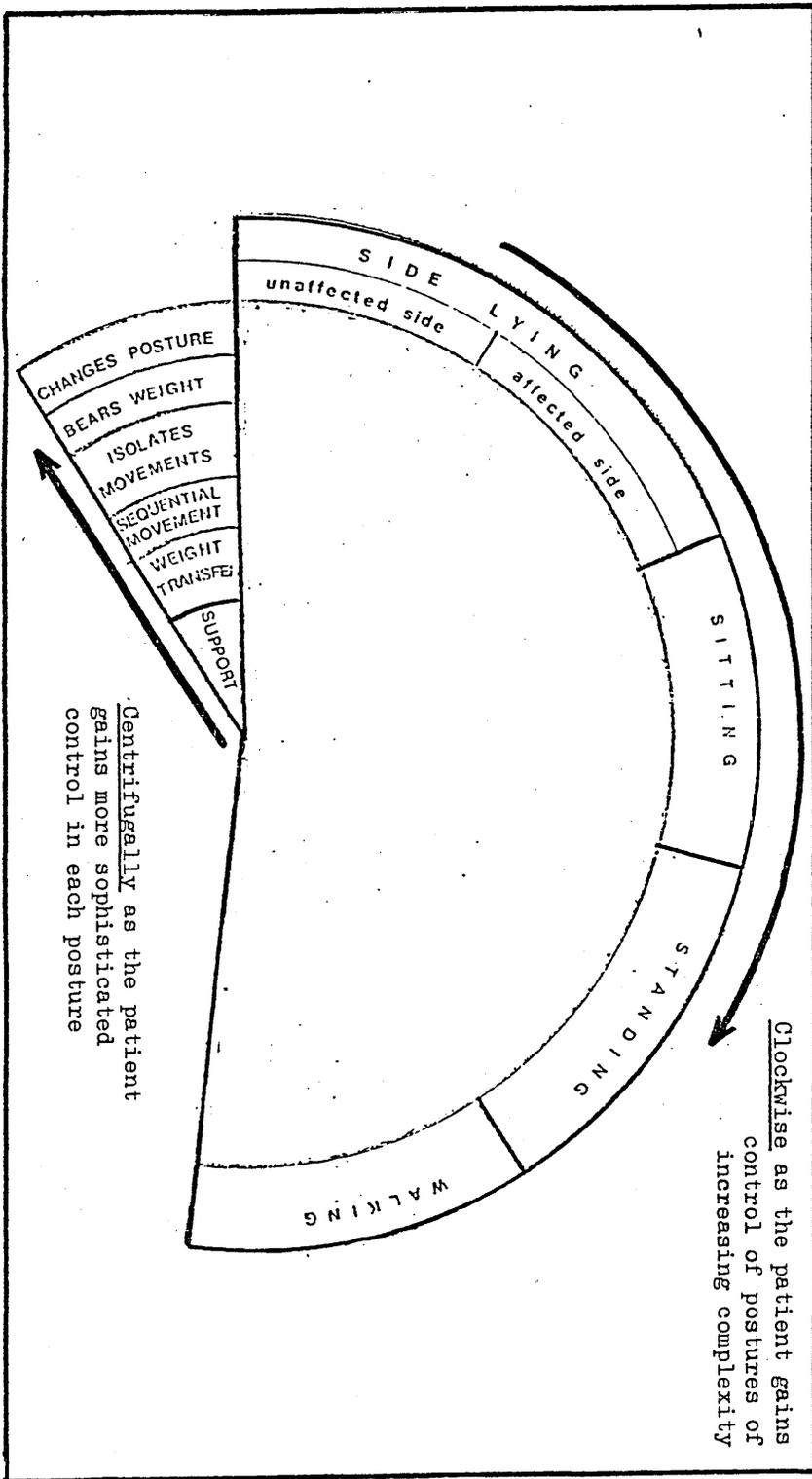
A circular, target-like display appeared to have potential as a record for a physiotherapeutic motor assessment. While there is no hard evidence that the chart of the Primary Progress Evaluation Index (Gunzburg, 1969) provides a clear channel of information to various users, or that it conveys meaning correctly, its widespread use in children's assessment centres demonstrates that it is attractive, acceptable and usable. Mitchell's outline draft of a circular display¹ for an assessment of stroke patients appeared to possess similar potential to present patients' status and progress attractively. However, the detail was insufficient for an estimate to be made of its ability to communicate successfully.

Therefore, a display was drafted to see if a similar design could present the items of the prototype protocol of SMAC in a manner which conveyed correct information (A) about a patient's motor status and (B) about his progress. This display was almost semicircular (Figure 31). However, it was intended to reduce the number of items of assessment (see Section 3.2.2). If this were achieved, it might be possible to record the assessments of other practitioners in other sectors in order to create a multidisciplinary "patient profile" for use in the rehabilitation of stroke patients.

¹ Confidential document to Motor Club of Ridgway Group.

FIGURE 32

MODES OF PRESENTATION OF PATIENTS' PROGRESS ON PROTOTYPE DISPLAY



Presentation of Information:

The semicircular display presented a patient's progress in two modes: clockwise, as he gained control of more precarious postural situations; and centrifugally, as he gained more sophisticated control of his movement and balance in each situation (Figure 32).

The several semicircular arcs were intended to perform different functions. That is,

The innermost arc displayed a very basic level of activity when normal posture might be maintained only with support at every segment of the body. The purpose of this was to record the status of very severely affected patients in the early days after their CVAs.

The intermediate arcs were intended to provide physiotherapists with specific information they need in order to plan and to monitor treatment.

The outermost arcs recorded the patient's ability to perform functional activities, such as getting out of bed and walking from place to place. These arcs were intended to communicate information to other practitioners eventually.

Each item was numbered on the display to correspond with its number on the prototype protocol. Following the pilot study, this system was changed; items were numbered consecutively in sectors of the chart and in columns of the protocol so that they would be located more easily. Two other alterations were made to the design also: Firstly, assessors found that the items performed in side lying were difficult to interpret and to record because the display did not distinguish clearly enough between the named side as the starting position or as the side to which a movement was made. Therefore, these items were recast with supine as the starting position (see Figure 33) so

that each item stated the direction of a movement unequivocally.

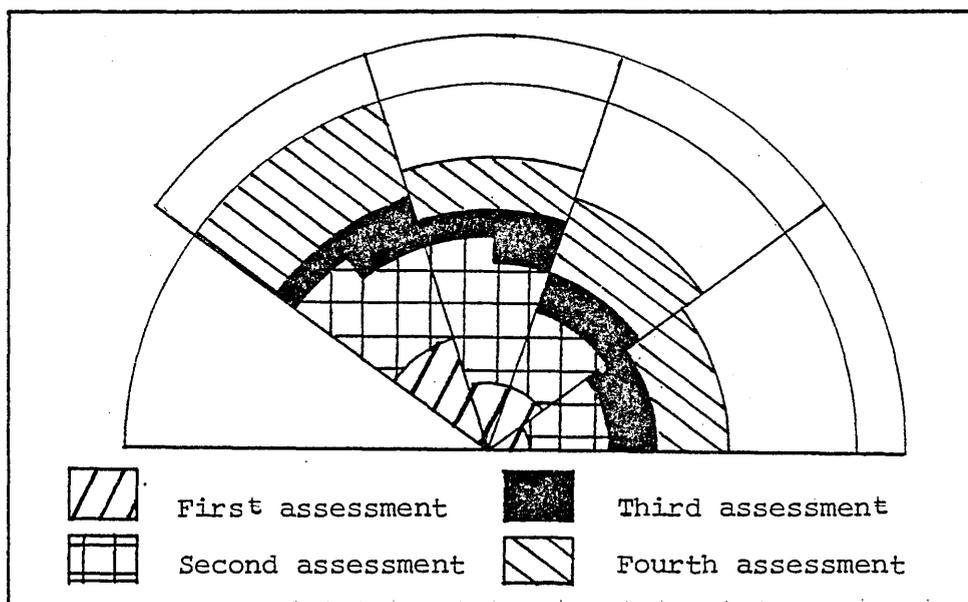
The second alteration concerned the arc labelled "bears weight". The record boxes had been drawn to overlap adjoining sectors to represent movement from one position to another. This was said to be unnecessary and distracting, and the display was redrawn to eliminate the overlapping boxes.

Method of recording:

All of the items which a patient passed at a given assessment were coded in a particular way. For example, diagonal bars for items passed at the first assessment, cross-hatching of items passed at the second assessment, total blocking of those passed at the third assessment; and so on. As well as clearly identifying items passed at each assessment, this method also demonstrated the progress a patient made between assessments. As a patient recovered, the pattern of recorded assessments developed upwards and sweeping to the right, as shown in Figure 34 (cf. Figure 8).

FIGURE 34

THE GENERAL PATTERN OF ASSESSMENTS RECORDED ON THE SEMICIRCULAR DISPLAY



Reasons for alterations following the field test of the preliminary assessment:

There were three main reasons for redrafting the display:

- A. The items of assessment were reduced in number and scaled.
- B. The protocol was refined so that resolution of impairment was represented by the scale of Physiotherapy Items and resolution of disability was represented by the scale of Gross Functional Items.
- C. The physiotherapists who participated in the field test requested space in which they could write specific comments.

FIGURE 35

THE INTERIM DISPLAY*

The Sheffield Motor Assessment Chart

NAME _____

DATE OF BIRTH _____ WARD _____

SIDE OF HEMIPLEGIA _____ HOSPITAL No. _____

DATE OF ONSET _____

TREATMENT BEGAN _____

REFERRING DOCTOR _____

Date	Code

With Assistance ★

Walking

Chair ↔ Chair

Sitting ↔ Standing

Lying ↔ Sitting

Rolling

19 Stairs

18 With aid Without aid

17 Walking

16 With aid Without aid

15 Chair ↔ Chair

14 With aid Without aid

Sitting ↔ Standing

With aid Without aid

Lying ↔ Sitting

13 Unaffected Affected

Sitting

12

11

10

9 Rolling

8

7

6

5

4 → Affected → Unaffected

3

2 Independently ★

1

Affected Arm

<input type="checkbox"/>	A Placing in elevation
<input type="checkbox"/>	B Touch top of head
<input type="checkbox"/>	C Lower and raise
<input type="checkbox"/>	D Supination / pronation
<input type="checkbox"/>	E Hand to shoulder
<input type="checkbox"/>	F Palm on table
<input type="checkbox"/>	G Grasp / release

<p>1 Turn to Affected side : lying</p> <p>2 Turn to Unaffected side : lying</p> <p>3 Turn to Unaffected side : sitting</p> <p>4 Turn to Affected side : sitting</p> <p>5 Flex and extend Affected leg</p> <p>6 Bridge</p> <p>7 Weight buttock to buttock : sitting</p> <p>8 Weight antero posteriorly : sitting</p> <p>9 Affected leg over bedside, return</p> <p>10 Cross Affected leg over unaffected</p>	<p>11 Weight through Affected forearm</p> <p>12 Turn to Unaffected side : standing</p> <p>13 Turn to Affected side : standing</p> <p>14 Tap Unaffected foot</p> <p>15 Step with Unaffected leg</p> <p>16 Affected knee release</p> <p>17 Step forward onto Affected leg</p> <p>18 Step up onto Affected leg</p> <p>19 Step down onto Unaffected leg</p>
---	---

For fuller descriptions refer to the Manual

* Reduced from A4 format

3.3.2 The rhomboidal display of the interim assessment

Graphic designers in the Faculty of Art and Design at Sheffield City Polytechnic were consulted about the design of the interim display. Two main factors were considered:

- A. Presentation of the scales of Physiotherapy Items and Gross Functional Items.
- B. The usability of different graphic formats.

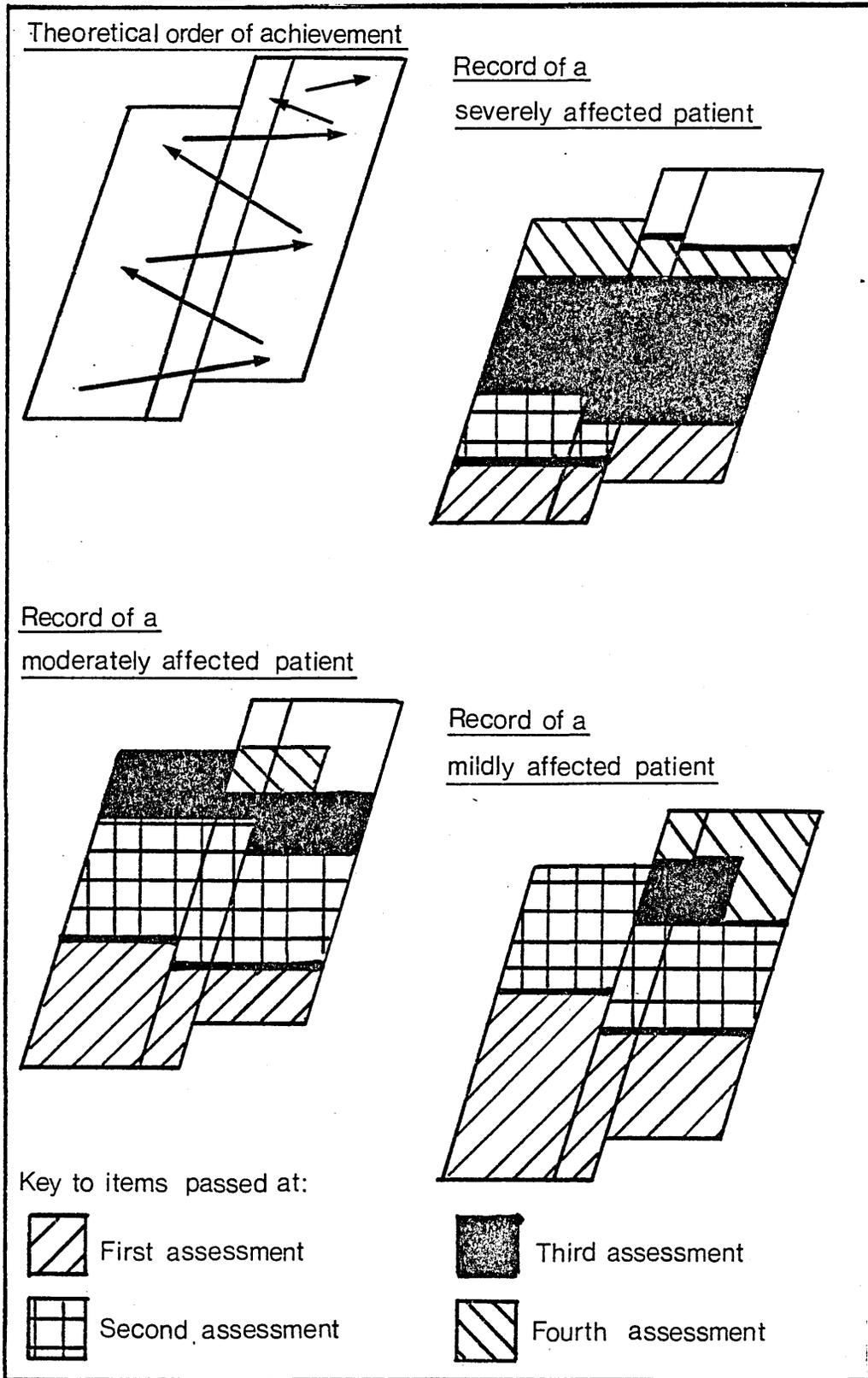
The graphic designers advised that a curvilinear design was both too complicated and graphically unacceptable. They suggested that a grid of straight lines would be more attractive, easier to fill in and easier to read back than was the semicircular design. The artwork for the new display was done by a graphic designer, and the rhomboidal shape obeyed the designers' maxim, "form follows function". That is, it retained the same characteristic of representing progress by development of the record upward and outwards, and it reflected the interim protocol better than did a drafted curvilinear design. Items assessing function of the upper limb, discussed in section 3.2.5, were presented in a separate box at the foot of the display (Figure 35).

Presentation of information:

The design was intended to demonstrate the relationship between resolution of impairment and resolution of disability by showing that the Physiotherapy Items and the Gross Functional Items belonged to a single unified scale. That is, the Physiotherapy Items were presented as the central spine with the Gross Functional Items as transverse processes. To aid users, items for which the patient

FIGURE 36

FACSIMILES OF PATTERNS OF PROGRESS RECORDED ON THE INTERIM DISPLAY



needed assistance were placed on the left and items which he could perform independently were placed on the right.

The Physiotherapy Items were represented by their ranks, or arbitrary signs; and an aide memoire was printed at the foot of the page. The Gross Functional Items were represented by written descriptions, with the intention that participants in the field test should sketch signs to represent them on the final display. The Gross Functional Items were emphasised (A) to aid communication; and (B) so that assessors could write in any special comments, such as where and when a patient required assistance, or the type of aid a patient commonly used. For example, he may stand up from sitting in a chair by leaning on his walking stick, or on the arms of a chair, or on a walking frame.

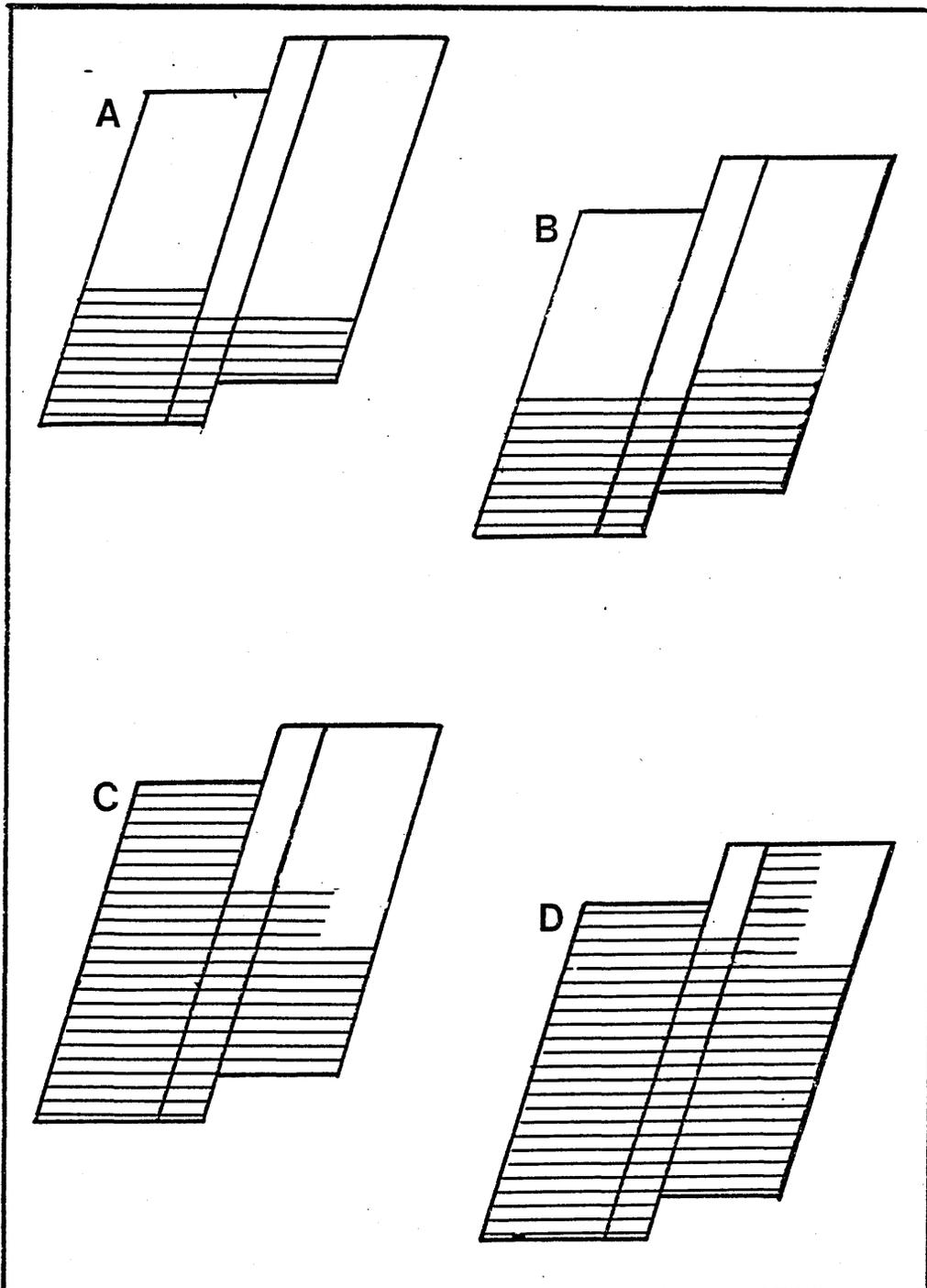
Methods of recording:

Essentially, the same method of coding each assessment was retained for recording the Physiotherapy Items and the Gross Functional Items. For this field test, assessors were supplied with coloured pens, so that collation of data would be assisted by colour coding. Additionally, assessors were instructed to enter the key letter of items of assessment of the upper limb in a panel at the right-hand side of the main display, in order to indicate other items with which their achievement was associated.

The Physiotherapy Items were assessed and recorded according to standardised descriptions written in the manual (Figure 25).

FIGURE 37

FACSIMILES OF RECORDS TO SHOW PRESENTATION OF STATUS



Copies of the charts of patients who were videotaped for the test of inter-observer reliability. Please see section 3.2.4 (1) for descriptions of the patients.

Facing page 232

In order to ensure patients' safety, assessors were instructed to use their clinical judgement when they recorded Gross Functional Items. These items were intended to communicate information to other practitioners; and this aspect of the procedure was particularly important if a less-skilled assistant might refer to the display. The chart was printed on A4 size card, so that it would fit the bed-end clipboard which carries charts recording the patient's vital signs and drugs. This format was used in order to encourage use of the chart to convey information about the patient's physiotherapeutic status and progress.

Examples of records are given in Figure 36 which shows how progress was demonstrated. In Figure 37, the displays of the patients who were videotaped for the test of inter-observer reliability (3.2.4) are reproduced, to show the status of each at the time they were assessed.

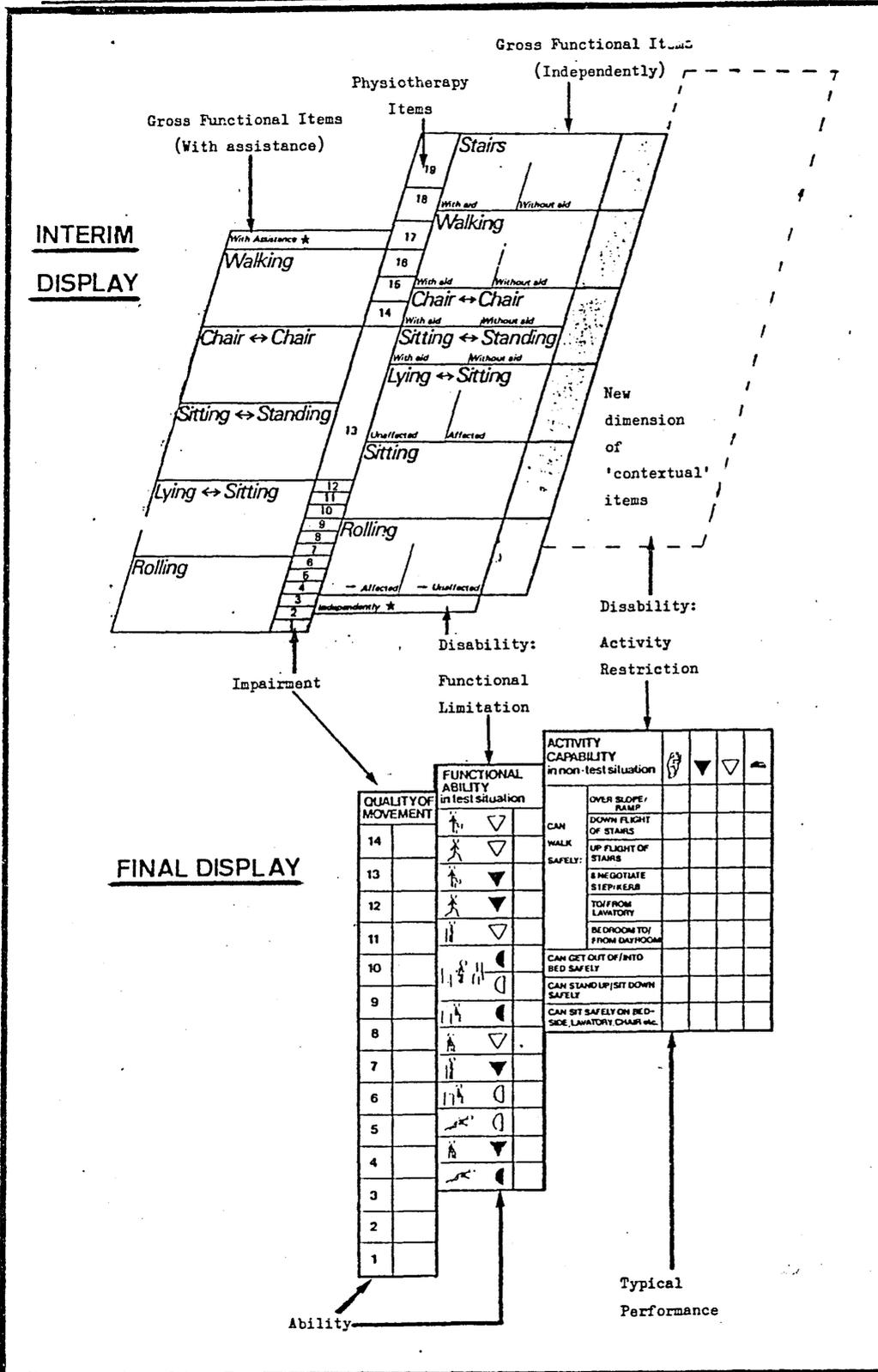
Reasons for alterations following the field test of the interim assessment:

- A. The physiotherapists who attended the study day requested a section of the assessment which:
 - recognised the exercise of clinical judgement explicitly;
 - discriminated between performances made with and for a physiotherapist and performances with less skilled assessors;
 - included a "contextual" element which acknowledged that, for example, different patients may need to walk different distances to reach the lavatory.
- B. The instruction concerning the exercise of clinical judgment had led to identification of items which were not scalable.

- C. Reproducibility and scalability of the items of upper limb assessment had been confirmed.
- D. In discussion with the graphic designer, graphic codes had been identified to represent specific items.
- E. The international classification of impairments, disabilities and handicaps had been published by the WHO. It authenticated the scales which had been identified previously and offered a means of fulfilling the physiotherapists' requests.

FIGURE 38

EVOLUTION OF THE INTERIM DISPLAY TO THE FINAL DISPLAY



3.3.3 The final display of SMAC

By the time that this display was drafted, the suitability of a rectilinear design had been established and the physiotherapeutic acceptability of SMAC had been confirmed (cf. section 3.4). The design followed directly from consideration of three factors:

- A. Provision of a clear channel to the findings of each of the four sections of the protocol - the assessments of Quality of Movement, Functional Ability, Activity Capability and the Upper Limb.
- B. Demonstration of the confirmed association between resolution of impairment and resolution of disability.
- C. Discrimination between a patient's ability in the assessment room and his typical performance in his living environment.

The way in which the interim display evolved into the final display accommodating these factors is illustrated in Figure 38. The full display, including the record of the assessment of the Upper Limb, is shown in Figure 39.

Presentation of information:

The vocabulary and graphic forms of the display (Figure 40) reflect (A) the WHO's definitions of impairment and disability; (B) physiotherapeutic terminology; and (C) recommendations concerning the communicability of graphic information discussed in section 2.5.4.

The items recording resolution of impairment, or restitution of the control of movement for the purposes of planning and monitoring physiotherapy, are called the assessment of

FIGURE 39

THE FINAL DISPLAY OF SMAC

SMAC*

Hospital/Unit _____

Referring Doctor _____

Physiotherapist _____

OP/IP Ward _____

AFFIX ADDRESSOGRAPH LABEL

Name _____

Address _____

Hospital No. _____ Age/D.of B. _____

Date of Onset _____

Admission Date _____

Left | Right HEMIPLEGIA		Left | Right HANDED		ACTIVITY CAPABILITY in non-test situation	 	<div style="border: 1px solid black; padding: 2px;">UPPER LIMB</div>
QUALITY OF MOVEMENT	FUNCTIONAL ABILITY in test situation		CAN			
14				OVER SLOPE/ RAMP		
13				DOWN FLIGHT OF STAIRS		
12				UP FLIGHT OF STAIRS		
11				& NEGOTIATE STEP/KERB		
10				TO/FROM LAVATORY		
9				BEDROOM TO/ FROM DAYROOM		
8				CAN GET OUT OF/INTO BED SAFELY		
7				CAN STAND UP/SIT DOWN SAFELY		
6				CAN SIT SAFELY ON BED- SIDE, LAVATORY, CHAIR etc.		
5				<div style="border: 1px solid black; padding: 5px; display: flex; align-items: center;"> <div>Early Indoor Goal</div> </div>		
4				<div style="border: 1px solid black; padding: 5px;">Physiotherapy Began</div>		
3				Dates of Assessments: 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____		
2						
1						

WITH HELP OF PERSON	HOME VISIT
WITH SUPPORT OF FURNITURE OR WALKING AID	TO AFFECTED SIDE
TOTALLY INDEPENDENT LY	TO UNAFFECTED SIDE

* The Sheffield Motor Assessment Chart & Handbook are available from: The Head of Department (SMAC), Department of Health Studies, Sheffield City Polytechnic, Collegiate Crescent, Sheffield S10 2BP

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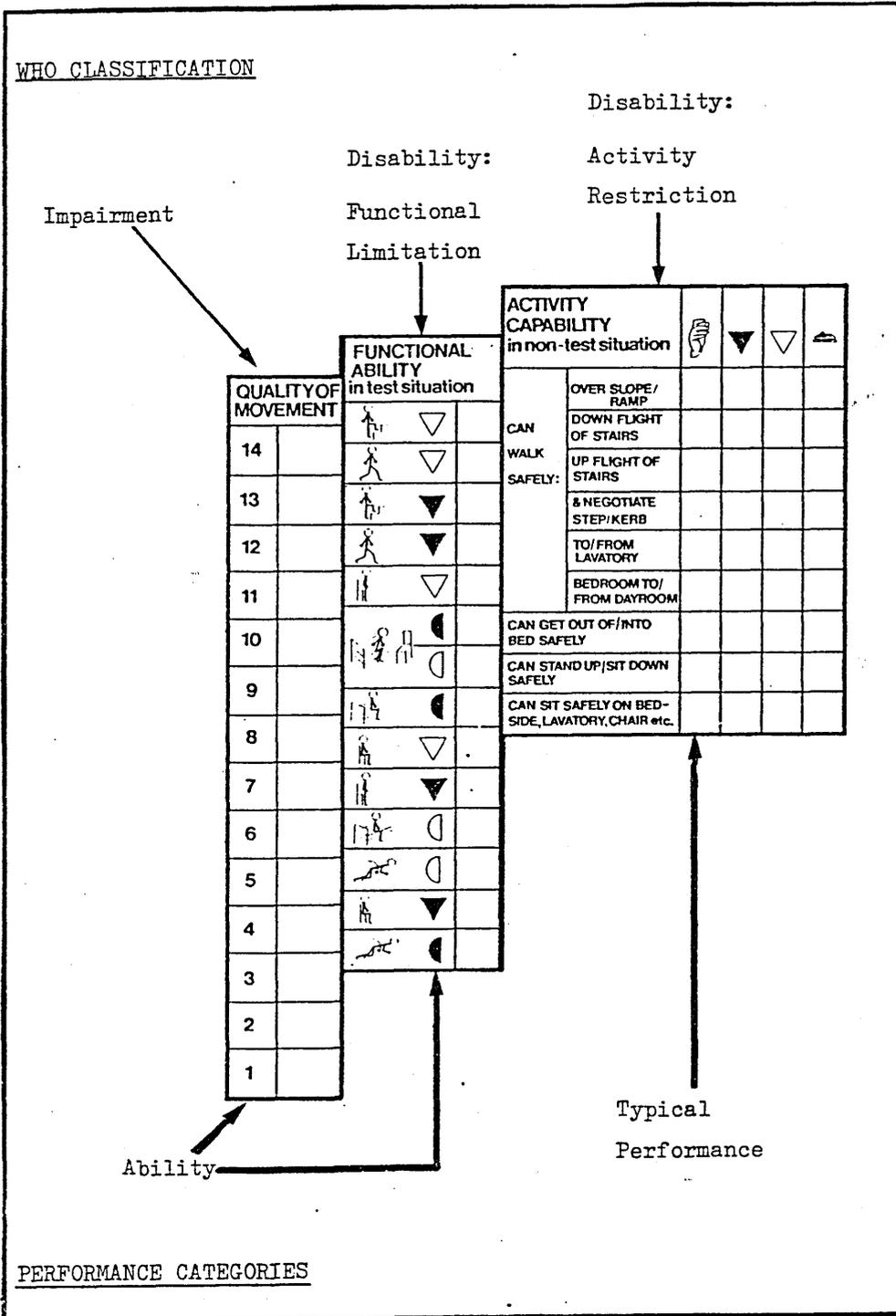
"Quality of Movement". They are represented by arbitrary signs; the rank of each item on the Guttman scale. It is expected that physiotherapists who use them frequently will learn and remember them.

Items which record resolution of disability in terms of limitation of function are called the assessment of "Functional Ability". They record the patients ability in the optimal condition of the assessment room. Like the record of Quality of Movement, they are also used to plan and monitor physiotherapy. However, they are represented by image-related signs so that they can be understood by patients and by other practitioners who might use the information, or might assess similar abilities (cf. Figure 6, section 2.4.4; and section 3.5.2). The panel labelled "Early indoor goal" is intended to be used with this assessment, so that a realistic goal can be set with each patient to assess his ability to walk with or without an aid.

Items which record resolution of disability in terms of restriction of activities are called the assessment of "Activity Capability". This is the new "contextual" dimension of the display which was requested by participating physiotherapists. It recognises the clinical judgement exercised to ensure the safety of patients (cf. Conclusions to section 3.2.4). By recording a patient's disability as it restricts his activities in the ward, or at home, it allows SMAC to be related to each person's

FIGURE 40

DIMENSIONS OF THE FINAL DISPLAY



PERFORMANCE CATEGORIES

living environment. Thus, these items record his typical performance. Additionally, by recording his need for assistance or his use of an aid, as well as his ability to perform totally independently, it also records his progress as he becomes both less dependent and able to perform more activities. For in-patients, a home assessment may also be recorded. These items are described in words so that they can be comprehended more easily by elderly patients and other people who have little experience with signs.

Items which record resolution of impairment of the Upper Limb record a patient's ability in the assessment room. Like the assessment of Functional Ability, they are represented by image-related signs, so that other practitioners who are concerned with function of the upper limb can refer to them. Additionally, two "boxes" have been left at the top of the scale in order to accommodate the need of some physiotherapists to describe items which assess functional activities of the upper limb.

An aide memoire, called the "SMAC Crib Card" (Figure 41) was produced on wipe-clean, pocket-sized card, to help them to remember the items represented by the arbitrary signs of the assessment of Quality of Movement. Other signs which allow practitioners to interpret a patient's performance, particularly of the items assessing Activity Capability, are printed on the face of the chart. In the absence of universally understood signs to represent a

FIGURE 41

THE AIDE MEMOIRE FOR ASSESSORS

SMAC CRIB CARD

This crib card should be used with the standardised descriptions and procedures detailed in the handbook.

QUALITY OF MOVEMENT SYMBOLS

- 1 Trunk rotation to AFFECTED side
- 2 Trunk rotation to UNAFFECTED side
- 3 Trunk rotation to UNAFFECTED side
- 4 Trunk rotation to AFFECTED side
- 5 Trunk lowering and raising
- 6 AFFECTED hip and knee flexion and extension
- 7 Legs crossed sitting
- 8 Trunk rotation to UNAFFECTED side
- 9 Trunk rotation to AFFECTED side
- 10 AFFECTED knee release
- 11 Weight transfer
- 12 Stepping through
- 13 Stepping up onto AFFECTED leg
- 14 Stepping down onto UNAFFECTED leg

GENERAL SYMBOLS

-  Moves to AFFECTED side
-  Moves to UNAFFECTED side
-  At Home Visit
-  With help of person(s)
-  With support (Walking aid or furniture)
-  Totally Independently

FUNCTIONAL ASSESSMENT SYMBOLS

-  Rolling supine to side
-  Lying to sitting on side of bed
-  Transferring bed to chair
-  Climbing stairs
-  Sitting balance
-  Standing up from sitting
-  Walking
-  Descending stairs

UPPER LIMB SYMBOLS

-  Passive movement
-  Placing in elevation
-  Weight bearing
-  Touch top of head
-  Arm lowering and raising
-  Supination and pronation
-  Palm to shoulder
-  Reaching and holding with both hands
-  Grasp/release
-  Opposition

Copies of the Sheffield Motor Assessment Chart and Handbook are available from: The Head of Department (SMAC), The Department of Health Studies, Sheffield City Polytechnic, Collegiate Crescent, Sheffield S10 2AP.

hemiplegic person's affected or unaffected side of the body and performance with or without an aid, concept-related signs are used. Signs depicting a hand and a house appear to be universally understood, but they are reproduced in order to complete the set.

Method of recording

Assessors who attended the study day requested:

- A. Some means of demonstrating patients' rates of progress.
- B. A quick and accurate means of obtaining copies of a patient's chart.

Demonstration of rate of progress:

Assessors are instructed to make assessments at their own discretion, when they observe change in their patients. Consequently, those patients who are assessed frequently are likely to be progressing quickly, and those who are assessed occasionally are likely to be progressing slowly. To make use of the frequency with which assessments are made, the first edition of the final SMAC included a graph whereby the number of weeks or months a patient had been receiving treatment was plotted against the number of assessments that had been made.

Examples of this graph will be found in the charts reproduced at the back of the manual to the final SMAC (Appendix V). A steeper curve is plotted for those who are progressing quickly, and, eventually, a plateau may be reached. Several curves are plotted for comparison in Figure 42.

During interviews with practitioners (section 3.5), it was said that this graph did not provide the information which was needed and that it detracted from the chart. Consequently, it was removed from the chart, and, when a new

edition is printed, the format shown in Figure 39 will be used.

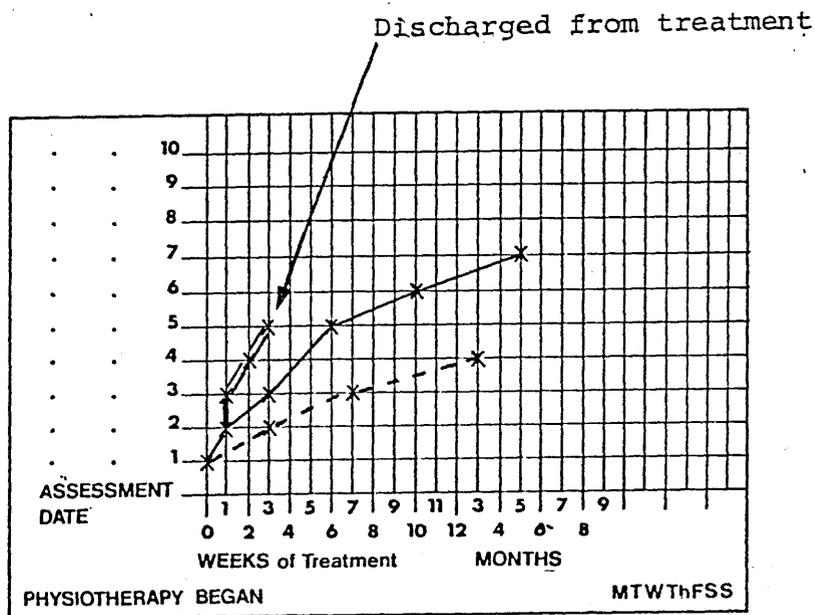
Means of replication:

Assessors may require copies of charts for various reasons. For example, they may send a copy with other information when a patient is transferred to the care of another physiotherapist, or to another treatment centre. Or they may file a copy with the medical notes as well as the physiotherapeutic notes when an in-patient is discharged.

Some physiotherapists did not have easy access to a photocopier, and copying by hand was both tedious and liable to error. Therefore, the final chart was printed as a "triplet" consisting of a base of thin card and two sheets of self-duplicating paper. A clear copy is made on each sheet if the number against the date of an assessment is recorded in the boxes next to the items passed on that date. The patient's status at successive assessments is shown and his progress between assessments is immediately apparent.

FIGURE 42

EXAMPLES OF GRAPHS TO ILLUSTRATE RATE OF PROGRESS



- x====x Mildly affected patient who recovered rapidly.
- x——x Moderately affected patient who reached a plateau in progress
- x---x Patient who progressed slowly.

3.3.4 Conclusions to the development of the display

The final display of SMAC presents the items and scales of the developed and tested protocol on a single-sheet which fulfils specifications concerning the appearance and performance of the assessment. The chart:

- A. Displays both a patient's status at any assessment and the progress he has made between assessments;
- B. Demonstrates the relationship between resolution of impairment and resolution of disability;
- C. Discriminates between the patient's ability under optimal conditions in the assessment room or physiotherapy department and his typical performance in the hospital ward or at home.

Additionally, the display has been designed to assist planning and monitoring of physiotherapy and to assist communication of physiotherapeutic rationales of treatment. Evidence concerning these specifications is presented in the following sections.

3.4 EVALUATION OF THE CHART'S ACCEPTABILITY TO PHYSIOTHERAPISTS

The participating physiotherapists were surveyed twice in order to evaluate the adequacy, appropriateness and acceptability of SMAC for the physiotherapeutic assessment of hemiplegia. The size of the sample of physiotherapists had been increased for the field test of the interim chart so that data could be collected from a larger number of patients (cf. Section 3.1.1). It was planned also to recruit new physiotherapists at each stage of the development, in order to ensure that SMAC would not be developed to fulfil the needs of one group of participants who might become increasingly familiar with the researcher's rationales and theoretical framework. Therefore, the size of the sample of physiotherapists was increased also for the equally important purpose of estimating the extent to which findings could be generalised beyond the boundaries of the project itself, in order to show that SMAC is acceptable for routine clinical use.

Methods:

The first questionnaire, or "postal questionnaire", was distributed during the first month of the field test of the interim chart. The second questionnaire, or "study questionnaire", was completed by physiotherapists who attended the study day at the end of the field test. It was also distributed to participants in the field test who were unable to attend the study day.

The data collected on the postal questionnaire were collated so that responses made by physiotherapists who participated in both field tests could be compared with responses made by those who used only the interim version of the chart. The data collected on the study day questionnaire were collated so that the responses of a third group, who had not used SMAC in a field test, could be compared with the responses of those who had used the chart clinically. The main samples of respondents are listed below; but, for some analyses, the samples vary slightly in order to accommodate a number of independent factors so that the results are not compromised. Additionally, because the questionnaires were completed at the beginning and the end of the field test respectively, data were also examined to see if users changed their opinions as they gained experience with the assessment and it became more familiar to them.

Materials:

The questionnaires are reproduced in Appendix II.2.

Samples:

- | | | |
|------------------|---|---------------------|
| A: | Respondents to the postal questionnaire who participated in both field tests | A = 22 |
| B: | Respondents to the postal questionnaire who participated in the field test of the interim version only | B = 22 |
| A ₁ : | Respondents to the study day questionnaire who participated in both field tests | A ₁ = 16 |
| B ₁ : | Respondents to the study day questionnaire who participated in the field test of the interim version only | B ₁ = 16 |
| C: | Respondents to the study day questionnaire who did not participate in a field test | C = 14 |

The equal numbers of respondents in samples A and B and in samples A₁ and B₁ were fortuitous.

Data and analyses:

The full table of data is reproduced in Appendix II. 3.

Results are presented under the following headings:

- 3.4.1 The design of the display
- 3.4.2 The utility of the items of assessment
- 3.4.3 The clarity of the manual
- 3.4.4 The methods of physiotherapy used in the United Kingdom
- 3.4.5 The physiotherapeutic acceptability of the chart.

In appropriate sections, a table has been constructed to summarise the following information: the relevant questions on the questionnaires, the purpose of each analysis, the statistical tests which were used, and the results which were obtained. Detailed analyses will be found in Appendix II. 4.

3.4.1 The design of the display

Procedure:

These analyses were undertaken in order to evaluate the semicircular and rhomboidal designs in terms of three basic attributes discussed previously:

- A. Their comparative attractiveness;
- B. Their comparative complexity;
- C. The use of the rhomboidal display to convey information to patients and to other practitioners.

Data from questions 1 and 2 on the postal questionnaire (Tables 17 and 18) were used to evaluate the first two attributes and to compare the preferences of physiotherapists who had used both versions of the display (sample A) with the preferences of those who had used only the rhomboidal version (sample B). A confidence interval was estimated for the proportion of the population of physiotherapists who would find a rectilinear design less complicated, and therefore easier to use, than a curvilinear design. Finally, frequency counts were made of responses to questions 13, 14 and 18 by members of both samples so that estimates could be made of the use of the rhomboidal display to convey information about a patient's status and progress.

TABLE 17

NUMBER OF MEMBERS OF EACH SAMPLE FINDING EITHER DISPLAY
VISUALLY MORE ATTRACTIVE

	More attractive design		
	Semicircular	Rhomboid	
Sample A	7	15	22
Sample B	6	16	22
Totals	13	31	44

TABLE 18

COLLATION OF DATA CONCERNING THE ATTRACTIVENESS AND COMPLEXITY
OF EACH DISPLAY

		More attractive design		
		Semicircular	Rhomboid	
Less complicated design	Semicircular	4	1	5
	Rhomboid	9	30	39
		13	31	44

Results:

1. Comparison of the semicircular and rhomboidal displays

Four analyses were made of the data in Tables 17 and 18. They are listed with the results in Table 19.

TABLE 19

ANALYSES OF THE DESIGN OF THE DISPLAY

Null hypothesis	Source of data	Statistical Calculation	Result
That preference for either display is not influenced by membership of either sample.	Q. 1	Chi square test for two independent samples	$\chi^2 = 0$ $p > 0.45$
That there is no significant difference between the proportions of assessors finding either display more attractive.	Q. 1	Binomial test	$z = -2.56$ $p = 0.0052$
That all assessors perceive both displays to be equally complicated.	Q.2	Binomial test	$z = 4.974$ $p = 0.00003$
That there is an equal probability of assessors finding the alternative displays more attractive but less complicated on closer inspection.	Q. 1 and Q. 2	McNemar test for significance of changes	$\chi^2 = 4.9$ $p < 0.025$

2. Evaluation of the use of the display to convey information

Thirty-two respondents (73%) showed 93 patients their own Charts and 65.6% were said to be "interested" to see them. A further 22.5% were said to be "motivated" by seeing a display of their progress.

Ten (31.25%) of the physiotherapists who showed patients their Charts said that the emphasis of the "Gross Functional Items" on the rhomboid display aided communication with patients. Eight of these physiotherapists treated ten patients who were described as "motivated". However, the other ten patients who were also said to be "motivated" by seeing their own Charts were treated by physiotherapists who said that emphasis of the "Gross Functional Items" had not aided communication.

Eight physiotherapists said that this emphasis had also aided communication with patients' relatives. This is a fairly small proportion (18.2%) but 22 (50%) did not answer the question. Several pointed out that the question was inappropriate to them because they infrequently or never had contact with patients' relatives. Some of them were able to answer the question with regard to other practitioners although others wrote on the questionnaire that they could not comment because they did not see practitioners of other professions in their treatment settings. Forty-three per cent did not answer this question but 36.8% found that communication with other practitioners was aided by the design of the display.

Discussion of results:

As forecast by the graphic designers, a significant proportion of participants found the rhomboidal display more attractive ($p=0.0052$) and less complicated ($p=0.0003$) than the semicircular design. Among the physiotherapists who had made recordings on both displays, there was no significant difference between the proportion of them who preferred the rhomboidal design and the proportion of those who had used only the rhomboidal design and found it more attractive ($p > 0.45$). Even among the smaller proportion of all respondents who found the semicircular design more attractive (29.5%), there was a significant tendency for them to find the rhomboidal display less complicated ($p < 0.025$).

A rectilinear design could be used for the display of the final SMAC with 99 per cent confidence that 76.24 per cent to 100 per cent of physiotherapists would find it more acceptable and easier to use than a curvilinear design. There is no conclusive evidence that communication with patients, relatives and other practitioners was aided by the emphasis laid on the Gross Functional Items by the design of the rhomboidal display.

3.4.2 The utility of the items of assessment

Procedure:

These analyses were made in order to assess the ease with which assessors could understand, remember, apply and record the items of assessment. Frequency counts were made of the responses of:

sample A to question 4 on the postal questionnaire; and samples A₁, B₁ and C to question 12 on the study day questionnaire.

All preferences for the interim assessment were given a score of 1. All preferences for the preliminary assessment "Don't know" responses, or where no choice was made, were awarded a score of 0. The proportions of respondents of each sample who found the items of the interim assessment easy to understand, remember, apply and record are tabulated in Table 20.

TABLE 20

PROPORTIONS OF RESPONDENTS FINDING ITEMS OF THE INTERIM CHART EASY TO UNDERSTAND, REMEMBER APPLY AND RECORD

	ease of understanding	ease of remembering	ease of application	ease of recording
Clinical use				
Sample A ₁	.94	.5	.875	.94
Sample B ₁	.94	.44	.94	.875
Assessments from videotapes*				
Sample A ₁	.6	.3	.3	.8
Sample B ₁	.64	.21	.5	.71
Sample C	.45	.18	.27	.36

*During test of inter-observer reliability (section 3.2.4)

Results:

Two analyses were made, as shown in Table 21. The detailed results of the second analysis are tabulated in Table 22.

TABLE 21

ANALYSES OF THE UTILITY OF THE ITEMS OF THE ASSESSMENT

Null hypothesis	Source of data	Statistical calculation	Results
The probability of members of sample A preferring interim SMAC is the same for all three attributes	<u>Postal questionnaire,</u> question 4	Cochran Q test	Q = 4.75 p > 0.05
There is no difference in the proportions of each sample who find the items of interim SMAC easy to understand, remember, apply & record.	<u>Study day questionnaire,</u> question 12	Test for significant differences in proportions	See Table 22

TABLE 22

Z STATISTICS CALCULATED TO COMPARE PROPORTIONS OF SAMPLES ENDORSING ATTRIBUTES OF THE INTERIM CHART

Samples compared:	ease of understanding	ease of remembering	ease of application	ease of recording
In clinical use: A ₁ and B ₁	.0	.34	-.64	.67
From videotapes: A ₁ and B ₁	.2	.504	.985	.504
A ₁ + B ₁ and C	.97	.456	.83	<u>2.215</u>

Discussion

Physiotherapists who had used both the preliminary protocol and the interim protocol, found that the items of the interim chart were easier to understand, remember, apply and record than the items of the preliminary protocol.

For all four tasks, there was no significant difference between the members of samples A_1 and B_1 with regard to the clinical use of the chart. This suggests that the ease with which items could be used was not related to involvement in the production of the interim chart. Consequently, future users of the same items on the final version are likely to find them as easy to understand, apply and record.

It was expected (1) that those who had used the interim chart in the field test would find remembering the most difficult task; and (2) that they would find all tasks more difficult while they were watching videotapes. These expectations were borne out by their responses.

The problem of remembering could be lessened, to a certain extent, as users gain experience with the chart. However, use of the final chart could be assisted by an aide memoire.

The results related to the videotapes are important in so much as they affect the results of the tests of inter-observer reliability (cf. Section 3.2.4). More specifically, although members of samples A_1 and B_1 found the items more

difficult to use while watching videotapes than they had clinically, possibly because of this clinical experience they found them easier to use while watching tapes than did members of sample C.

3.4.3 The clarity of the manual

Procedure:

In order to evaluate the clarity of the manual and to identify sections which were confusing, respondents were asked to assess the descriptions of the display, the procedure for use, the Physiotherapy Items and the Gross Functional Items. They were given four alternative categories of response "very clear", "clear", "confusing" and "very confusing".

The following sources of data were used:

Responses to question 23 on the postal questionnaire made by forty four members of samples A and B.

Responses to question 9 on the study day questionnaire made by fourteen members of sample C.

"Clear" and "very clear" responses were combined into one category, "clear", and given a score on "1". "Confusing" and "very confusing" responses were combined into one category and given a score of "0". Two respondents who did not answer the question were also given scores of "0" for each section. The Cochran Q test was applied to determine if there was an equal probability of all sections of the manual being described as "clear" by all respondents.

Results:

$$Q = 3.4615$$

$$0.5 > p > 0.3$$

While individuals reported that they were confused by one or other sections of the manual, the majority of assessors found all sections to be clearly explained. This was so

to the extent that the probability of all assessors finding
a section to be clear was the same for all four sections.

3.4.4 The methods of physiotherapy practised in the United Kingdom

Procedure:

This analysis was undertaken in order to test the compatibility of SMAC with the methods of physiotherapy used in the United Kingdom. Data were collected from fifty-eight physiotherapists in the United Kingdom who responded to questions 24 and 25 on the postal questionnaire and questions 6 and 7 on the study day questionnaire

Data were collated to identify the most common method of physiotherapy used to treat hemiplegic patients. Confidence limits were calculated for the proportions of the population of physiotherapists using specific methods. A confidence interval was calculated for the proportion of the population with whose working methods SMAC would be compatible.

Results:

TABLE 23

PROPORTIONS OF THE POPULATION OF PHYSIOTHERAPISTS IN THE UNITED KINGDOM USING VARIOUS METHODS OF PHYSIOTHERAPY FOR HEMIPLEGIA

Method	n	estimates of population	
		proportions	percentages
Bobath used	54	.93± .0656	86.44 -99.56%
Functional used	42	.724±.115	60.9 -83.9%
Bobath used with other techniques	41	.706±.117	58.9 -82.3%
Bobath and Functional	20	.345±.122	22.3 -46.7%
PNF used	17	.293±.117	17.6 -41.0%
Bobath exclusively	13	.224±.107	11.7 -33.1%
Rood used	7	.12 ±.08	4.0 -20.0%
Other named techniques	3	.05 ±.056	0.0 -10.6%

Discussion:

There is 95% confidence that 86.44% to 99.56% of physiotherapists in the United Kingdom use Bobath's techniques to treat hemiplegic patients. However, only 11.7% to 33.1% of these physiotherapists use Bobath's method exclusively; and 58.9% to 82.3% have her techniques in their repertoires.

A very small proportion is estimated for the "other named techniques" of Brunnstrom, Petö and Johnstone, which were each mentioned by one physiotherapists. This may be because physiotherapists who use these methods did not volunteer. Alternatively, respondents may have named only the method or techniques which they use most commonly.

This survey was conducted with the aim of estimating the compatibility of SMAC with the methods of treatment used in the United Kingdom. There is 95% confidence that it is compatible with the methods used by $.93 \pm .065$ physiotherapists, or 86.5% to 99.5%. A survey of a larger sample, aimed exclusively at methods of treatment, might provide more accurate estimates of the "minority methods", it might also allow the confidence limits to be narrowed for other categories. However, all of the respondents who used the techniques of Rood, PNF and the minority methods also included Bobath's techniques or Functional techniques among their skills.

Only one respondent used Functional Physiotherapy exclusively and it is estimated that 60.9% to 83.9% use Functional techniques as well as other techniques. Interestingly, 22.3% to 46.7% are estimated to use both Functional Physiotherapy and Bobath's method. There is little evidence how physiotherapists combine the techniques of the different methods. Physiotherapists who attended study day or were interviewed in Stage 4 on the project suggested that Bobath's method is used in the early stages of recovery to counteract the establishment of spastic patterns of movement or to raise very low tone and to achieve bilateral activity. In the later stages Functional Physiotherapy may be given to elderly patients in particular to enable them to perform domestic and social activities. Neurophysiological treatment is likely to be continued into the later stages of recovery of younger patients to enable them to perform a wider range of occupational, domestic and social activities during the longer length of survival they are expected to have. The data suggest that Bobath's method is used most commonly but that techniques of other neurophysiological methods may be used to treat particular symptoms.

These data give the lie to the common and unsubstantiated idea of "The Bobath Physiotherapist" and "The Functional Physiotherapist" and suggest that physiotherapists are eclectic in the treatment they give and select techniques to fulfil particular aims of treatment.

3.4.5 The physiotherapeutic acceptability of SMAC

In order to evaluate the chart's acceptability to physiotherapists for routine clinical use, responses to the following questions were collated: questions 7, 9, 11, 24, and 26 on the postal questionnaire; and question 13 on the study day questionnaire. These data are tabulated in Tables 24 and 25.

The data were treated to determine:

If the physiotherapist who had participated in the development of the interim chart held different opinions to those who had not;

if respondents changed their opinions during the course of the field test;

if opinions were related to the method of physiotherapy respondents professed to use.

Results:

Four analyses were undertaken. These are listed with the results in Table 26.

TABLE 24

AFFIRMATIVE AND NEGATIVE OPINIONS EXPRESSED ON POSTAL QUESTIONNAIRE

	Sample	"No"	"Yes"
Q. 7: Order of physiotherapy items agrees with intuitive concept of recovery	A	0	22
	B	6	16
Q. 9: Physiotherapy items constitute a valid physiotherapeutic motor assessment	A	3	19
	B	1	21
Q. 11: Physiotherapy items represent the most significant movements in the sequence of restitution of normal movement	A	6	16
	B	4	18
Q. 24: SMAC is compatible with method of physiotherapy	A	0	22
	B	1	21
Q. 26: SMAC is acceptable for routine clinical use	A	4	18
	B	1	21

TABLE 25

COMPARISON OF RESPONSES TO SIMILAR QUESTIONS ON DIFFERENT QUESTIONNAIRES, SHOWING CHANGES OF OPINION

	postal questionnaire	study day questionnaire	
		No	Yes
Q. 7/Q. 13A: Order of physiotherapy items agrees with intuitive concept	Yes	0	24
	No	0	5
Q. 11/Q. 13b: Significant items in process of motor recovery identified	Yes	0	22
	No	1	6
Q. 26/Q. 13B: SMAC is acceptable for routine clinical use	Yes	1	26
	No	0	2

TABLE 26
 ANALYSES OF PHYSIOTHERAPEUTIC ACCEPTABILITY OF THE ASSESSMENT

Null hypothesis	Source of data	Statistical calculation	Results
1. That equal proportions of sample A and sample B hold affirmative opinions about the assessment	<u>Postal Questionnaire</u> Q: 7,9,11,24,26	Fisher test	Q7 : p = 0.0106 Q9 : p = 0.303 Q11: p = 0.36 Q24: p = 0.5 Q26: p = 0.1725
2. That the probability of an affirmative response is the same for all five opinions about the assessment	<u>Postal Questionnaire</u> Q: 7,9,11,24,26	Cochran Q test	Sample A: Q = $\frac{11.826}{0.2}$ > p > 0.1 Sample B: Q = $\frac{9.217}{0.1}$ > p > 0.05 A + B: Q = $\frac{8.976}{0.05}$ > p > 0.02
3. That physiotherapists who change their opinions about SMAC are equally likely to change from affirmative to negative as negative to affirmative	<u>Postal Questionnaire</u> Q: 7, 11 <u>Study Day questionnaire:</u> Q: 13	Binomial test	Q7/13A: p = 0.03125 Q 11/13B: p = 0.016
4. That equal proportions of samples A ₁ , B ₁ & C agree with statements 13A, B, C.	<u>Study Day Questionnaire</u> Q13	Fisher Test	p > 0.05

Discussion of results:

The majority of physiotherapists who responded to the postal questionnaire considered that (Table 24):

the order of the items of assessment agreed with their intuitive concept of the sequence of recovery from hemiplegia;

the physiotherapy items constituted a valid physiotherapeutic motor assessment;

the most significant movements in the restitution of normal movement had been identified;

the SMAC was compatible with their method of treatment;

the SMAC was acceptable for routine clinical use.

However, there was a significant difference between the proportion of Sample A, who had participated in the field tests of both the preliminary and the interim assessments and the proportion of Sample B, who had participated in the field test of the interim version only, whose concept of restitution of normal movement was satisfied by the order of items of assessment (Table 26, Analysis 1). The six members of Sample B who were dissatisfied suggested either that other items ought to be included or that two or three items should be reordered. These suggestions may account for the differences between the samples, because members of Sample A had contributed such suggestions to the revision of the preliminary assessment.

This difference is not significant when responses to all five questions about the assessment are considered together (Table 26, Analysis 2). That is, a physiotherapist who holds one affirmative opinion about SMAC is likely to respond affirmatively to the other four questions.

For those physiotherapists who had responded to both the postal questionnaire and the study day questionnaire, and who had changed their opinions during the field test of the interim version (Table 25) only changes between question 7 (postal questionnaire) and statement 13A (study questionnaire), and between question 11 and statement 13B could be tested. The results Table 26, Analysis 3) show that there is a significant tendency for the opinions of physiotherapists who are undecided, or who change their opinions, to become more favourable towards the assessment as they become more familiar with it and more experienced in its use. The number of respondents who changed their opinions with regard to question 26 and statement 13A (Table 25) was so small that a result could have been due to chance factors and was not calculated. The majority of respondents did not change their opinions but responded affirmatively to both questionnaires.

Comparing the responses made by members of samples A, B and C to statements 13A, 13B and 13C (Table 26, Analysis 4) the majority of whom agreed with these statements, then agreement was not influenced by membership of any sample. Therefore, it can be assumed that other physiotherapists who, like members of sample C, have not participated in the development of SMAC will also find the assessments acceptable, confidence limits were calculated for the proportion of the population of physiotherapists who would find SMAC acceptable on the grounds of responses to statements 13A, 13B and 13C given by those physiotherapists who had not participated in a field test. It can be said with 95 per cent confidence that:

the order of the items of assessment will agree with the intuitive concept of the sequence of recovery of 0.93 ± 0.13 of the population of physiotherapists, or 80 to 100 per cent;

0.93 ± 0.13 of the population will also agree that the significant movements in the process of motor recovery have been identified;

0.79 ± 0.21 of the population, or 58 to 100 per cent would find the interim version acceptable for routine clinical use.

Responses to statements 13A, 13B and 13C were also collated according to the method of physiotherapy used by the particular respondent (3.4.4). None of the physiotherapists who used Bobath's method exclusively disagreed with any of the statements. However, Bobath's method was the only method which was common to those who disagreed with any of the statements. Consequently, it is assumed that opinions concerning the suitability and acceptability of the assessment are associated with the personal preferences of individuals rather than approaches or methods of physiotherapy.

3.4.6 Summary and conclusions

Although the change in the design of the display, from a curvilinear design to a rectilinear design, had been implemented before participating physiotherapists had been consulted, results show this change to be advantageous. It is estimated that 79 per cent to 98 per cent of potential users would find a rectilinear design more attractive and easier to use.

Respondents also found the Physiotherapy Items of the interim assessment easier to understand, to remember, to apply and to record than were the items of preliminary assessment. This may be because the instructional manual accompanying the interim assessment was clearly comprehensible. Further improvements in the manual, particularly in the presentation of the items of assessment, should facilitate physiotherapists' use of the items of the final assessment which assess Quality of Movement. The presentation of the Gross Functional Items provided inconclusive evidence concerning the effectiveness of their communications of a patient's status and progress. The presentation of the items of the final assessment which assess Functional Ability and Activity Capability may provide more substantial evidence.

Several very important conclusions can be drawn from these results and from the results of analyses of respondents' opinions of the assessment. Firstly, affirmative opinions concerning the assessment do not appear to be associated with

the extent of a respondent's participation in its development. Secondly, although a minority of physiotherapists held one or more negative opinions when they were first questioned, or were undecided, there was a very strong tendency for their opinions to become affirmative as they gained experience with the assessment and became more familiar with it. Thirdly, neither negative opinions nor affirmative opinions are associated with any particular approach, method or technique of physiotherapy. Consequently, if future users have the same characteristics as these respondents, then SMAC can be described as:

- A. Valid for the physiotherapeutic assessment of hemiplegia
- B. Compatible with the methods of physiotherapy practised by British physiotherapists
- C. Adequate for description of the status and progress of hemiplegic patients
- D. Acceptable for routine clinical motor assessment of hemiplegic patients.

3.5 EVALUATION OF THE CHART'S POTENTIAL CONTRIBUTION TO THE REHABILITATION OF STROKE PATIENTS

Following evaluation of the physiotherapeutic acceptability of SMAC, the function of the display as a communicator of relevant information was investigated. Patients and practitioners were interviewed with the aim of assessing the potential contribution of SMAC to multidisciplinary rehabilitation of stroke patients by:

confirming that the items of assessment which are intended to communicate findings of the physiotherapeutic assessment do convey information which other practitioners use and need;

identifying the points at which SMAC coincides with assessments made by other practitioners;

ensuring that the signs which describe functional abilities are readily understandable by those who use them;

reporting the facets of the behaviour of teams which affect the chart's use as an aid to communication.

Interviews were conducted at six treatment units. SMAC was being used at four of these units. At two of them, physiotherapists had been involved in the development since the pilot study two years previously. At the other two, physiotherapists had participated in the field test of the interim version. Physiotherapists at the fifth centre had participated in the inter-observer test of the reliability of the interim version, as members of sample C. The sixth centre was an entirely new location. It was included so that the chart's acceptability to physiotherapists who had not participated in its development in any way could be investigated.

FIGURE 43

INTERVIEWS WHICH WERE CONDUCTED

Team Code	Practitioners who were represented					Types of units represented
	Physiotherapists	Nurses	Occupational Therapists	Doctors	Social Workers	
A	x	x	x	x	x	GERIATRIC Day Hospital
B	x	x	x		x	STROKE UNIT
C	x	x	x	x		GERIATRIC Community
D ¹	x	x	x	x	x	STROKE UNIT Day hospital
E	x	x	x	x	x	REHABILITATION Day Hospital
F ²	x	x	x	x	x	GERIATRIC Medical Wards
Numbers interviewed	12	34	14	6	6	

- Key:
1. Physiotherapists participated in test of reliability but did not use SWAC in a field test
 2. New centre: physiotherapists did not participate in the development of SWAC.

Methods:

Practitioners were not selected individually to create representative samples. Rather, their places of work were selected to represent the various types of units in which hemiplegic patients are treated:

Geriatric hospital, or geriatric ward in a general hospital; purpose-built stroke unit, or ward designated as a stroke unit; day hospital; rehabilitation unit; and acute medical ward, or neurological ward, in a general hospital.

To this end, the physiotherapists who responded to the study day questionnaire were asked about the centres in which they worked, the frequency with which they treated hemiplegic patients, and their colleagues in other health care professions (Study day questionnaire, questions 20 and 21).

Centres which lay within a thirty-five mile radius of Sheffield were selected for practical reasons of time and cost. Several visits to each centre were required, according to the times at which practitioners were available for interview.

At each centre, a team associated with a particular unit was identified for interview. These teams are coded A to F in Figure 43. The specific unit with which all members of any team were associated is given in block capitals on the same figure. Except for nurses, each practitioner was usually a member of another team, or other teams, also. Where these teams are associated with different units, they are given in lower case letters.

Pilot interviews were conducted using draft interview schedules in order (A) to identify questions which required clarification; and (B) to illuminate the dynamics of a situation in which members of different professions take expectations of each other to an interview (cf. Appendix II.1).

During the interviews, respondents were allowed to ask for clarification of questions. The interviewer rephrased questions, and phrased probes, according to respondents' apparent comprehension of the questions. No explanation or discussion which might have invalidated the data was entered into until an interview was completed.

All interviews were audio-taped. The tapes were transcribed within twenty-four hours of each interview by the researcher for three reasons: (A) respondents had been promised confidentiality; (B) so that unified impressions could be formed by matching verbal responses with remembered cues, such as gestures and casual glances; and (C) because, if the tapes had been transcribed by another person, the probing questions and the frequent replaying of tapes for transcriptions might have disrupted the formation of impressions and dislocated results from the real clinical situation.

Materials:

Copies of the following interview schedules will be found in Appendix II. 5.

1. Professionals' interview schedule

2. Patients' interview schedule
3. Physiotherapy teachers' interview schedule
4. Physiotherapists' interview schedule.

The interview schedule for practitioners other than physiotherapists (1) was drafted to provide a framework of features and processes of team care which would allow the relevance and appropriateness of the display of SMAC to be assessed relative to the needs of the team and its individual members. The physiotherapists' interview schedule (4) was drawn up around the critical issues and basic phenomena of care which emerged from the transcriptions of interviews with other practitioners.

Samples:

In order to investigate potential of the display to communicate to patients information which might reinforce their collaboration in treatment, six patients were interviewed at a treatment centre where SMAC was not being used. These patients were chosen so that they could not have seen charts of their own status and progress, or received an explanation of the chart, before they were interviewed. They were chosen by the physiotherapist concerned according to their ability to comprehend and answer questions.

Thirty interviews were conducted with practitioners.

Figure 43 shows that the consultant in Team B was not interviewed. He postponed his interview several times, and did not forward permission for his senior registrar to be interviewed in his stead. One consultant invited his senior registrar to his interview: the other consultants chose to be interviewed alone.

Occupational therapists and nurses were interviewed in small groups. During the interviews with nurses, consultants and occupational therapists, social workers emerged as significant members of rehabilitation teams who are not trained in a health care profession. The project was extended to include them; but a social workers was not available for Team C. The representativeness of these practitioners is not thought to be open to criticism because the survey was directed towards respondents' personal experiences and attitudes, and towards the cumulative pattern concerning the provision of rehabilitation rather than towards one interactive situation.

At different times, staff of the Rivermead Rehabilitation Unit, Oxford, and the author of this thesis had attended the "Motor Club". This is a multidisciplinary discussion group in the south of England which was established for the purpose of developing a standardised assessment. The Rivermead Hemiplegia Motor Assessment - discussed in section 2.4.4 - was published during the development of SMAC (Lincoln and Leadbitter, 1979). Therefore, a visit was arranged to the unit to discuss both assessments during the closing weeks of the evaluation of SMAC. Physiotherapists in the Motor Club also described "A physical assessment for stroke patients" during the period in which SMAC was developed and evaluated. It was published while this thesis was being completed (Ashburn, 1982). Consequently, material from an interview with a physiotherapist who is using the "Motor Club Assessment" was extrapolated from the main reports of physiotherapists' reactions to SMAC.

Additionally, teachers of physiotherapy, in two schools which were not associated with the project or the researcher, were questioned in order to assess the potential of SMAC as an aid to the teaching and learning of students of physiotherapy.

Data and analysis:

Initially, the tapes were transcribed under the headings and questions of the interview schedules. The data were treated according to the descriptive analytic method described in section 2.7.3. Transcriptions were reviewed, and categories of analysis, their properties and associated rationales of practitioners were identified. Consequently, it is not appropriate to emphasise the frequency of occurrence either of assertions among respondents or of phenomena in treatment units. However, the nature of assertions is seen as providing valuable insights into the dynamics of the provision of rehabilitation. To a certain extent, the reported findings are dependent on the researcher's sensitivity when integrating the material into a coherent picture. Protection against idiosyncratic interpretation was provided through discussion with the researcher's supervisor.

Results:

The findings will be presented in two sections:

3.5.1 The context of care.

The interactions between practitioners and the manner in which decisions are made are presented so far as they concern the use of SMAC. Respondents compared and contrasted their relationships with all members of a team; but information which does not concern interactions between physiotherapists and other practitioners has been suppressed so that data which is pertinent to SMAC could be identified.

3.5.2 Reactions to SMAC

The reactions of practitioners and patients are presented before an estimate of the potential of SMAC to contribute to rehabilitation of stroke patients is made.

3.5.1 The context of care

This section concerns the provision of services to stroke patients according to the reports of seventy-two practitioners. The findings are based on their responses to questions in Section B, "Roles" and Section C, "Knowledge and use of standardised assessments" in the professional interview schedule; and to questions in Section B, "Physiotherapists' roles and skills", Section C, "Communication", and Section D, "Discharge planning", in the physiotherapists' interview schedule. Where appropriate, the attitudes, opinions and expectations of each professional group are presented separately. Otherwise, the general view of all practitioners is expressed.

1. The team approach to care and rehabilitation

"Team work", as opposed to each discipline working in isolation according to its own aims and methods, was reported as a positive feature of all but one location. Two types of team were identified: the "every day team" and the team which meets with the consultant at ward rounds and at case conferences.

"Every day teams":

These teams usually include sisters and staff nurses, occupational therapists and physiotherapists, because they meet frequently and may assess or treat patients simultaneously. Physiotherapists meet sisters and staff nurses most regularly; and there appears to be better cooperation and understanding between them than there is between physiotherapists and occupational therapists. In general, there appears to be an uneasy alliance between physiotherapists and occupational therapists; although they make home assessments together commonly, and seek each other out to discuss individual patients.

These practitioners exclude consultants, other medical practitioners and social workers from the "every day team" if they are not seen to exchange information about patients frequently and informally. Ward sisters and staff nurses are the main channels of this information between practitioners. It may never be recorded, but it appears to be the mainstay of effective care.

Teams which include the consultant:

These teams usually have a meeting or case conference once a week. At these meetings, team members (A) draw together the information and plans of each practitioner which are specific to the needs of individual patients and (B) make joint decisions regarding their future care.

According to the expressed attitudes, the essence of effective team work appears to be the confidence that members have in each other. The effectiveness of the "every day team" in particular can be affected by the change of just one member.

2. Planning for patients' discharge from hospital

"Discharge home" is the common goal for each patient. The "every day team" appears to agree about a patient's readiness for discharge before the ward round and case conference. One consultant described himself as "rubber stamping" the decision which had been reached by the ward sister, occupational therapist and physiotherapist following the "home assessment".

The way in which decisions are made at case conferences appears to reflect the personality and style of the particular consultant. For example, some respondents had experience of consultants who discharged patients against the recommendations of other practitioners. They described the patients as being "on a piece of elastic" because of the high rate of readmission. In order to delay the date of discharge, practitioners had colluded to present to the consultant either a united front or an acceptable delaying reason - such as that a commode was not available for another three or four weeks.

In general, the teams which were interviewed reviewed patients and monitored their progress continually in order to decide whether a patient could be expected to return home, or if he would require long-term care. The multiplicity of problems presented by stroke patients demands team work. Therefore, the overall impression of these teams was that members were united in looking at a person's problems from every point of view, including the patient's

aspirations and preferences.

The planning for discharge practised by most teams allowed practitioners to focus their attention on aspects of care related to a patient's life outside the hospital. Specific problems were dealt with by the practitioner who had the knowledge and skills needed to plan and implement the necessary action. The actual date of discharge was usually set by the ward sister when all other interventions had been completed.

3. Potential for conflict between practitioners

Potential for conflict was centred on pressure for beds in hospital. Ward sisters accused some consultants of "seeing beds rather than people" and of reacting to pressure for beds rather than to the needs of individual patients. Consultants admitted that they may decide to discharge patients precipitately, principally because they needed to admit patients who were straining the resources of their families. Additionally, they accused physiotherapists who challenged their proposals to discharge patients of being unrealistic and "insufficiently pragmatic". Physiotherapists were described as wanting to retain patients in hospital in order to achieve "physiotherapeutic perfection" beyond the person's ability to perform social and domestic activities. Consequently, they were said to lose sight of the general aim of getting the patient home from hospital, and of enabling him to get out of his home.

The physiotherapists' side of this conflict included accounts of realism and eclecticism in their approach to the needs of individuals. For all patients, the physiotherapists' early aims of treatment include restoration of bilateral activity. Restoration of normal motor function is pursued more vigorously for those people who have a larger number of roles to fulfil. One of the physiotherapists' main concerns was that patients' abilities in hospital were often taken as evidence that they could perform light domestic duties and self-care activities at home. They also expected the greater part of

of a patient's recovery to have been achieved before he left hospital, because of the attitudes of caring relatives and difficulties in the provision of services for out-patients.

Physiotherapists and consultants can be seen as reporting conflicting priorities, which may be expected to occur when several disciplines are involved in interactions which are centred on individuals such as hemiplegic patients. While the conflict is potential rather than actual usually, it may become outwardly more apparent on occasions. For example, both physiotherapists and consultants reported arguments about standing patients up and "walking them". Physiotherapists said that these arguments took place at times when the consultant was encouraging walking but they thought that it was too early in the process of recovery for the patient to be "on his feet". They attributed the conflict to lack of evidence, firstly, that physiotherapy is efficacious, and, secondly, that there is an optimum sequence of restoration of motor function.

The conflict also demonstrates that consultants' allocations of beds are finite and that they must discharge one patient to admit another. Conversely, physiotherapists' lists are more elastic. In most situations, the potential for conflict was never realised because of the relationships which had been established between team members. It was usually resolved in favour of the in-patient who was considered to have potential to benefit from further treatment.

4. Utilisation of findings of physiotherapeutic assessments

The physiotherapists reported that they made assessments in order to identify what a patient could not do, rather than what he could do, for two purposes: (A) to assess why a movement cannot be performed, and (B) to formulate aims of treatment. At reassessments, they record the achievement of aims, assess the progress that has been made, identify new problems and formulate new aims of treatment.

Other team members use information about the patient's abilities:

nursing staff are concerned with a patient's mobility in the ward;

occupational therapists mentioned a patient's ability to balance in sitting and standing as prerequisites for activities they will teach;

social workers needed a judgement of a patient's capabilities at home.

Many decisions about the patient's future care hinge on his mobility, in particular his ability to walk independently. Such emphasis is laid on walking, which was constantly referred to throughout the interviews, that it appears to be the one finding which other practitioners are interested in and utilise.

5. Other practitioners' perceptions of physiotherapists and physiotherapy

All of the occupational therapists, consultants, nurses and social workers identified unique characteristics of physiotherapists which were felt to confer "expert" or "specialist" status on them:

They are trained to observe patterns of movement and to use their hands to facilitate normal patterns of movement.

They have developed their own methods of treating hemiplegic patients.

They are able to make estimates or predictions of a patient's potential: the extent of his recovery; his potential to benefit from further physiotherapy; and his ability to take care of himself at home.

Occupational therapists used various pairs of words to compare their own practice with physiotherapy. For example, they described occupational therapy as "applied" and fulfilling broad functional aims; in contrast, physiotherapy was seen as "pure" and fulfilling narrow "pattern of movement" aims. One occupational therapist distinguished the two:

"The occupational therapist will look at how to make something functionally easier for the patient to perform. The physiotherapist will look at improving the patient's ability to perform."

Occupational therapists also suggested that physiotherapeutic practice has developed further in the treatment of hemiplegia than has their own practice. Consequently, they have adapted neurophysiological methods of physiotherapy for occupational therapy. However, it was felt that early preventative physiotherapy is a preliminary to rehabilitation which they undertake.

The consultants emphasised that they did not "dictate or interfere in physiotherapy any longer" because physiotherapists had become "experts" in the recovery of movement. Consequently, their expectations of physiotherapists had also changed. What one called "an abdication of consultant responsibility in some peoples' eyes" is really more demanding of physiotherapists, because consultants' interests lie with the results of physiotherapy and with physiotherapists' ability to achieve desirable results. A desirable result was always couched in terms of a patient's ability to walk, and to return to his home.

Consultants also identified a teaching role for physiotherapists.

One saw this role as teaching:

"That stroke patients are worth attention and effort if treatment is started early enough."

Another consultant described teaching as:

"... Fundamental. A large part of successful rehabilitation is prevention of complications. Therefore, the physiotherapist should have the personality and motivation to educate ambulancemen and porters, and professional members of the team - including the consultant - in general handling and motivation of the patient; and to involve the family actively in rehabilitation."

Nurses conferred an "expert" or "specialist" status on physiotherapists:

"... Because there is no magic cure for stroke; only physiotherapy, then occupational therapy, and hard work for the patients."

Sisters and staff nurses also stressed the paramountcy of cooperation between practitioners: firstly, because

physiotherapists need nurses to reinforce treatment; and, secondly, because physiotherapists solve some of their problems by demonstrating easier ways for them to move patients. In all but one unit physiotherapists undertook their most practical teaching role with nurses who were taught handling skills.

Nurses also commented on the rapport which physiotherapists develop with patients because of the one-to-one interactions in sessions of treatment. Sisters in particular have a large number of calls on their time and "can only skate over the surface of rehabilitation".

Social Workers also said that they "use the physiotherapist's rapport with a patient", although they and occupational therapists also devote periods of time to one person. The social workers said that physiotherapists gained information which was valuable to them but which was not divulged during social work interviews. They felt that confidence was not breached if they were informed about such things as potential or actual marital problems which they could deal with. Most frequently they learned about a patient's motivation and "aggression signalling". They found this information as valuable as information which helped them to assess the amount and nature of assistance which was needed, or alterations to accommodation which were needed, to enable a patient to live at home. One social worker, who draws a "social network diagram" to identify the key person in the community who can be relied upon to report to her, described:

"... A large subjective element in assessment, particularly regarding motivation. A patient may be able to perform activities in hospital, but he is not motivated at home. Discrepancies arise between the patient's assessed performance and his actual performance because the problem is not identified before discharge."

In this respect, and particularly with regard to the attitudes and actions of caring relatives, social workers also identified a teaching role for physiotherapists which assisted them to perform their own role of counsellor to the family.

6. Physiotherapists' reactions to the roles attributed to them

The principal impression left by the physiotherapists was that they were dissatisfied with their ability to alter the condition of hemiplegic patients for the better. However, they thought that their unique contribution to rehabilitation of stroke patients was their interest in the quality of patients' movements. They considered that they did have specialised knowledge of recovery and rehabilitation through the experience of combining both the handling skills and the skills of observation identified by other practitioners. They also considered that their ability to communicate their rationales of treatment was limited by the lack of a universally understood vocabulary to describe these skills and their products. They felt that the main prediction which they were expected to be able to make was whether or not a patient would eventually walk independently. They doubted their own ability to make other predictions which would be acceptable to the team, if only because there was no substantive evidence to support their reference to a sequence of recovery from hemiplegia.

Those who conduct teaching sessions with nurses, and with care assistants in local authority institutions in one centre, considered that they would teach handling skills more successfully if students in other professions could also be taught how people normally move. They appeared to find the teaching role quite onerous, not least because it is not acknowledged in calculations for authorised financed

staff of physiotherapy departments.

A more serious concern was that their "preventive, counteractive and restorative skills" were not recognised as well as they might be, and therefore they were not utilised. Some ironic comments were made concerning the notion of "expert" status, and they complained that they were seen only as people "who get the patient out of bed and walking". "Walking" was constantly stressed throughout the interviews with all practitioners; and consultants include it in their definitions of successful outcome from physiotherapy. It is clear that physiotherapists feel that their contribution to rehabilitation is perceived only in terms of this ability because such emphasis is laid on it and associated activities. Physiotherapists are concerned that the focus on a patient's achievement of independent walking conceals inadequate appreciation of the pre-requisites for a safe gait.

3.5.2 Reactions to SMAC

1. The reactions of occupational therapists, consultants, nurses and social workers

The final version of SMAC was shown to these practitioners after they had discussed the physiotherapeutic information they used and needed. They all commented on the items of the assessment of Activity Capability first, possibly because of the written descriptions, but each group gave different reasons for looking at them. Only the occupational therapists paid any attention to the assessment of the Upper Limb. They all answered questions in sections C, D and F of the professionals' interview schedule.

Occupational therapists identified the items assessing Activity Capability as a section into which an assessment of ADL could be keyed. However, hostility was sensed in two groups who complained that these items "belonged" to occupational therapy. This resolved into a suggestion that the items represented the point of overlap between occupational therapy and physiotherapy. In all but one location, it was said that a joint occupational therapeutic/physiotherapeutic profile of the patient was required.

Consultants commented immediately on items which are directly concerned with "getting the patient home from hospital and then out of the house". They obtained the information contained in the section concerning Activity Capability at

ward rounds and at case conferences. They implied that no record could replace or supplement this communication; but added that the SMAC display might be useful when a patient's progress was reviewed. All but one of them looked at the items of Functional Ability, and commented on the distinction between a patient's ability and his typical performance.

Consultants would prefer a combined display of the assessments made by occupational therapists and physiotherapists. They also suggested some additions to SMAC. Some of these are more closely related to a social worker's assessment than to a physiotherapeutic assessment. For example, extension of the assessment of Activity Capability by linking together items which assess safe walking and negotiating a kerb or ramp, in order to answer the question, "Can he go and collect his pension?". Principally, consultants require some means of predicting a patient's future capacity; or, at least, a means of demonstrating his rate of progress.

The consultants also offered personal caveats: one found the signs using pin-pen irritating, and one was concerned that there was too much information on the display. He said:

"There is a danger in rehabilitation that information which is of interest to the doctor or physiotherapist is included in an assessment, and data which is of fundamental importance to the patient is ignored or submerged. There should be somewhere where we can answer the questions:

What does he want to do?
What does he need to be able to do?
Are we achieving them?"

The consultants suggested personal uses for SMAC also: to refer to when the physiotherapist is not available; to refer to if a patient is readmitted; and to collect data for studies of personal interest. One of them ended on a pessimistic note:

"Until there are enough physiotherapists available to treat the patients, the full benefit of work of this kind will not be realised."

Nurses picked out the assessment of Activity Capability

because:

"People are brainwashed into thinking when they are in hospital, 'The nurse will do it. It's her job.'"

In one unit, a summary of the physiotherapeutic assessment was filed in the ward office. However, sisters remarked on the discrepancy between items a patient was recorded as performing with and for the physiotherapist and how he performed on the ward. All of the nurses talked about this same discrepancy; and they thought that the distinction between the assessments of Functional Ability and Activity Capability might solve this problem. One group thought that SMAC would also identify those patients who should be assessed as "able" but who were occasionally, or frequently, confused. Items of Functional Ability would be recorded for these patients, but items of Activity Capability might not be recorded because they could not be considered to be safe at any time and in any circumstance.

The sisters also thought that SMAC might enhance continuity with night staff, which they find problematical. Even in

the unit where the team approach was said to be "non-existent", they suggested that copies of each patient's chart should be attached to his bed-end clip board, or filed with the "Nursing Process" notes.

Social Workers were interested in the record of Activity Capability because it answered their need for an estimate of a patient's potential capacity at home. One commented on "blind spots" which practitioners have:

"Are we assessing for performance in the clinical situation, or for performance at home which is affected by many intrusions?"

Another social worker considered that the distinction between the records of Functional Ability and Activity Capability were very important because:

"Discharge decisions are frequently based on a patient's ability at one instant or in one place, rather than on his typical performance."

They all thought that they could use SMAC to illustrate to relatives the need for change of accommodation and to indicate activities which a patient should be allowed to perform alone. To make SMAC more useful, they wanted assessments of feeding and dressing and of outdoor activities, such as going to the shops.

Although individual practitioners could not comprehend a particular sign, in general practitioners interpreted the signs correctly. Individual consultants and occupational therapists were interested in the items assessing Quality

of Movement also. Three of the consultants thought that medical practitioners should be provided with a copy of the "SMAC Crib Card" so that they could follow a patient's progress more closely.

2. Physiotherapists' reactions to the final chart.

The physiotherapists were expected (A) to have seen and used the chart before their interviews and (B) to be able to answer questions about the procedure and the record. However, at one centre another assessment was being used by the physiotherapist with whom arrangements had been made. Her opinions of SMAC will be reported later. Unfortunately, she had not passed SMAC on to other physiotherapists prior to interview. While their responses are reported in "the context of care", because they are pertinent to the responses made by other practitioners at that centre, they were not qualified to discuss SMAC itself. The immediate reaction of one physiotherapist was that the display was attractive, and she identified the assessment of Activity Capability as relevant to her work in a Day Hospital.

The physiotherapists at the other centres were satisfied with the procedure and the display. Most importantly, SMAC was adopted for routine clinical use at the centre which had been introduced specially. All of the physiotherapists found that displays agreed with their subjective impressions of their patients. Less experienced physiotherapists said that the assessment had helped them to "sort out thoughts and impressions", to put their observations into perspective, and to identify a patient's principal problems at a particular time. The display had also been useful when progress was reviewed, "because we forget how severely affected they were immediately after onset". Several physiotherapists suggested

that a complementary sensory assessment should be developed next.

SMAC had not been used as an aid to communication at any location. Several physiotherapists said this was because SMAC was a physiotherapeutic assessment which could only supplement verbal exchanges of information. Two experienced physiotherapists suggested that the chart should be treated exclusively as a physiotherapeutic assessment, to the extent of eliminating the assessment of Activity Capability from the display.

The main reason for which SMAC had not been introduced to other practitioners emerged from all of the interviews: The physiotherapists did not feel that they had had sufficient time to become fully acquainted with the final version. The introduction of change, even requested change which is undertaken voluntarily, appears to cause anxiety and some resistance to promoting change to other practitioners.

3. Patients' reactions to SMAC

Patients stated their ultimate aim as "being like I was before". However, they were unable to compare their current capabilities with their previous capabilities; and, consequently, they could not list activities which they still wanted, or needed, to achieve. Possibly due to cerebral shock, their recollections of their condition immediately after their CVAs were unreliable in comparison with the physiotherapist's records.

Most of the patients were ambivalent about the progress which was illustrated on facsimile displays of their early and recent assessments. They doubted that they had ever been "that bad", with only a few items recorded. Then they dismissed the idea that they could see any change, or the suggestion that it might benefit them to see the display filled in as they improved. These responses were difficult to interpret in the light of physiotherapists's claims that the display was meaningful to patients as findings of successive assessments were added. Instead of answering questions, they frequently said, "The physiotherapist says I'm better." They gave the impression that people can expect things to happen to them in hospital which they will not understand, but which they must accept.

One patient was interested in "seeing something on paper showing progress". She was particularly interested in the panel labelled "Early indoor goal", and suggested that a "Late Goal" should be recorded also. Her recollection of

of her earlier condition was unreliable also; but she was more realistic about the possible outcome from physiotherapy, and she was the only one of these patients whose collaboration in treatment might have been reinforced by the display.

Although this was a very small sample, the patients represented physiotherapists's descriptions of patients' attitudes towards physiotherapy.

The main group either thought that they would be restored as swiftly as the stroke had happened, or their instinct was to reject the idea that they had a permanently disabling condition. In either case, physiotherapy was more or less irrelevant. Physiotherapists find these patients very difficult to motivate.

The woman who was interested in seeing her own chart represented a smaller group of patients who accept that they have, most probably, a permanent disability. The purpose of physiotherapy is apparent to these patients; they are more willing and more able to collaborate in treatment; and they practice on their own.

4. Reactions of teachers of physiotherapy

Teachers of physiotherapy were not selected to form a representative sample of the population of teachers of physiotherapy in the United Kingdom. They were interviewed so that an estimate could be made of the potential of SMAC as a teaching aid. The chart was not proposed as a method of assessment to be taught to all students of physiotherapy. The main concern was to determine whether or not it offered a systematic approach to assessment which could be utilised in teaching about hemiplegia.

These teachers perceived successful physiotherapy for hemiplegia as a combination of achieving a patient's aspirations and physiotherapeutic aims. They pointed out that although functional abilities and other improvements could be scored on a list in order to demonstrate progress, this may not be equatable with the patient "feeling better". Progress in physiotherapy was discussed in relation to a patient's expectations. Consequently, students are taught that their role is affected by a patient's needs and desires. Students must also be enabled to "sell the idea of physiotherapy to the patient", especially to a patient who expected a "miracle cure" or did not accept his hemiplegia.

Education in physiotherapy is said to be focussed on preventative and restorative intervention. With regard to rehabilitation of stroke patients, rather than physiotherapy for hemiplegia, it is directed towards illumination of landmarks

in the process of recovery for other practitioners who might not witness them as important steps. The need to explain the rationales of neurophysiological methods of physiotherapy is also stressed.

The teachers in these two schools of physiotherapy held quite different ideas of the potential of SMAC:

In the first school, the assessment was considered to be insufficiently detailed for use as a clinical assessment by students. While an experienced physiotherapist might remember why a performance was not acceptable, it was felt that students should record their reasons. However, it was also felt that the items of assessment could be used to direct students' attention. The "disqualifiers" were considered useful in the "observation-reasoning" process in order to lead students along the path followed by experienced assessors.

In the second school, SMAC was adopted both as an aid to teaching assessment of hemiplegic patients and as an assessment used by students in their clinical placements. It was said to provide them with the means of organising their observations, of formulating their aims of treatments, and of discussing the status and progress of their patients with greater clarity and understanding.

5. Reaction of physiotherapists who were involved in the development of other assessments

The physiotherapist who was using the "Motor Club assessment" disliked the signs on SMAC. Principally, she complained that a total "SMAC score" was not available: the "Motor Club assessment" enables her to encourage patients by saying, "You've scored twenty-eight out of fifty-four. You're half-way there!" The author of an article about this assessment writes of the four-point scale for assessing items of the "examination of functional movement activities":

"... the chart can provide a total score. The top rate is 54 which indicates total independence."

(Ashburn, 1982)

Clearly, advantage should be taken of any opportunity to enhance a patient's motivation (cf. section 2.4.4). However, substantial doubts have been raised concerning the feasibility of summated rating scales (cf. section 2.6.2). Consequently, the value of such a scale was probed at this interview. In particular, the meaning of scores such as eleven, twenty-eight or forty-three out of fifty-four was probed, but unproductively. It appeared as if there was no point of mutual agreement, although similar fundamental assumptions underlie both the Motor Club assessment and SMAC. That is, the items of the Motor Club assessment of the upper and lower limbs "have been chosen to follow the neuromuscular pattern of recovery"; and these items are assessed using starting positions which require increasingly finer neuromuscular

control. However, the items are not arranged in an order from "least recovered" to "most recovered" and there is no evidence that they represent recovery from hemiplegia truthfully.

The physiotherapists at the Rivermead Rehabilitation Unit had considered each item of SMAC, and they criticised each of them. This type of criticism is on-going at the unit: items of the Rivermead assessment are being refined continually as new members join the staff.

There also appeared to be a great deal of common ground between the Rivermead Hemiplegia Motor Assessment and SMAC, principally because the items of both assessments have been generated by patients and their order has confirmed as a valid representation of the sequence of recovery from hemiplegia. As far as could be judged, because the same scales were not used in both assessments, similar items were in the same order on both. Unfortunately, a unified scale of items of the Rivermead assessment was not available for comparison with the unified scale of items from SMAC.

In comparison with the criticism levelled at the Rivermead assessment because it appeared to contain too many advanced items (2.4.4), SMAC was criticised for assessing too many very early items. It was concluded that each assessment reflected the patients who had provided the data on which they were based; and, consequently, each may be more appropriate in different circumstances.

3.5.3 Discussion and Conclusions

Physiotherapeutically, for clinical use and as a teaching aid, the acceptability of SMAC appears to depend upon the preferences of individual clinicians and teachers. However, unlike other assessments, SMAC has been found acceptable to physiotherapists who have not contributed to its development or to its refinement.

With regard to the use of SMAC in multidisciplinary rehabilitation of stroke patients, the evaluation is more complex:

Firstly, the informal exchange of information between the members of effective teams is jealously guarded. Consequently, the notion that SMAC might replace it in any way is protested against and resisted. Informal discussions and discussions at case conferences are effective in the care of in-patients only. However, a lot of this information is easily lost because no record is made, or only a decision or comment is recorded. Additionally, although patients were patently unreliable at remembering their earlier condition, practitioners also admitted that their remembrances might be less than accurate.

Secondly, throughout its development, all decisions concerning SMAC have been grounded in the needs and opinions of clinical physiotherapists. Some of them now consider that it was a mistake to have attempted to create an aid to communication as well as a physiotherapeutic assessment. It is likely that

they will not use the display to convey information to other practitioners. However, nurses and occupational therapists consider it to be an acceptable model for their own assessments.

Thirdly, the change which would be brought about by the introduction of SMAC into team care appeared to provoke some anxiety in physiotherapists. It also appeared to pressurise the practitioners who would be expected to accept it and to refer to it. New procedures and new responses had to be learned by the assessors and by other users, who are already expending physical and emotional energy providing care. Consequently, they seemed reluctant to spend energy on "paper work", however dissatisfied they were with their current system of providing a permanent record. Although SMAC was designed to minimise "paper work" for physiotherapists, they appear to be rejecting its function as an aid to communication because it presents them with the need to instruct other practitioners how to use the record at a time when they are learning themselves.

Fourthly, the team as a whole wants easy access to information about a patient's typical performance. The team may refer to the whole display (A) to review a patient's progress intermittently, (B) when his discharge from hospital is being planned, or (C) if a patient needs to be readmitted to hospital. Members are principally concerned with activities associated with independent walking! the importance of walking is reflected in the assessment of Activity Capability.

Finally, in order to enhance communication between team members, it would seem more appropriate to encourage the development of other practitioners' assessments using the same model as SMAC. Then, to extract from each the equivalent of the assessment of typical performance. While individual practitioners might refer to the full display of each assessment, for case conferences and other meetings of the team profiles of patients could be constructed which would help the team to make decisions concerning each person's future accommodation and care. Presently, whether or not SMAC fulfils its potential to contribute to multidisciplinary rehabilitation of stroke patients depends upon the use which individual physiotherapists make of the display. Ultimately, this is linked to the development of multidisciplinary records which provide a clear picture of a patient's status and progress.

4. CONCLUSIONS

The Sheffield Motor Assessment Chart fulfils the purposes outlined in the introduction for which a physiotherapeutic assessment of hemiplegia was required. That is, the chart displays a patient's progress clearly and continuously throughout the process of motor recovery while,

- A. providing specific information for physiotherapists concerning a patient's control of movement and balance which they can use both to formulate aims of treatment and to evaluate the effectiveness of their treatment;
- B. informing other practitioners about basic activities a patient can perform in his everyday environment on which they can base decisions concerning his future care.

During the development of the chart, information concerning the process of recovery has also been gathered and tested. Consequently, both the sequence of restitution of the control of movement and balance and the sequence of restitution of functional abilities have been defined. These sequences are the basic framework of the assessment. They are used to describe items of assessment which have been shown to be both adequate and comprehensive, and to form an assessment which is acceptable to physiotherapists for routine clinical use. The chart also has potential to contribute to the wider context of multidisciplinary rehabilitation of stroke patients.

Consequently, because the main objective of the research has been fulfilled by the production of a valid and reliable clinical assessment, the chart could now be used,

- A. in studies to evaluate both the effectiveness of different methods of physiotherapy and the role of physiotherapy in rehabilitation of stroke patients;

- B. as a model for the assessments of other practitioners so that a "patient profile" could be developed for use in the multidisciplinary "team" approach to the rehabilitation of stroke patients.

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STATISTICAL TESTS

1. Significance levels

In general, $\alpha = 0.05$ has been set as the significance level at which a null hypothesis will be rejected. Although this low level carries the danger of a Type I error, or of rejecting a null hypothesis which is true, Blalock (1960) says that the Type II error is more common. That is, a null hypothesis which is false is not rejected and a result is not claimed.

The significance level which is set indicates the possibility of committing a Type I error. Therefore, the significance levels for the tests which have been made during this project have been set according to the following precepts:

- A. In those situations where error in the direction of claiming a false result would not jeopardise the substantiveness of the findings, $\alpha = 0.05$ is used in order to avoid failure to claim a result (Type II error).
- B. In those situations where false rejection of a null hypothesis might produce spurious results, $\alpha = 0.01$ is used to avoid claiming a result which is false (Type I error).

2. Confidence intervals for proportions (Spiegel, 1972)

For samples of less than thirty subjects drawn from a binomial population in which p is the probability that an event will occur in any single trial:

$$\text{the confidence interval} = P \pm z_c \sqrt{\frac{pq}{N}}$$

- where, N = the size of the sample
- P = the proportion of the sample being studied
- p = P if N is less than or equal to 30
- q = 1 - p
- and, z_c denotes the critical value
 - of 1.96 for 95% level of confidence
 - or 2.58 for 99% level of confidence

3. Test of significant differences in proportions (Spiegel, 1972)

To test the null hypothesis that there is no difference between the parameters of the population and samples drawn from the same population:

$$z = \frac{P_1 - P_2}{\sqrt{pq \left(\frac{1}{N_1} + \frac{1}{N_2} \right)}}$$

- where, $p = \frac{N_1 P_1 + N_2 P_2}{N_1 + N_2}$ is used as an estimate of the proportion of the population
- q = 1 - p
- and z is the level of significance.

4. The Chi Square Test of the independence of categorical variables (Siegel, 1956)

This test is used to determine the significance of observed differences between two independent samples. The data consist of frequency counts which are cast in a 2 x 2 contingency table

	Sample 1	Sample 2	
Category I	A	B	A + B
Category II	C	D	C + D
	A+C	B+D	N

Then, $\chi^2 = \frac{N((AD - BC) - N/2)^2}{(A+B)(C+D)(A+C)(B+D)}$

The two-tail values are as follows:

- χ^2 . 2.71 is significant at the 0.1 level
- χ^2 . 3.84 is significant at the 0.05 level
- χ^2 . 6.64 is significant at the 0.01 level

5. The Spearman Rank Correlation Coefficient (Siegel, 1956)

This coefficient is a measure of association between objects or subjects which are ranked in ... ordered series according to two variables.

$$r_s = 1 - \frac{6 \sum d^2}{N^3 - N}$$

where N = the number of subjects or objects
and d = the difference between the rank of the subject or object for each variable.

Where two or more subjects or objects receive the same "score" for the same variable, each of them is assigned the average of the ranks which would have been assigned had no ties occurred.

The critical values of r_s for the 0.05 and 0.01 levels of significance can be found in statistical tables if there are no less than four and no more than thirty subjects. Alternatively, if there are ten or more subjects, the significance of an obtained value of r_s can be tested by calculation of the student's t:

$$t = r_s \sqrt{\frac{N - 2}{1 - r_s^2}}$$

The significance of the obtained value of t can also be found in statistical tables.

6. The Cochran Q Test

This statistic is calculated in order to test if three or more matched sets of frequencies or proportions differ significantly among themselves.

The data are cast in a table in which the number of rows is equal to the number of subjects and the number of columns is equal to the number of items. The particular response which is being investigated is represented by "1", and its alternative is represented by "0".

$$Q = \frac{k-1(k\sum G^2 - (\sum G)^2)}{k\sum L - \sum L^2}$$

where k = the number of columns
 G = the total number particular responses in a specific column
 L = the total number of particular responses in a specific row.

The probability associated with the occurrence under the null hypothesis of values as large as the obtained Q is determined by reference to a table of probabilities associated with chi square.

7. The Binomial Test

This is a test of the "goodness of fit" of observed frequencies or proportions to the binomial distribution to determine if they could have been drawn from a population in which the proportion (P) of cases expected in one category is specified. The null hypothesis may be expressed in terms of obtaining the observed values and values more extreme.

If there are twenty-five subjects or fewer in a sample and fifty per cent are expected in each of two categories, the one-tailed probability of the observed frequency in the category under study can be found in statistical tables. For a two-tailed test, the probability is doubled.

If there are more than twenty-five subjects in the sample and the proportion which is expected to fall in a particular category is close to a half, the null hypothesis can be tested by the following formula:

$$z = \frac{(x \pm 0.5) - NP}{\sqrt{NPQ}}$$

where, N = the number in the sample
 P = the proportion expected in one category
 $Q = 1 - P$
 x = the number of cases in the category under study
0.5 = the correction for continuity
 $x + 0.5$ is used when $x < NP$
 $x - 0.5$ is used when $x > NP$

The significance of the obtained z is determined by reference to statistical tables.

8. The Fisher Exact Probability Test

This test is used to determine whether two groups differ in the proportions in which they fall into two categories. The frequencies are cast in a 2 x 2 table, as follows:

	Class	Class	
	1	2	
Group I	A	B	A+B
Group II	C	D	C+D
	A+C	B+D	N

The exact probability is found by:

$$p = \frac{(A+B)!(C+D)!(A+C)!(B+D)!}{N!A!B!C!D!}$$

If none of the cells of the 2 x 2 table has a frequency of zero, more extreme deviations could occur with the same marginal totals. In this case, p is calculated for more extreme occurrences, with the marginal totals unchanged. All of the obtained values of p are then added together.

To avoid calculation of three, four or more exact probabilities, a table of critical values of D or C in the Fisher Test may be used to determine the approximate level of significance if the sample is smaller than twenty subjects.

9. The McNemar Test for the significance of changes

This test is applicable to "before and after" situations where each person is used as his own control. A 2 x 2 table is set up to represent the first and second sets of responses from the same individuals, as follows:

		After	
		-	+
	+	A	B
Before	-	C	D

Where, A = the frequency of changes from positive to negative
 B = no change in positive response
 C = no change in negative response
 D = the frequency of changes from negative to positive.

The sum of A+D represents the total number of persons who changed their opinions, and the expectation would be that (A+D)/2 people changed their opinions in each direction.

The test concentrates on change and the following equation is applied:

$$\chi^2 = \frac{((A-D) - 1)^2}{A+D}$$

If (A+D)/2 is less than 5, the Binomial Test is applied using N = A+D and x = the smaller of the observed frequencies.

THE GUTTMAN STATISTICSCoefficient of reproducibility:

Guttman (1974) offered this coefficient as a measurement of the correspondence between the distributed of collected data and the expected distribution of the ideal model. The maximum value obtainable is CR = 1.00. Guttman laid down CR = 0.90 as the minimum acceptable value for indicating reproducibility, on the basis that if errors are random then the standard error of the sample proportion is no more than 0.013. This allows deviation in the proportion of, at most, 0.04 at the level of confidence of three standard errors (99.7%) This is voided if the errors are not random. Additionally, the CR of any single item should be 0.85 or above.

The coefficient of reproducibility is calculated by summing the number of responses which are wrongly predicted, or the errors, for each person for each item; then dividing the errors by the total number of responses; and subtracting the result from one.

$$\text{CR of an item} = 1 - \frac{\text{errors for item (E)}}{\text{number of subjects (n)}} = 1 - \frac{E}{n}$$

$$\text{CR of a scale} = 1 - \frac{\text{errors for all items}}{\text{subjects x items (k)}} = 1 - \frac{\sum E}{nk}$$

Minimum marginal reproducibility:

The coefficient of reproducibility has no unique minimal value. Minimum marginal reproducibility has been offered by White and Saltz (1974) as a means of evaluating the coefficient of reproducibility of any item or scale of items by estimating the minimum value obtainable for that item or scale.

The minimum marginal reproducibility is obtained by summing the number of endorsements in each category of an item, or the number of persons passing and failing the item, and dividing the larger number by the number of subjects. For a scale, the larger number of endorsements for each item is summed and the

total is divided by the number of items as well as by the number of subjects.

$$\text{MMR of item} = \frac{\text{Larger marginal frequency}}{\text{number of subjects}}$$

$$\text{MMR of scale} = \frac{\text{Sum of largest marginal frequencies}}{\text{subjects} \times \text{items}}$$

Percentage improvement (%IMP):

This statistic is also known as Jackson's Plus Percentage (White and Saltz, 1974). To calculate it, the minimum marginal reproducibility is subtracted from the obtained coefficient of reproducibility. It shows how much better is the CR than the minimum obtainable. For example, a CR above 0.90 may be shown by the percentage improvement to be little better than the minimum obtainable.

$$\%IMP = CR - MMR$$

Coefficient of scalability:

This statistic, which is also known as Jackson's Plus % Ratio, has an absolute maximum of one and an absolute minimum of zero. It describes the homogeneity of the scale. Jackson (White and Saltz, 1974) suggested that CS = 0.70 was the minimum acceptable level and Nie (1970) suggests "a figure well above 0.60".

The coefficient of scalability is calculated by dividing the obtained percentage improvement by one minus the minimum marginal reproducibility for the scale.

$$CS = \frac{CR - MMR}{1 - MMR} \quad \text{or} \quad \frac{\%IMP}{1 - MMR}$$

Sampling distribution:

Little is known about the sampling distribution of the major scale criteria. Many scales have been reduced to four or five items with the lowest amounts of error (cf. Lyle, 1979) by the scaling procedure is completed. However, Guttman (1974) specified at least ten items in a scale if the items classify subjects in either of two mutually exclusive categories, such as

"pass" and "fail". This requirement is supported by other authors (cf. Torgerson, 1958; Mayntz et al, 1976).

In scalogram analysis, sampling distribution is concerned with the sampling both of items and of subjects. In Guttman's theorising, it is the universe of content, or all possible items that could be constructed to deal with the topic under investigation, for a given population which is being tested; not the scale of items itself, for either the population or the sample. Thus, the coefficients are statistics of "construct validity". Items are not drawn at random from this universe, but constructed by the developer of the scale to represent the variable or concept underlying the scale.

There are criteria for the exclusion of items from a scale: the principal one is to discard the "worst" items in terms of the amount of error and their low reproducibility. There is no criterion or procedure for determining whether or not an item is a member of the universe, other than the scale constructor's knowledge and experience. Therefore, the following factors are important:

- A. The order of subjects, except for ties, should show very little variability if several samples of items are drawn from the scale.
- B. Auxilliary criteria which leave little room for variation should be utilised.

Auxilliary criteria:

Several authors have discussed criteria which ensure that advantage is not taken of chance variability. Schooler (1974) has criticised such criteria because they are,

"Rule of thumb rather than deductions from the relationship between scalogram analysis and probability theory."

In the absence of such deductions by theorists, the following criteria are selected on the assumption that commonsense criteria are preferable to no control over variability:

Firstly, the recommendation made by Torgerson (1958) and Oppenheim (1966) that all items which are passed or failed by eighty per cent or more of subjects should be excluded from the analysis.

The reproducibility of a scale is the average of the reproducibilities calculated for each item. Therefore, the reproducibility of any single item can never be less than the percentage of subjects falling into one category of that item; regardless of whether or not a scale exists. Guttman (1974) suggests that such items are acceptable in, for example, a scale of twelve items if the majority of items dichotomise at a ratio smaller than 80:20. A large number of such items might give the whole scale a spuriously high reproducibility.

Secondly, Ford (1950) recommended that all items which are responsible for the same pattern of error in more than five per cent of subjects should be excluded.

Guttman (1974) wrote that the existence of independent variables was indicated by the existence of:

"'Non-scale types' (of individuals) occurring with sufficient frequency to be noticed."

Torgerson (1958) has also recommended that the same non-scale pattern should not be demonstrated by a large number of subjects.

Thirdly, Ford (1950) recommended that the frequency of error in any category should be less than half of the frequency of response in that category.

These criteria were applied in the development and evaluation of the scales of SMAC.

TESTS OF THE PRELIMINARY PROTOCOL (cf. section 3.2.2)

1. Informal multivariate analysis
2. Taxonomic study of clusters of items
3. Guttman scaling of selected items
4. The homogeneity of the scale
5. Refinement of the protocol

1. Informal multivariate analysis

Aim:

To identify a sequence of items which describes restitution of motor function.

Data:

TABLE 7

NUMBER OF CATEGORICAL DATA FOR ANALYSIS FROM FIRST FIELD TEST

Number of hemiplegic patients assessed:	n = 61
Number of items of assessment categorized "pass" or "fail":	k = 70
Data for analysis:	nit = 4270

Method:

1. To organize the data in groups of manageable size, the variables were grouped:
 1. By the class of the assessment (first, second, third, etc).
 2. By the interval between the patient's CVA and his first assessment.
 3. By intervals of seven days.
 4. By intervals of twenty-eight days.
2. Records of first assessments were analyzed first:
 1. The records were arranged in order, according to the length of time between each patient's CVA and his first assessment.
 2. Records of assessments made within eight days of the CVA were inspected to see if the same items were recorded on each.

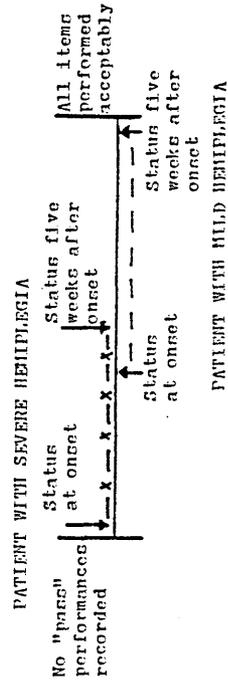
3. All of the records were individually inspected and grouped according to the apparent status of the patient.
 4. Items which were recorded as "pass" performances for members of each group were listed.
3. This process was repeated for each class of assessment, beginning by using intervals of seven days to order the records and then by inspecting each group of records.
4. The lists of items compiled for each group were compared.
5. Several "clusters" of items were identified. They were numbered and a chart was drawn up to demonstrate the relationships between clusters

Results:

The analysis suggested a continuum from onset to recovery with items clustered along it (Figure 23; cf. textual discussion).

FIGURE 23

THE APPARENT "RECOVERY CONTINUUM"



2. Taxonomic study of clusters of items

Aim:

To reduce the number of items of assessment from seventy to thirty-five, plus or minus five, by: excluding redundant and insignificant items; and, identifying items which do not have a constant ordinal relationship with other items;

The remaining "significant" items should chart the process of motor recovery unequivocally.

Data:

Clusters of items identified during multivariate analysis.

Protocols marked with asterisks and deletions by physiotherapists.

Method:

1. Analysis of clusters: The clusters were analysed along a nominal classificatory time scale because (1) some patients were more affected than others when their first assessments were recorded at entry to treatment, and (2) the patients progressed at different rates.

1. The frequency of occurrence of items in each cluster was counted for each group of displays.
2. Relative frequencies were calculated according to the number of patients in each group.
3. Frequencies were reviewed in conjunction with the time scale to identify (a) the minimal frequencies associated with the earliest and the latest recorded performance, and (b) the point of greatest frequency of occurrence.

2. Exclusion of items:

1. Using the frequency counts, items were arranged in a preliminary order of precedence.
2. A histogram was drawn using data from all first assessments made in less than twelve calendar months.
3. Items which could not be ordered were excluded.
4. Copies of the protocol which had been marked with asterisks and deletions by twenty-two physiotherapists were examined, and the participants' comments were reviewed.
5. Items which were identified as repetitions or redundant were excluded if they held the same rank as another item in the preliminary order.

3. Review of remaining items

1. The remaining items were reviewed in their clusters to confirm the ordinal relationships.
2. Where two or more items held the same rank, with the exception of one patient, one item was selected on Guttman's criterion of satisfying the scale developer's construct rather than a theoretical principle.
3. Items which assessed function of the upper limb were set aside and a histogram was drawn for the remaining twenty-nine items.

Results:

A scale of twenty-nine items was identified. Thirty-two repetitions, redundant or variable items were excluded. Thirteen items which had special characteristics are discussed in section 3.2.2; results, 2.

3. Guttman scaling of selected items

Aim:

To test the extent of the correspondence between the postulated scale of twenty-nine items and data collected from patients who were assessed within twenty-eight days of their CVAs.

Sample and sub-samples:

- n_1 : All first assessments made within twenty-eight days of the CVA. $n_1 = 32$
- n_{1a} : All records of odd-numbered items from first assessments made with twenty-eight days. $n_{1a} = 25$
- n_{1b} : All records of even-numbered items from first assessments made within twenty-eight days. $n_{1b} = 25$

Method:

1. The items of the postulated scale were numbered from one to twenty-nine in order of precedence.
2. A scalogram matrix was constructed:
"pass" performances were assigned a score of "1", "fail" performances were assigned a score of "0";
each individual's number of "passes" was counted and the number of individuals passing each item was counted;
individuals and items with tied scores were ordered on Guttman's principle of minimising the number of "errors", i.e. "passes" in a sequence of "fails", and vice versa.
3. The matrix was inspected for evidence that the scale could discriminate between individual patients at different levels of recovery.
4. Coefficients of reproducibility and scalability were calculated.

Results:

Coefficients of reproducibility of items: 0.85 - 1.00
Coefficient of reproducibility of scale: 0.946
Coefficient of scalability: 0.83

These results, which are well above the minimum acceptable levels for confirming that a scale is valid and cumulative, are discussed in section 3.2.2; results, 3.

4. The homogeneity of the scale

Aim:

To estimate the homogeneity of the Guttman scale of items by dividing the scale into two series and estimating the extent of the association between them.

Null hypothesis:

That there is no association between the levels of recovery of individuals recorded with each series, or their ranks on Guttman matrices; and that the correlation coefficient differs from zero only by chance. Therefore, the Guttman scale of items is not internally consistent.

Test used:

The degree of association is represented by the Spearman Rank Correlation Coefficient (r_s).

Data:

Records of assessments of twenty-five patients which were made within twenty-eight days of their CVAR.

Method:

The "split-half" method was used:

1. Twenty-eight items of the Guttman scale were numbered 1 to 28.
2. All even-numbered items were placed in one series and all odd-numbered items were placed in another series.

3. Scalograms were constructed for each series of items using data from twenty-five patients.
4. The rank of each person was determined for each series.
5. The correlation coefficient was calculated using these ranks.

Result:

$r_s = 0.987$, significant at the 0.01 level.

Statistical decision:

The Guttman scale has internal consistency and homogeneity.

5. Refinement of the protocol

Aim:

To determine the extent of the correspondence between postulated scales of "Physiotherapy Items" and "Gross Functional Items" and data collected from patients.

Method:

1. Two sub-scales were identified within the main Guttman scale.
2. The scales were postulated as the scale of "Physiotherapy Items" and the scale of "Gross Functional Items".
3. Scalograms were constructed for each scale.
4. Each matrix was inspected for evidence that it could discriminate between individual patients at different levels of recovery.
5. Coefficients of reproducibility and scalability were calculated for each scale.

Results:

Physiotherapy Items

Coefficient of reproducibility: 0.94

Coefficient of scalability: 0.795

Gross Functional Items

Coefficient of reproducibility: 0.94

Coefficient of scalability: 0.804

The implications of these results is discussed in section 3.2.2

TESTS OF THE INTERIM PROTOCOL AND THE FINAL PROTOCOL

1. The reproducibility and scalability of the postulated scales. (Reported in section 3.2.3 as results 2, 3 and 4)
2. Estimation of the correspondence between progress reported on the scale of Physiotherapy Items and progress on the scale of Gross Functional Items. (Reported in section 3.2.3 as result 5.)
3. Evaluation of the predictive ability of the Physiotherapy Items. (Reported in section 3.2.3 as result 6.)
4. Test of the inter-observer reliability of the interim protocol. (Reported in section 3.2.4(1))
5. Test of the inter-observer reliability of the final protocol (Reported in section 3.2.4(2))
6. Tests of items of assessment of the upper limb. (Reported in section 3.2.5)

1. The reproducibility and scalability of the postulated scale and sub-scales.

Aim: To confirm that the postulated recovery scale of 37 items and the sub-scales of 19 "physiotherapy items" and 18 "gross functional items" are valid unidimensional Guttman scales.

Data: 4,847 categorical data collected at 218 assessments of 131* patients.

These data were collated and analysed in three ordinal series:

1. The "recovery scale". $k = 37$
2. The scale of "physiotherapy items". $k_{PI} = 19$
3. The scale of "gross functional items". $k_{GFI} = 18$

Samples and sub-samples:

- $N = 131^*$
Field Test.
- n_a : All patients assessed during the Second Field Test.
 $n_a = 25$
- n_b : All patients assessed in less than eight days after their CVA.
 $n_b = 58$
- n_c : All patients assessed in less than 29 days after their CVA.
 $n_c = 84$
- n_d : All patients assessed over 84 days after their CVA.
 $n_d = 112$

Method: 1. Scalograms of the scale and subscales were constructed for each sub-sample.

2. The matrices were inspected and compared and common patterns of error were identified.
3. The matrices and patterns of error of the sub-scales were compared with those of the main scale.

* 133 displays were received but only 118 limb assessments were recorded on two of them. It was not assumed that these patients could bear all items of the "physiotherapy items" and "gross functional items" scales.

4. Items which were responsible for the same patterns of error in more than 5% of the samples and which were not scalable were excluded.

5. Matrices were constructed for the remaining items in each scale using data from the sample.

6. Guttman scalogram co-efficients were calculated for each scale:

- a) For all items in the scale.
- b) Excluding items which were passed or failed by 80% of the sample or more.

Results (cf. Table II)

TABLE I.1

CO-EFFICIENTS CALCULATED FOR SCALE OF PHYSIOTHERAPY ITEMS

1. <u>Total Scale:</u> subjects with no pass recorded = 7 idiosyncratic recording, data excluded = 3	
$n = 121$	CR = 0.97
$k = 14$	MHR = 0.78
$\Sigma E = 48$	%IMP = 0.19
$\Sigma MH = 1316$	CS = 0.87
Item CR range: 0.92 - 1.00	
2. <u>Scale excluding items with 80% of subjects in either category.</u> (Marginal frequencies below 25 and above 96)	
Additional subjects with no pass recorded = 28	
$n = 93$	CR = 0.95
$k = 7$	MHR = 0.73
$\Sigma E = 29$	%IMP = 0.22
$\Sigma MH = 476$	CS = 0.83
Item CR range: 0.92 - 0.98	

TABLE I.2

COEFFICIENTS CALCULATED FOR SCALE OF GROSS FUNCTIONAL ITEMS

1. Total Scale: subjects with no pass recorded = 39 idiosyncratic recording, data excluded = 3	
n = 89	CR = 0.95
k = 12	MNR = 0.72
$\Sigma E = 54$	%IMP = 0.23
$\Sigma MI = 768$	CS = 0.82
Item CR range: 0.91 - 1.00	
2. Scale excluding items with 80% of subjects in either category. (Marginal frequencies below 13 and above 71)	
Additional subjects with no pass recorded = 7	
n = 82	CR = 0.94
k = 9	MNR = 0.66
$\Sigma E = 45$	%IMP = 0.28
$\Sigma MI = 483$	CS = 0.82
Item CR range: 0.90 - 0.98	

TABLE I.3

COEFFICIENTS CALCULATED FOR COMBINED SCALE

Number of items more than 80% popular	= 9
Number of subjects with no pass recorded	= 20
Idiosyncratic recording, data excluded	= 3
n = 108	CR = 0.92
k = 17	MNR = 0.67
$\Sigma E = 154$	%IMP = 0.25
$\Sigma MI = 1230$	CS = 0.75
Range of CRs of items: 0.88 - 0.97	

These results, which confirm that all three scales are valid, cumulative and unidimensional, are discussed in section 3.2.3.

2. Estimation of the correspondence between progress recorded on the scale of Physiotherapy Items and progress on the scale of Gross Functional Items

Aim:

To estimate a parameter for the population of hemiplegic patients in order to show the relationship between performances recorded as patients on each of the scales.

Null hypothesis:

That there is no association between performances recorded on each scale in the population from which the samples are drawn; and the correlation coefficients differ from zero only by chance.

Tests used:

The degree of association is represented by the Spearman Rank Correlation Coefficient (r_s) which requires the variables to be measured on an ordinal scale, at least. Kendall's tau is used to confirm the result for one sample.

Sampling distribution:

Critical values have been tabled for the distribution of r_s where there are thirty or fewer subjects in a sample. If there are more than thirty subjects, student's t is calculated and the critical value of the obtained statistic is determined. The student's t may also be used to confirm the significance of r_s when samples contain ten to thirty subjects.

Rejection region:

All values of r_s , t and tau for which the probability associated with their occurrence is equal to or less than the highly significant 0.01 level indicate rejection of the null hypothesis.

Data:

Records of assessments of the following samples of patients made during the field test of the interim charts

- $n_a = 25$
 $n_b = 33$
 $n_c = 26$
 $n_d = 28$
- a: Patients assessed less than eight days after their CVAs.
 b: Patients assessed between seven days and twenty-nine days after their CVAs.
 c: Patients assessed between twenty-eight days and eighty-five days after their CVAs.
 d: Patients assessed more than eighty-four days after their CVAs.

Method:

The "split-half" method was used.

1. Scalograms were constructed for each scale using each sample of patients.
2. For each sample, each patient's rank for each scale was determined.
3. Correlation coefficients were calculated for each sample.

Results:

TABLE I.4 (cf. Table 12)

RANK CORRELATION COEFFICIENTS OF ASSOCIATION BETWEEN PERFORMANCES RECORDED ON THE SCALE OF PHYSIOTHERAPY ITEMS AND THE SCALE OF GROSS FUNCTIONAL ITEMS

Sample	a	b	c	d
n	25	33	26	28
r_s	0.83	0.79	0.77	0.64
critical value of r_s : $p <$	0.001	0.001	0.001	0.001
t	4.796	7.174	5.91	4.247
$p <$	0.0005	0.0005	0.0005	0.0005
tau	0.00003			

Statistical decision:

The probability of obtaining values of r_s as large as those calculated is less than 0.001. Since this is such a small probability, the null hypothesis is rejected in favour of association between the recordings on the two scales.

The implication of these results is discussed in section 3.2.3.

3. Evaluation of the predictive ability of the Physiotherapy Items

Aim:

To assess the predictive ability of the scale of Physiotherapy Items by estimating the proportions of the population of hemiplegic patients for whom the order of pass and fail performances will be wrongly predicted.

Preamble:

If the postulated ideal model of Physiotherapy Items fit the data exactly the extent of predictive validity would allow three forecasts to be made correctly.

1. An exact description of the patient's status could be given from knowledge of the highest ranked item which had been passed.
2. If the patient could pass any item on the scale, pass performances could be recorded for all items of lower rank.
3. If the patient failed any item the assessment could be terminated at that item because all items of higher rank would also be failed.

A deterministic model is not expected to fit the data exactly but to be a good approximation to them. The coefficients calculated for the scale of Physiotherapy Items (Table 6) show that it is imperfect but that it is a valid Guttman scale which possesses predictive validity. In order to write a procedure for use of the Final SHAC it was necessary to estimate the extent of its predictability so that correct forecasts can be made.

Statistic calculated:

Confidence intervals were calculated for proportions of the population when $p = 0.01$ is the probability that an event will occur in the population from which the sample is drawn.

Data:

1. PATIENTS

$N = 133$ Idiographic recording, data excluded = 3

$N_p = 121$ No recording on scale = 9

2. ASSESSMENTS

Number of assessments recorded, $A = 218$

First Assessments: $a_1 = 121$ number without error = 86
number with error(s) = 35

Second Assessments: $a_2 = 73$ number without error = 51
number with error(s) = 22

Third Assessments: $a_3 = 22$ number without error = 16
number with error(s) = 6

Fourth Assessments: $a_4 = 2$ number without error = 2

3. ERRORS

assessments with
Number of/Items wrongly predicted by scale, $E = 66$

Number of assessments with one item wrongly predicted, $e_1 = 50$

Number of assessments with two successive items
wrongly predicted, $e_2 = 7$

Number of assessments with three successive items
wrongly predicted, $e_3 = 5$

Number of assessments with four or more successive
items wrongly predicted, $e_4 = 4$

Method:

1. The number of errors, or items which were wrongly predicted as "pass" or "fail" performances by the scale of Physiotherapy Items, were counted in up to four assessments and reassessments of one hundred and twenty-one patients.
2. The number of assessments was counted in which two, three and four or more errors occurred in succession.
3. If, for example, a patient passed item 1 to 6, but failed items 7 and 8, then passed item 9 but failed all subsequent items, two errors were recorded to represent items 7 and 8. This inflated the number of errors, but it was necessary because prediction is based on the highest ranked item which is passed.

Results:

There is 99 per cent confidence:

1. That the scale of Physiotherapy Items will correctly predict "passes" and "failures" of items for,
0.71 ± 0.1 patients at their first assessments;
0.7 ± 0.14 patients at their second assessments.
2. That, for all assessments using the Physiotherapy Items,
0.96 ± 0.04 assessments will contain two or fewer incorrect predictions.
3. That, for all assessments using the Physiotherapy Items which contain incorrect predictions,
0.75 ± 0.14 will contain only one error,
0.11 ± 0.1 will contain two errors.

The implications of these results for the procedure of the assessment are discussed in section 3.2.3.

4. Test of inter-observer reliability of the interim protocol

Aim:

To evaluate the inter-observer reliability of assessments recorded on the interim display and to assess the level of standardization of the description of each item of assessment.

Null hypothesis:

That each item of assessment is inadequately standardized so that observers use it unreliably and "pass" and "fail" judgments are recorded in equal proportions; and that any difference between the proportions of "pass" and "fail" recordings is a random result.

Statistical test:

The Binomial Test was used to test the data collected for each item from each patient.

Level of significance:

Let $\alpha = 0.01$ to ensure that differences between frequencies are not due to random effects.

Region of rejection:

This region consists of all values of x , the smaller of any pair of observed "pass" and "fail" frequencies, associated with $p < 0.01$. Items for which x is associated with $p > 0.01$ will be examined sample by sample to identify any differences between assessors with different levels of experience with SHAG.

Samples:

The Patients: Four patients were chosen to represent the range of factors described by physiotherapists who participated in the field tests -

Patient A whose progress had been hindered by a deep vein thrombosis was over eighty years of age and had a left-sided hemiplegia following a CVA five months previously.

Patient B, who had been confined to a wheel chair since a CVA four years earlier, and had suffered another CVA a month previously, was over sixty years of age and had a right-sided spastic hemiplegia with expressive aphasia.

Patient C was over seventy years of age and had a left-sided hypotonic hemiplegia following a CVA less than three months previously.

Patient D, whose date of discharge from hospital was forecast, was over fifty years of age and had a right-sided hypotonic hemiplegia with expressive aphasia following a CVA less than three months previously.

The Observers were a self-selected sample of physiotherapists who had participated in the field test of the interim chart, or who had volunteered but had been unable to participate in a field test, or who attended the Motor Club of the Ridgway Group.

N: All observers $N = 36$
n₁: Observers who had used the preliminary chart and the interim chart in field tests. $n_1 = 8$
n₂: Observers who had used only the interim chart in a field test. $n_2 = 15$
n₃: Observers who had not participated in a field test. $n_3 = 13$

Method:

1. The researcher was videotaped while assessing the four patients.
2. A micro computer program was prepared in order to make a preliminary analysis of the data.
3. The videotapes were shown to thirty-six physiotherapists through two television monitors. Approximately fifteen observers could see only one monitor, and six could see both monitors.
4. To simulate direct observation across a room, the tape of each patient was played once with sound, so that observers could hear the assessor's requests and the conversation with the patient, and then silently.
5. Observers recorded their assessments from the second viewing.
6. At the end of the test, observers fed their own data into the microcomputer program. A print-out of frequency counts for each item for each patient and for each sample of physiotherapists was discussed with the observers.

Results:

The probability of reliable use was calculated to be highly significant for twenty-eight items. Nine items for which $p > 0.01$ are discussed in section 3.2.4.

5. Test of inter-observer reliability of the final protocol

Aim:

To evaluate the inter-observer reliability of assessments recorded on the final display, with particular reference to items where were not found to be reliably used during the test of the interim chart.

Null hypothesis:

That the items of assessment are inadequately standardised and are open to misinterpretation so that they will show maximum variance.

Statistical test:

The Binomial Test is used because all recorded observations are independent and the test focuses on the frequencies of two mutually exclusive events, one of which must occur. The quick, but mathematically inelegant, method described by Maxwell (1961) for item analysis was used to estimate if the unreliabilities demonstrated in the inter-observer test using the interim chart were existent with the final chart.

Sampling distribution:

If p is the majority proportion of observers agreeing that a performance should be rated "pass" or "fall" and q is $(1 - p)$, by the binomial distribution the variance of the item is pq and its standard deviation is \sqrt{pq} . Variance is at its maximum when $p=q=\frac{1}{2}$, and it is at its minimum when p or $q = 0$. Therefore, items which are recorded as "pass" and "fall" in equal proportions have maximum standard deviation. In this case, the items would be said to lack reproducibility, as the term applies to reliability. When the proportion of p or q is less than twenty per cent, the variance of an item decreases rapidly.

Region of rejection:

All items for which $pq > 0.21$.

Samples:

The Patients: Three patients were chosen by the assessor, a clinical physiotherapist, to demonstrate items which are assessed at different levels of recovery -

Patient A could walk with supervision and with occasional assistance.

Patient B could stand up from sitting in a chair independently but could not walk independently.

Patient C could sit in an arm chair safely with support to maintain the position.

The Observers: Six physiotherapists, of varying levels of experience with hemiplegic patients and with SMAC, observed the assessment. Therefore, seven records were available for each patient.

Results:

The null hypothesis could be rejected for twenty-seven items, including all items which had been found to be unreliable at the test using the interim chart. One item was used unreliably because observers had not adhered to instructions given in the manual. This is discussed in section 3.2.4.

6. Tests of items of assessment of the upper limb

Aim:

To test the homogeneity and unidimensionality of the "Arm Function" series of items of assessment.

Preamble:

Following the multivariate analysis of data collected on the preliminary chart, all but one of the items assessing function of the upper limb had been excluded from the main sequence of items because of their inconstant relationships with the scalable items. A separate protocol of items to assess the upper limb was devised and called the assessment of "Arm Function" on the interim chart.

Samples and sub-samples:

1. The data from first assessment were analyzed in aggregated frequencies -

N_1 : All first assessments. $N_1 = 51$
 n_{1a} : Assessments made in less than eight days. $n_{1a} = 8$
 n_{1b} : Assessments made in less than twenty-nine days. $n_{1b} = 21$
 n_{1c} : Assessments made in less than fifty-seven days. $n_{1c} = 27$
 n_{1d} : Assessments made in less than eighty-five days. $n_{1d} = 32$

2. The goodness of fit of the postulated scale to the data as recovery proceeded was also tested where data from reassessments were available -

N_2 : All first and second assessments. $N_2 = 56$
 n_{2a} : First assessment in less than eight days plus second assessment. $n_{2a} = 12$
 n_{2b} : First assessment in less than twenty-nine days plus second assessment. $n_{2b} = 25$
 n_{2c} : First assessment in less than fifty-seven days plus second assessment. $n_{2c} = 34$
 n_{2d} : First assessment in less than eighty-five days plus second assessment. $n_{2d} = 38$

3. Third Assessment:

n_{3a} : First Assessment in less than 29 days plus 2nd and 3rd assessments, $n_{3a} = 23$
 n_{3b} : First Assessment in less than 85 days plus 2nd and 3rd assessments, $n_{3b} = 33$
 n_{3c} : First Assessment in more than 84 days plus 2nd and 3rd assessments, $n_{3c} = 45$

Method:

1. Guttman scalograms were constructed for all of the sub-samples.
2. For all analyses using aggregated frequencies, patients who passed all items were retained for succeeding analyses and patients who passed no item at the first assessment were excluded until a pass was recorded.
3. Guttman coefficients of reproducibility and scalability for the scale were calculated with each sub-sample. These coefficients are presented as general indices only, because there are less than ten items in the scale and because some of the sub-samples are small.

Results:

The coefficients are shown in Table I.5. Acknowledging the report in the literature that many scales are reduced to four or five items by the time the scaling procedure is completed, the coefficients calculated for this scale are acceptable as general indices implying that the scale is reproducible and scalable, and, therefore, that it is homogeneous and unidimensional. Further discussion, including the implications of these results for the production of the final version, is contained in section 3.2.5.

TABLE 1.5

COEFFICIENTS OF REPRODUCIBILITY AND SCALABILITY FOR THE SCALE OF ITEMS ASSESSING THE UPPER LIMB

Sample	n	nk	ΣE	GR	GS
n ₁	51	357	35	0.9	0.73
n _{1a}	8	56	6	0.89	0.71
n _{1b}	21	147	13	0.91	0.75
n _{1c}	27	189	16	0.91	0.78
n _{1d}	32	224	19	0.91	0.78
n ₂	56	392	21	0.95	0.78
n _{2a}	12	84	1	0.99	0.97
n _{2b}	25	175	3	0.98	0.94
n _{2c}	34	238	8	0.97	0.88
n _{2d}	38	266	11	0.96	0.84
n _{3a}	23	161	1	0.99	0.95
n _{3b}	33	231	1	0.99	0.96
n _{3c}	45	315	1	0.99	0.97

n: number in sample
nk: number of data (number of items x number in sample)
 ΣE : number of errors
GR: coefficient of reproducibility
GS: coefficient of scalability

SPECIFIC ISSUES RELATED TO THE DESIGN AND ADMINISTRATION OF
QUESTIONNAIRES AND INTERVIEW SCHEDULES

There are few principles for the construction of questionnaires or interview schedules; but several authors have provided guidance on what to ask, when to ask it, what choices of response to offer, and how to order questions (Goode and Hatt, 1952; Maccoby and Maccoby, 1954; Oppenheim, 1966; Mayntz et al, 1976; Weisberg and Bowen, 1977). Wright and Barnard (1975) have summarised conclusions from studies of the kind of language that people understand most easily. They offer general rules for the design of forms in order to make them easier to fill in. However, authorities on the design of questionnaires and interview schedules agree that there is no method for wording a question perfectly. Secondly, there is always a certain degree of vagueness about language which has to be minimised during interviews if meaning is to be conveyed accurately by both the interviewer and the respondent. The two main issues of concern here are (A) the possible sources of error and bias when data are collected by questioning; and (B) the effects of situational factors during interviews.

Possible sources of error and bias:

There are research findings on some forms of questions (Brown, 1968); but a great deal still needs to be investigated about different types and forms of questions. Bias can be minimised by attention to vocabulary, syntax and grammar. However, there are many pitfalls which are said to bias results, or, at worst, to totally invalidate the data.

One of the most important principles is avoidance of ambiguity (Oppenheim, 1966). Weisberg and Bowen (1977) have also warned of the hidden suggestion which draws the desired response. Brigham (1975) has said that the interest and motivation of respondents is a critical factor which should be reflected in the design of questionnaires and the wording of individual questions. Spurious responses may also be obtained through the creation of a "response set" (Weisberg and Bowen, 1977). That

is, if respondents are presented with a series of short, direct questions requiring a "Yes" or "No" answer, they might not give due consideration to each question, especially if they are busy, but tick all affirmative or all negative responses.

Other sources of error can be traced to respondents. For example, they may be forgetful; or they may deliberately distort their responses in order to present themselves in a better light or to provide researchers with the responses they are thought to want (Phillips, 1976). The reliability of data may also be affected by bias in the judgment of respondents (Guilford, 1954; Duncanson, 1970). Some respondents to pre-coded questions may use a narrower range of categories of judgment than do other respondents. That is, if respondents are offered six categories it may become apparent over several questions that some of them are using only three categories. Other respondents may have a tendency towards more favourable or less favourable responses because of social influences (Brigham, 1975).

If respondents are practitioners of different professions, the most important influences may be their previous experiences which might bias subsequent judgments. For example, because of different professional experience, some respondents may be able to answer questions about a display of the findings of an assessment as questions of fact about its content. Other respondents may be able only to express an opinion about its visual impact. Alternatively, if they are asked about its potential contribution to team care, interpersonal relationships among members of particular teams may cause some respondents to hold favourable or unfavourable attitudes which will bias the specific judgment required.

Duncanson (1970) suggests that, because the researcher cannot control respondents' previous experience, they should be offered a standard against which they can make their own judgment. However, it appears as if it may be more valuable to utilise that experience by relating questions to their immediate and recent experience, rather than to generalities. Respondents' candour and veracity in response to sensitive topics may be encouraged if an interviewer indicates that other people may also have what

are thought to be undesirable attitudes, and issues which are important in rehabilitation, for instance, may be revealed. In the interests of honesty and accuracy, and the eventual validity and reliability of the data, respondents also need to be able to admit that they are not familiar with a topic, or that they have not formed an opinion.

The interview:

The literature concerned with the significance and effect of situational factors is comprehensive (Hyman, 1954), but Mayntz and his co-authors (1976) have written that it can rarely be used during interviews. The interviewer is presented as a neutral instrument who communicates stimuli to respondents and records their reactions accurately (Kahn and Cannell, 1957). This assumes that both the validity and the reliability of the interviewer can be ascertained, that these factors are constant, and that the respondent reacts to the pure stimulus of the question only.

However, interviewing is a social interaction, and both the interviewer and the respondent bring expectations of each other to the meeting. According to Hyman (1954), a physiotherapist will feel able to predict some of the answers given by patients and members of other health care professions, as well as the answers given by physiotherapists, on the basis of certain attributes. Similarly, respondents will regulate their behaviour and attitudes to their image of the interviewer.

The reciprocal effect of the behaviour and expectations of the interviewer and the respondent persists throughout the interview. How it affects the data is largely unknown. Phillips (1976) points out that there are few answers to such questions as: Why do respondents consent to be interviewed? How are their responses influenced by ideas of the social desirability of giving a particular response? Do they react differently with different interviewers?

There is little doubt that practitioners may be influenced by the profession of the interviewer, and completely undistorted data cannot be obtained. However, the researcher might attempt to

identify factors of influence which exist at an interview, and include them as marginal conditions when interpreting the data. Mayntz and his co-authors (1976) say that this is rarely done because of its "sheer difficulty". The situation is further complicated by researchers' tendencies to interpret data according to expectations that they have formed (Goode and Hatt, 1952; Phillips, 1976).

The use of standardised or unstandardised questions has been one focus of the discussion concerning the conduct of interviews. That is, should the interviewer always use the same wording so that every respondent receives an identical stimulus and differences among respondents will not be caused by the interviewer? This question really concerns the impact on respondents from whom a researcher wants information about behaviour and attitudes rather than fact and opinion. Although an interviewer may be afraid of affecting the data by relating to the respondent, it is suggested by Hyman (1954) and by Maccoby and Maccoby (1954) that respondents will not react well to the wooden interviewer who performs like a questionnaire by reading each question from the schedule, and by refusing to answer questions, or by giving memorised replies. The consensus of opinion appears to be that the ideal lies somewhere between the highly structured interview and the other extreme of avoiding instructions to respondents entirely and entering into a discussion of topics.

To the extent that communication is for the purpose of conveying correct meaning, then an interviewer needs to be able to develop the kind of structure which is conducive to the transmission of information. A very rigid approach would militate against this and would prevent the interview from being a learning situation for the researcher. Although an interview will be focussed on particular topics, an interviewer needs discretion to rephrase questions from the schedule in keeping with her understanding of the situation and of the respondents' ability to understand and answer the scheduled questions (Goode and Hatt, 1952; Maccoby and Maccoby, 1954; Phillips, 1976).

In general, the controversies surrounding any technique of research appear to involve argument between fundamental views.

The standardised interview demonstrates the view that differences between individuals can be inferred to be a product of their different attitudes if all other factors are held constant. The unstandardised interview presents creative research as a product of an equal relationship between the interviewer and the respondent. Therefore, the semi-standardised interview may be seen as "the path of least resistance".

Alternatively, it is a method which recognises that all factors cannot be held constant, and that the relationship between the interviewer and the respondent cannot be fully equalitarian, if only because the respondent will always be trying to guess the motives of the interviewer and if they are different from the aims made explicit to them (Goode and Hatt, 1954; Mayntz et al, 1976; Phillips, 1976). The main advantage of the semi-standardised interview may be that it allows the researcher to direct the respondent to topics and to explore them, and to learn from respondents through two-way communication.

THE QUESTIONNAIRES

15. Have you been able to attach the chart's of ward patients to their bed-end clip boards?

No Go to 18
Yes

16. Have people been curious about them?

No Go to 18
Yes

Please tick:

Nurses Doctors OTs Relatives Others
Please name

17. Please list the main topics of enquiry.

18. Has the emphasis of gross functional items on the display aided communication with:

	Yes	No
Patients?		
Relatives?		
Other enquirers?		

19. Have you pinned up the posters?

No Go to 23
Yes

Please tick:

In Treatment Area Ward Elsewhere
Where?

20. Did the poster prompt enquiries?

No
Yes

21. Were you able to use the poster as a visual aid?

Yes Go to 23
No

22. Was this a fault of the poster design or content?

No
Yes

Please describe faults,

23. How comprehensible is the manual?

	Very Confusing	Confusing	Clear	Very Clear
Introduction (p. 2)				
Content (p. 4)				
Display (p. 5)				
Procedure (p. 6)				
Physiotherapy Items (p. 8)				
Gross Functional Items (p. 21)				

24. Is SMAC compatible with your method of treatment?

Yes
No

25. What methods and techniques do you use?

Bobath		IMF
Functional		Food
Other		Combination
Please name:		Please describe:

26. If it were generally available, would you use SMAC routinely to assess the motor function of all your hemiplegic patients?

Yes Go to end.
No

27. What changes do you require to be made to make it appropriate to your routine clinical use?

Please elaborate on any of your answers or make any other comments, particularly on the assessment of upper limb function.

Signed..... Date

THE STUDY DAY QUESTIONNAIRE

1. Did you use the semicircular chart? Yes No

2. Did you receive a Trial Pack for the January-March field test? No Yes Go to Q6

3. Was the reliability test the first time you had filled in a chart? Yes No Go to Q5

4. How many patients did you chart in the field test? (An estimate will do.) Yes No Go to Q12

5. Did you return the first questionnaire? Yes No

6. What treatment methods do you use?

Both	PHF
Functional	Food
Other	Combination
Please name: _____	

7. Is SMAC compatible with your method of treatment? Yes No

8. When you saw the chart for the first time did it:

have immediate appeal?

look very complicated?

9. How comprehensible did you find the manual?

Description of: The Display	Very Confusing	Confusing	Clear	Very Clear
Procedure for use				
Physiotherapy Items				
Gross Functional Items				

10. Does the sequence described on the display agree with your own concept of the sequence of restitution of normal movement in hemiplegia? Yes No Go to 12

11. Can you describe where and how there is disagreement?

12. Did you find the assessment items easy:

to understand?	Charting from videotapes

13. The following inferences were made after analysis of responses to the first questionnaire. Please indicate whether or not they correspond to your own opinions of SMAC.

	Agree	Disagree
A. The SMAC sequence agrees with physiotherapists' concepts of the sequence of recovery after hemiplegia.		
B. The significant items in the process of motor recovery have been identified.		
C. SMAC is acceptable for routine clinical use for the assessment of the motor function of hemiplegic patients.		

14. For which hemiplegic patients do you think SMAC is unamiable?

15. Do you think SMAC might be used to assess motor function in other neurological conditions?

No Go to 17
Yes

16. From the topics discussed today, please list the changes to SMAC which you think are essential.

18. Given that all the changes that you consider essential might not be incorporated in SMAC, would you be willing to use SMAC routinely over a long period so that a revised edition could be produced, say 2 or 3 years ahead?

No Go to 21
Yes

19. In there any possibility of every physiotherapists who treats patients in the department in which you work using SMAC?

Yes
No

20. Does the treatment setting in which you work offer the possibility of establishing inter-active groups with members of other disciplines to discuss the use of SMAC as a communication aid?

No
Yes
With OTs
Nurses
Doctors

21. Please mark the categories which describe you and your work. Add to the lists if you wish.

A. TREATMENT SETTING	Out-patients	In-patients
Small General Hospital		
District General Hospital		
Stroke Unit		
Rehabilitation Unit		
Other (Name):		

B. WORK TIME: Full Part

C. GRADE	on rotation	neurological brief	non-neurological brief
Basic			
Senior II			
Senior I			
Superintendent			
Teacher			
Researcher			
Other (Name)			

D. Please tick the sentence which best describes you work load:

- a) I treat hemiplegic patients only.
- b) I treat hemiplegic patients and a small minority of other patients.
- c) I treat hemiplegic patients and patients with other conditions in about equal numbers.
- d) I treat patients with a wide variety of conditions but always have at least two hemiplegic patients.
- e) I treat hemiplegic patients occasionally and irregularly.
- f) I treat hemiplegic patients rarely.

Thanks for your help. As this questionnaire was written before the outcome of the study day discussions was known many points may have been omitted. Please make any comments you wish to make below.

Name

TABULATION OF DATA COLLECTED ON THE QUESTIONNAIRES

Frequency counts of responses which are amenable to quantification are tabulated in Table II.1. These data are presented in separate tables in the text and Appendix II.4

DATA FROM QUESTIONNAIRES

Key to codes on Table II.1:

1. Respondents

Group A: Physiotherapists who participated in field tests of the preliminary and interim versions of SMAC.

Respondents to the postal questionnaire comprise sample A.
Respondents to the study day questionnaire comprise sample A₁.

Group B: Physiotherapists who participated in the field test of the interim version only.

Respondents to the postal questionnaire comprise sample B.
Respondents to the study day questionnaire comprise sample B₁.

Group C: Physiotherapists who did not participate in a field test.

Respondents 1 to 14, who participated in the inter-observer test of reliability, comprise sample C.

2. Questions

Subscripts to question numbers are used to distinguish categories of response where appropriate, as shown on the questionnaires.

3. Coding of responses

Postal questionnaire, questions 1, 2, 4 and 5:
O: preliminary SMAC preferred
I: interim SMAC preferred

Postal questionnaire, questions 7, 9, 11, 13, 18, 24 and 26:
Study day questionnaire, questions 7, 8, 11, 12, and 13:
O: negative response
I: positive response

Postal questionnaire, question 23:
Study day questionnaire, question 9:
1: very confusing
2: confusing
3: clear
4: very clear

Postal questionnaire, question 25:
Study day questionnaire, question 6:
A: Bobath's method used exclusively.
A+: Bobath's method, plus unspecified techniques.
B: Functional approach used exclusively.
B+: Functional approach, plus unspecified techniques.
C: Bobath's method and Functional approach.
D: Bobath's method, Functional approach and proprioceptive neuromuscular facilitation (PNF).
E: Bobath's method, Functional approach and Rood's techniques.
F: Bobath's method, Functional approach, PNF and Rood's techniques.
G: Functional approach and PNF.
H: Bobath's method, Functional approach, PNF, Rood's techniques and Brunnstrom's techniques.
I: Bobath's method, Functional approach, PNF, Rood's techniques and Johnstone's techniques.
J: Bobath's method, Functional approach, PNF, Rood's techniques and Peto's techniques.
K: Bobath's method, PNF and Rood's techniques.

Postal questionnaire, question 14:
The number of patients reported in each category.

For all questions: Ø - question not answered
Q - no firm opinion, e.g. "Don't know" written in.

TESTS OF THE DATA COLLECTED ON THE QUESTIONNAIRES

These tests are presented in the same order as the results are reported in section 3.4.

1. The design of the display.
2. The utility of items of assessment.
3. The clarity of the manual.
4. Methods of physiotherapy practised in the United Kingdom.
5. Evaluation of the physiotherapeutic acceptability of SMAC.

1. The Design of the Display

Analysis 1

Aim: To determine whether preference for either graphic design of the Chart is influenced by familiarity.

Null hypothesis:

H_0 : There is no difference between the group of physiotherapists who used both the Preliminary and Interim versions of the Chart (Sample A) and the group which used only the Interim version (Sample B) in the proportions of members who find the Preliminary semicircular display more attractive than the Interim rhomboidal display.

H_1 : A greater proportion of Sample A who made recordings on the semicircular display find it attractive than the proportion of Sample B who are only being asked to choose between two designs.

Statistical Test:

The Chi square test for two independent samples is used because one group has recorded assessments on the semicircular display and the other has not, and because the numerical data are frequencies in discrete categories. ($N = 44$)

Significance level: Let $\alpha = 0.05$ to avoid accepting the null hypothesis when no relationship exists.

Rejection Region: The region of rejection consists of all values of chi square which are so large that the probability of their occurrence is equal to or less than $\alpha = 0.05$.

The test is one-tailed because H_1 predicts the direction of the difference between the two groups. For a one-tailed test when there is one degree of freedom a chi square value of 2.71 or larger has a probability of occurrence under H_0 of $p = \frac{1}{2}(0.1) = 0.05$. Therefore, the region of rejection consists of all values of chi square with are equal to or greater than 2.71 if the direction of the result is that predicted by H_1 .

Source of data: Postal questionnaire, question 1.

Data:

Number in Sample A preferring semicircular display = 7
Number in Sample A preferring rhomboidal display = 15
Number in Sample B preferring semicircular display = 6
Number in Sample B preferring rhomboidal display = 16

Result:

$\chi^2 = 0$
The probability of occurrence under H_0 for $\chi^2 = 0$ is greater than 0.45.

Statistical decision: The decision is to accept H_0 : There is no significant difference in the proportions in either group preferring the rhomboidal display or the semicircular display.

Analysis 2

Aim:

To determine if the proportions of users finding the semicircular display more attractive is greater or less than the proportion finding the rhomboidal display more attractive.

Null hypothesis: There is no difference between the proportion of users finding the semicircular display more attractive (p_1) than the proportion of users finding the rhomboid display more attractive (p_2) and any difference between the frequencies which may be observed might be expected in a sample of the population of physiotherapists under H_0 .

$$H_0: p_1 = p_2 = \frac{1}{2}$$
$$H_1: p_1 < p_2$$

Statistical Test: The Binomial Test is used because the data are in two discrete categories and they are collected from one sample (all respondents to the postal questionnaire; $N = 44$).

It has already been shown that there is no difference in the proportions of Samples A and B, who make up this sample, who prefer either design so there is no reason to assume that the semicircular display will be found less attractive than the rhomboidal display. Therefore, $p = \frac{1}{2}$.

Significance level: Let $\alpha = .05$ because the shape or design of the display may have an important effect on the acceptability of the Chart to individual physiotherapists.

Rejection Region: The normality of the binomial distribution is

tested by the calculation of z and the rejection region consists of all values of x (where x equals the number of respondents finding the semicircular display more attractive) which are so small that the obtained z is significant at less than $\alpha = .05$. The direction of the difference is predicted; therefore the rejection region consists of all values of $z \geq 1.56$.

Source of data: Postal Questionnaire, question 1.

Data:

Users finding semicircular display more attractive, 13 = x $p = .295$
Users finding rhomboidal display more attractive 31 $q = .705$
Number in sample, 44

Result:

$z = -2.56$
 $p = .0052$

Statistical Decision: H_0 is rejected.

Analysis 2

Aim: To determine if there is a significant difference in the proportions of respondents perceiving the rhomboidal display or the semicircular display to be less complicated.

Null hypothesis: That all users perceive both displays to be equally complicated.

$$H_0: p_1 = p_2 = \frac{1}{2}$$

H_1 : That the proportion of respondents who perceive the semicircular display to be more complicated (p_1) is greater than the proportion who perceive the rhomboid display to be more complicated (p_2).

$$H_1: p_1 > p_2$$

Statistical Test: The Binomial Test. $n = 44$

It has already been shown that a larger proportion of respondents find the rhomboidal display more attractive but this judgment was related to the immediate visual impact of the design rather than to its content. A significant number of respondents preferred the semicircular shape, and there is no reason to assume that the semicircular display will be found more complicated than the rhomboid display on closer inspection. Therefore, $P = 0 = \frac{1}{2}$.

Significance level: Let $\alpha = 0.05$.

Rejection Region: The normality of the binomial distribution is tested by the calculation of z and the rejection region consists of all values of x (where x equals the number of respondents finding the semicircular display more complicated) which are so small that the obtained z is significant at less than $\alpha = 0.05$, or all values of $z \geq 1.56$.

Source of data: Postal Questionnaire, question 2.

Data:

Users finding the semicircular display more complicated,

$$39 = x, \quad p = 0.886$$

Users finding the rhomboid display more complicated, 5
Number in sample, 44

Result:

$$z = 4.974$$
$$p = 0.00003$$

Statistical Decision: The result is highly significant and H_0 is rejected in favour of the hypothesis that the rhomboid design is much less complicated than the semicircular design.

Analyses 4

Aim: To determine the significance of changes in users' opinions about the design.

Null hypothesis: For those respondents who changed their display of preference, that the probability that any physiotherapist who finds the semicircular display more attractive visually will find the rhomboid display less complicated on inspection (P_A) is equal to the probability that a physiotherapist will change her display of preference from the rhomboid to the semicircular display (P_D).

$$H_0: P_A = P_D = \frac{1}{2}$$

$$H_1: P_A > P_D$$

Statistical Test: The McNemar Test for significance of changes.
 $N = 44$.

Significance level: Let $\alpha = 0.05$.

Rejection Region consists of all values of χ^2 computed from data in which $A > D$ which are so large that they have a one-tailed probability associated with their occurrence under H_0 of .05 or less, or all values of $\chi^2 \geq 2.71$.

Sources of data: Postal questionnaire, questions 1 and 2.

Data: (cf. Table 18, textual report)

More attractive design	Less complicated design	
	Rhomboid	Semicircular
Semicircular	A 9	B 4
Rhomboid	C 30	D 1
	39	5

Result:

$$\chi^2 = 4.9$$
$$p < .025$$

Statistical decision: H_0 is rejected in favour of H_1 and it is concluded that physiotherapists show a significant tendency to find the rhomboid display less complicated than the semicircular display even if they find the semicircular display more attractive.

Analysis 5

Aim: To estimate a confidence interval for the proportion of the population of physiotherapists who would find a rectilinear design less complicated and therefore easier to use than a curvilinear design.

Method: The confidence limits for the population are:
 $p \pm z_c \sqrt{pq/n}$ where $z_c = 1.96$ for 95% confidence limits
and $z_c = 2.58$ for 98% confidence limits.

Source of data: Postal Questionnaire, question 2

Data: Number in sample, 44
Number finding rhomboid design less complicated, 39 $p=.886$
Number finding semicircular design less complicated, 5 $q=.114$

Results: 95% confidence limits for the population of physiotherapists treating hemiplegic patients, $.886 \pm .094$
99% confidence limits for the same population, $.886 \pm .1236$

Conclusions: There is 99% confidence that 76.2% to 100% of physiotherapists will find a rectilinear design less complicated. At the 95% level the limits are reduced marginally to 79.2 - 98%. Therefore, if a rectilinear design is chosen to suit the majority of users up to 2% of physiotherapists might find it unacceptable.

Source of data: Postal questionnaire, question 4.

Data: All preferences for items of the interim version are given a score of "1". All preferences for items of the preliminary version, "Don't know" responses, and where no choice is made, are given a score of "0".

Result: $Q = 4.75$, significant at a level greater than 0.05.

Statistical decision: The null hypothesis may not be rejected. Members of Sample A found that they could use the items of Interim SMAC with greater ease than they could use the items of the preliminary version.

2. The utility of items of assessment

Analysis 1

Aim: To determine if the items of assessment of the interim SMAC are more easily understood, remembered and applied than the items of the preliminary version.

Null hypotheses:

H_0 : The probability of members of Sample A preferring the interim version is the same for all three attributes.

H_1 : The probability of members of Sample A preferring the interim version is different for one or more of the three attributes, in favour of the preliminary version.

Statistical test: The Cochran Q test is used because the data are dichotomised for more than two items. $N = 22$.

Significance level: Let $= 0.01$, to avoid rejecting a null hypothesis which is true.

Rejection Region: It consists of all values of Q which are greater than 9.21 for which the probability of occurrence under H_0 with two degrees of freedom is equal to or less than 0.01.

Analysis 2

Aim:

To test if there are significant differences in the proportions of assessors in Samples A₁, B₁ and C who find the items of assessment of the Interim SHAC easy to understand, remember, apply and record.

Null hypothesis: There is no difference in the proportions of assessors in Samples A₁, B₁ and C who find the items of assessment easy to understand, remember, apply and record.

H₁: There are significant differences in the proportions in each group of users.

Statistical Test: Test for significant differences in proportions of the population.

Significance level: Let $\alpha = 0.05$.

Rejection Region: This is a two tailed test because the direction of the difference is not predicted and H₀ can be rejected at the .05 level if z lies outside the -1.96 to +1.96 interval.

Source of data: Study Day Questionnaire, question 12.

Data: All positive responses are given a score of "1" and counted to produce the data in Table

If no response is made on the questionnaire or a negative response is made a score of "0" is given.

Results:

Table 22 (cf. textual report)
z statistics calculated to compare proportions

Samples compared	ease of understanding	ease of remembering	ease of application	ease of recording
In clinical use: A ₁ and B ₁	.0	.34	-.64	.67
From videotapes: A ₁ and B ₁	.2	.504	.985	.504
A ₁ + B ₁ and C	.27	.456	.83	<u>2.215</u>

All of these statistics, except the one underlined, are within the -1.96 to +1.96 interval and there is no significant difference in the proportions of the populations from which the samples are drawn.

There is a significant difference in the ease with which Sample C and Samples A₁ and B₁ can make recordings from observation of videotapes.

Discussion: 1. There is no significant difference in the proportions calculated for Sample A₁ and Sample B₁ for all categories of ease. Both groups found remembering most difficult when they were making clinical assessments. Sample A₁ found recording slightly easier and Sample B₁ found application slightly easier.

These results suggest that the ease with which the items can be used is not affected by involvement in the production of the Interim Chart and that future users of the same items on the Final version will find them as easy to understand, apply and record.

2. The results related to the videotapes are important in so much as they might affect the results of the test of inter-observer reliability. That is, members of samples A₁ and B₁ found the items more difficult to use than they had found them clinically; but, possibly because they had used the assessment clinically, they found the items much easier to record than did the members of Sample C.

3. The clarity of the manual.

Aim: To test if there is an equal probability of sections of the manual being described as "clear" by all respondents.

Null hypothesis:

H_0 : The probability of a "clear" response is the same the named sections of the manual.

H_1 : The probabilities of "clear" responses differ for all four named sections.

Statistical Test: The Cochran Q Test is used because the data are dichotomized as "clear" and "confusing" for more than two related items.

Significance level: Let $\alpha = 0.05$

Rejection Region consists of all values of Q which are so large that the probability associated with their occurrence under H_0 is equal to or less than 0.05.

Sources of data: Responses to Question 23 on the Postal Questionnaire for 44 respondents in samples A and B and responses to Question 9 on the Study Day Questionnaire for fourteen respondents in Sample C.

Data:

The questions concerned the comprehensibility of the manual. "Clear" and "Very Clear" responses have been combined in one category "Clear" and given a score of "1". "Confusing" and "Very confusing" responses have also been combined in one category and scored "0". Two respondents who did not answer the question are also given scores of zero for each section.

The scores were arranged in four columns representing the sections of the manual:

- a. The Display
- b. The procedure for use
- c. The Physiotherapy Items
- d. The Gross Functional Items

G is the number of "clear" responses for each section
 L is the number of "clear" responses made by each individual.

g_a	g_b	g_c	g_d	L	L^2	$(g_i)^2$
43	46	47	49	185	675	34225

Result: $Q = 3.4615$ which has a probability of occurrence under H_0 of $.5 > p > .3$ when there are three degrees of freedom.

Statistical Decision: The value of Q is outside the region of and it is accepted that the probability of a "clear" response is the same for all four sections of the manual.

4. Methods of physiotherapy practised in the United Kingdom

Analysis 1

Aim: To identify the most common method of physiotherapy used to treat hemiplegic patients in the United Kingdom and to calculate confidence limits for the proportions of the population of physiotherapists using specific methods.

Sources of data: Replies to Question 25 on the postal questionnaire and to Question 6 on the study day questionnaire given by 58 physiotherapists practising in the United Kingdom.

Data:

Table II.2

Absolute numbers of physiotherapists practising various methods of physiotherapy

Method	FQ SDQ			Data collated for analysis ¹							
	FQ	SDQ	H	1	2	3	4	5	6	7	8
Bobath (B) only	10	3	13	3	3						
B and unspecified	3		3								
Functional (F)	1		1	1							
F and unspecified	15	5	20	20	20	20	20				
B and F	5	4	9	9	9	9	9				
B, F and PNF	3		3	3	3	3					3
B, F and Hood (H)	1	2	3	3	3	3					3
B, F, PNF and R	2		2	2							2
F and PNF	1	2	3	3	3	3					3
B, F, PNF and another ²	41	17	58	54	42	41	20	17	13	7	3

FQ: Respondents to Postal Questionnaire

SDQ: Respondents to Study Day questionnaire

1. Numbers refer to categories of Table
2. "another" refers to methods of Brunstrom, PNF and Johnstone, each mentioned by one physiotherapist.

Results

Table 23 (cf. textual report)
Proportions of population of physiotherapists in the United Kingdom using different methods of treatment for hemiplegia

Method	n	P	estimates of population proportions	percentages
1. Bobath used	54	.93	.93 ±.0656	86.44-99.56%
2. Functional used	42	.724	.724 ±.115	60.9 -83.9 %
3. Bobath used with other techniques	41	.706	.706 ±.117	58.9 -82.3 %
4. Bobath and Functional	20	.345	.345 ±.122	22.3 -46.7 %
5. PNF used	17	.293	.293 ±.117	17.6 -41.0 %
6. Bobath exclusively	13	.224	.224 ±.107	11.7 -33.1 %
7. Hood used	7	.12	.12 ±.08	4.0 -20.0 %
8. Other techniques named	3	.05	.05 ±.056	0.0 -10.6 %

Discussion

There is 95% confidence that 86.44% to 99.56% of physiotherapists in the United Kingdom use Bobath's techniques to treat hemiplegic patients. Only 11.7% to 33.1% use these techniques exclusively and 58.9% to 82.3% have Bobath's techniques in their repertoires.

A very small proportion is estimated for Brunstrom, PNF and Johnstone techniques. This may be because physiotherapists who use these methods did not volunteer or because respondents have named the method or techniques they most commonly use. This survey was conducted with the aim of estimating SHAG's compatibility with the methods of treatment used in the United Kingdom. A survey of a larger sample (N=500), directed at methods of treatment exclusively, would provide more accurate estimates of the "minority methods" and allow the confidence limits to be narrowed for other categories. However, all of the respondents who used Hood, PNF and the "minority methods" also included Bobath's techniques or Functional techniques or both among their skills.

Analysis 2

Aim: To test if SHAC is compatible with the methods of treatment used by physiotherapists working in the United Kingdom.

Method: Calculation of the confidence interval for the proportion of the population of physiotherapists treating hemiplegic patients.

Sources of data: Question 24, Postal Questionnaire and Question 7, Study Day Questionnaire.

Data: Fifty five physiotherapists working in the United Kingdom said that SHAC was compatible with their method of treatment and three said that it was not. One physiotherapist who did not answer the question is counted in the 'incompatible' category.

Results: There is 95% confidence that SHAC is compatible with the methods used by .93±.065 physiotherapists treating hemiplegic patients in the United Kingdom, or 86.5% to 99.5%

Discussion: This proportion is very close to the proportion calculated for those who use Bobath's method (.93±.0656). However, all three who found it incompatible include Bobath techniques among their skills and those who find it compatible include four physiotherapists who do not use Bobath techniques at all.

5. Evaluation of the physiotherapeutic acceptability of SHAC

Analysis 1

Aim: To test if the opinions of physiotherapists who participated in the field test of the preliminary version and contributed to its revision differ significantly from the opinions of physiotherapists in the field test of the interim version only.

Null hypothesis:

H_0 : Equal proportions of Sample A and Sample B respond affirmatively to questions about the assessment.

H_1 : A greater proportion of Sample A respond affirmatively than the proportion of Sample B.

Statistical Test: The Fisher Test is used to determine the significance of the difference between two independent samples because data are dichotomous and because the expected frequency is less than five in more than 20% of the cells for each examination.

(N = 44)

Significance level: Let $\alpha = 0.05$

Rejection Region: Since H_1 predicts the direction of the difference, H_0 will be rejected if the probability associated with the occurrence of the observed values of the cells is equal to or less than $\alpha = 0.05$.

Source of data: Postal Questionnaire, questions 7, 9, 11, 24 and 26.

Data: If a respondent did not answer the question, the response is counted as negative. The "Yes" and "No" responses are tabulated for each question in the following table.

Table 24 (cf. textual report)

Affirmative and negative responses to questions about SHAC		"No"	"Yes"
7.	<u>Order of Physiotherapy Items agrees with intuitive concept of recovery</u>	0	22
	A	0	22
	B	6	16
9.	<u>Nineteen Physiotherapy Items constitute a valid physiotherapeutic motor assessment</u>	3	19
	A	3	19
	B	1	21
11.	<u>Identified Physiotherapy Items are the most significant movements in the restitution of normal movement</u>	6	16
	A	6	16
	B	4	18
24.	<u>SHAC is compatible with method of treatment</u>	0	22
	A	0	22
	B	1	21
26.	<u>SHAC is acceptable for routine clinical use</u>	4	18
	A	4	18
	B	1	21

Results:

Question 7	p = .0106
Question 9	p = .303
Question 11	p = .36
Question 24	p = .5
Question 26	p = .1725

Statistical Decision:

The null hypothesis must be accepted for questions 9, 11, 24 and 26 but there is a significant difference between the proportions of Samples A and B whose intuitive concept of restitution is satisfied by the order of items of assessment.

Analysis 2

Aim: To confirm that there is an equal probability of questions about SHAC being answered in the same way by respondents who have participated in its development and physiotherapists who have not.

Null hypothesis:

H_0 : The probability of an affirmative response is the same for all five questions about SHAC.

H_1 : The probability of an affirmative response differs according to the specific nature of each question.

Statistical test: The Cochran Q Test because the data are dichotomized into "Yes" and "No" categories for more than 2 questions. (N = 14)

Significance level: Let $\alpha = .01$ to avoid rejecting a null hypothesis which is true.

Rejection region consists of all values of Q greater than 13.28 for which the probability of their occurrence under H_0 with four degrees of freedom is equal to or less than $\alpha = .01$.

Source of data: Postal questionnaire, questions 7, 9, 11, 24, 26.

Sample	G ₇	G ₉	G ₁₁	G ₂₄	G ₂₆	ΣL	ΣL^2	$(\Sigma f)^2$
A	22	19	16	22	18	97	439	9409
B	16	21	18	21	21	97	439	9409
A+B	38	40	34	43	39	194	882	37636

Where G is the number of "Yes" responses to a question and the subscript refers to the number of the question and L is the number of "Yes" responses made by each subject

Results: A: Q = 11.826 significant at the 0.2 > 0.1 level
B: Q = 9.217 significant at the 0.1 > 0.05 level
A+B: Q = 8.976 significant at the 0.05 > 0.02 level

Statistical Decision: The probabilities associated with the occurrence of the obtained values of Q under H_0 are greater than 0.01 and the null hypothesis cannot be rejected.

Conclusion: The implication is that the frequency of "Yes" responses does not differ significantly among the five questions whether Samples A and B are treated as independent samples or as a single sample of respondents to the Postal Questionnaire who participated in the Second Field Test. The test also shows that the difference between the samples observed for question 7 in Observation 9 is not significant when all respondents and all five questions are considered together.

Analysis 2

Aim: To determine if users change their opinions of SHAC as their familiarity and experience with the Chart increases.

Null hypothesis:

H_0 : That, for those physiotherapists who responded to the Postal questionnaire and the Study day questionnaire, the probability (P_A) that any physiotherapist in the population will change her opinions as she gains experience with the Chart is equal to the probability (P_B) that she will change her opinion from positive to negative.

$$H_0: P_A = P_B = \frac{1}{2}$$

$$H_1: P_A > P_B$$

Statistical Test: The Binomial Test is applied using data from McNemar Tables because the expected frequency is too small in each case ($(A+D)/2 < 5$) for the McNemar Test to be used.

Where the number of physiotherapists who changed their opinion is less than five the data cannot be tested because the 0.05 level of significance for inferring the operation of non-chance factors is not appropriate to very small samples.

Significance level: Let $\alpha = 0.05$

Rejection Region: H_1 specifies the direction of the difference and the null hypothesis will be rejected in its favour if the probability is equal to or less than .05.

Sources of data: Responses to questions 7, 11 and 26 on the Postal questionnaire and responses to question 13 4, B and C on the Study Day Questionnaire.

Data and Results: The data are cast in 2x2 Tables:

Study Day Questionnaire

	-	+
Postal Questionnaire	A	B
	C	D

A: Number who changed opinion from positive to negative
 B: Number whose opinion remained positive
 C: Number whose opinion remained negative
 D: Number who changed opinion from negative to positive.

Q7/13A

	-	+
+	0	24
-	0	5

$N = A+D = 5$ and x is the smaller proportion = 0

$$p = .03125$$

Q11/13B

	-	+
+	0	22
-	1	6

$N = 6$
 $x = 0$

$$p = .016$$

Q26/13C

	-	+
+	1	26
-	0	2

$N = 3$
 $x = 1$

$$p = .5$$

Discussion: 1. For Question 7/statement 13A and Question 11/statement 13B the results show that there is a significant tendency for the opinions of physiotherapists who are undecided or who change their opinions to become more favourable towards SHAC as they become more experienced with it.

2. For Question 26/statement 13C the result is unattractive because the sample is very small, $N = 3$. There would appear to be an equal probability of change in either direction but because the sample is so small the result may be due to chance factors.

Analysis 4

Aim: To test if physiotherapists who have been involved in the development of the assessment to varying extents hold different opinions of the assessment.

Null hypothesis:

H_0 : Equal proportions of samples A_1 , B_1 and C agree with statements about SHAC.

H_1 : The proportion of sample A_1 which agrees with with statements about SHAC is greater than the proportion of sample B_1 which agrees with them; and the proportion of samples A_1 and B_1 added together which agrees with the statements is greater than the agreeing proportion of sample C .

Statistical test: The Fisher Test is used to determine the significance of the differences between samples A_1 and B_1 , samples A_1 and C , and samples B_1 and C .

Rejection region: Since H_1 predicts the direction of the difference, H_0 will be rejected if the probability associated with the occurrence of observed values is equal to or less than $\alpha = 0.05$.

Source of data: Study day questionnaire, statements 13A, 13B and 13C.

Data: The frequencies of "agree" and "disagree" responses are tabulated below.

RESULTS

13A

	Agree	Disagree
A_1	16	0
B_1	16	0
A_1 or B_1	16	0
C	13	1

No difference in proportions

$p = .467$

13B

A_1	16	0
B_1	15	1
A_1	16	0
C	13	1
B_1	15	1
C	13	1

$p = .5$

$p = .467$

$p = .515$

13C

A_1	16	0
B_1	15	1
A_1	16	0
C	11	3
B_1	15	1
C	11	3

$p = .5$

$p = .009$

$p = .1992$

Statistical Decision: In all cases $p > .05$ and the null hypothesis cannot be rejected.

Agreement with statements about SHAC is not affected by physiotherapists' involvement in the development of SHAC.

THE INTERVIEW SCHEDULES

1. THE PROFESSIONAL INTERVIEW SCHEDULE for practitioners other than physiotherapists.
2. THE PATIENTS' INTERVIEW SCHEDULE.
3. THE PHYSIOTHERAPY TEACHERS' INTERVIEW SCHEDULE.
4. THE PHYSIOTHERAPY CLINICIANS' INTERVIEW SCHEDULE.

SHEFFIELD CITY POLYTECHNIC
DEPARTMENT OF HEALTH STUDIES

DISS RESEARCH FELLOWSHIP PROJECT
TO DEVELOP AND EVALUATE THE SHEFFIELD MOTOR ASSESSMENT CHART

PROFESSIONAL INTERVIEW SCHEDULE

HEALTH CARE SETTING.....INTERVIEW GROUP CODE.....
PROFESSIONAL GROUP.....SIZE.....DATE.....

SECTION A: INTRODUCTION

INTERVIEWER: I am interviewing nurses, doctors and occupational therapists to collect their opinions about physiotherapy assessment of hemiplegia in general and the Sheffield Motor Assessment Chart in particular.

The chart has been developed over the last two years with the collaboration of physiotherapists all over the country. The main objective has been to create an assessment suitable for everyday use in the wide variety of settings in which hemiplegic patients are treated: from Stroke Units to small general hospitals and from Geriatric Hospitals to out-patient departments in District General Hospitals.

At present I am investigating the links between physiotherapy assessment and assessments made by others members of the care team. The idea is to try to identify if any of the physiotherapy assessment information is also valuable to nurses, doctors and occupational therapists. I would be grateful if you would lend your experience to the project. If we can identify clearly information that you can utilize we can contribute to the care and rehabilitation of all hemiplegic patients assessed in the same way.

I am taping the interviews so that I can listen to what you are saying now and not make any mistakes in trying to recall the discussion later. Let me reassure you that everything you say will be absolutely confidential. No one else but me will hear the tape. In the report, I shall list the professional groups interviewed but comments will not be attached to any hospital or individual. Where identification is necessary, it will be made by profession or type of unit on which the person works.

* Social workers were included later

SECTION B: ROLES

B1: PERCEPTION OF PHYSIOTHERAPIST

Q: Are there any several different practitioners involved in the care and rehabilitation of each individual hemiplegic patient, can you tell me how you see the work of the physiotherapist relates to your own role with the patient?

Probes: Complementary? Supplementary? Varies with physio?

B2: TEAM APPROACH

Q: A lot has been written about and talked about "the team approach" how well do you think it works in practice?

Probes: re physio-
Initiate discussion with patient re physio?
Re-inforce physio?
Physio initiates discussion with you?
Make suggestions/requests to physio?

B3: JOINT DECISION MAKING

Q: Do you and the physiotherapist discuss individual patients regularly and reach joint decisions about future care?

Probes: On formal occasions such as ward rounds, case conferences?
'Accidental' meetings on ward/ in other places?
Seek each other out as necessary?

SECTION C: KNOWLEDGE AND USE OF STANDARDISED ASSESSMENTS

C1: ACCESS TO FORMAL ASSESSMENT INSTRUMENTS

Q: Do you have an assessment that all of you (doctors/nurses/OTs) use in the same way?

Probes: Locally devised or developed elsewhere?
Physio reads it and uses information?

C2: USE OF DEVELOPED DEVICES

Q: Have you tried any of the assessments published in (professional literature)?

Probes: Successfully?
If rejected, why rejected?
Do they assess what they are said to assess?

C3: RECOVERY CRITERIA

Q: How do you measure recovery?

Probes: Independent walking?
ADL independence?
Normal performance, or is that unimportant as long as patient can perform?
Does recovery mean that patient is ready for home?

<p>C4: <u>PHYSIOTHERAPIST'S ASSESSMENT</u></p> <p>Q: Is the physiotherapist's assessment made for her own use, for planning and monitoring physiotherapy?</p> <p>Probes: Do you see it? Read it?</p>	
<p>C5: <u>USE OF PHYSIOTHERAPY ASSESSMENT</u></p> <p>Q: What information from the physiotherapist's assessment do you use?</p> <p>Probes: How do you get this information currently? Verbally? As a permanent record?</p>	
<p>C6: <u>NEED TO KNOW</u></p> <p>Q: What activities is it useful to you in your work for the physiotherapist to inform you about?</p> <p>Probes: Or would it be useful to know about if you're not already told? Walking from place to place? How safe the performance is, i.e. not likely to need to fill in an accident form?</p>	
<p>SECTION D: <u>THE SWAC DISPLAY (present copy)</u></p>	
<p>D1: <u>SWAC PROVISIONS</u></p> <p>Q: Does this display appear as if it would provide the information you just said you needed? Look at the column in the middle headed 'Activity Capability'.</p> <p>Probes: Do these items relate to the activities you mentioned earlier? Is the wording clear? Do you assess the same activities?</p>	
<p>D2: <u>COMMUNICATION OF PHYSIOTHERAPY ASSESSMENT</u></p> <p>Q: What about the Functional Ability items? What do you think each pin-man is demonstrating?</p> <p>Probes: Are they meaningful to you regarding your care of the patient?</p>	
<p>D3: <u>INQUISITIVENESS RE PHYSIOTHERAPY ASSESSMENT</u></p> <p>Q: Do you want to know what the numbers 1-14 signify?</p> <p>Probes: Why/Why not? Can you use more information than the physiotherapist divulges? What for?</p>	
<p>D4: <u>CLINICAL ACCEPTABILITY</u></p> <p>Q: If you saw one of these charts filled in, would you re-assess any of the Functional Ability or Activity Capability items that the physiotherapist had marked 'panned' or would you accept her/his judgment?</p>	

<p>SECTION E: <u>THE SWAC ASSESSMENT RECORD (present filled in displays)</u></p>	
<p>E1: <u>IMMEDIATE IMPACT</u></p> <p>Q: Although you're not used to seeing one of these charts, can you say if it tells you anything about the patient immediately?</p>	
<p>E2: <u>PRIORITY ITEMS</u></p> <p>Q: What is the first item you've looked for?</p> <p>Probes: Is it on the display? Why did you look for it?</p>	
<p>E3: <u>CONTINUING USEFULNESS</u></p> <p>Q: If this were a display of one of your patients, would you find it useful to refer to it?</p> <p>Probes: In what circumstances? As patient progressed and new achievements were recorded? To base decisions on?</p>	
<p>E4: <u>ACCESSIBILITY</u></p> <p>Q: Where do you think is the appropriate place to keep an assessment record like this one?</p>	
<p>SECTION F: <u>RESPONDENT'S COMMENTS AND QUESTIONS</u></p>	
<p>F1: <u>FURTHER INFORMATION</u></p> <p>Q: Is there anything else you want to tell me or ask me about SWAC?</p>	
<p style="text-align: center;">END OF INTERVIEW</p> <p style="text-align: right;">Time taken</p>	

SHEFFIELD CITY POLYTECHNIC
DEPARTMENT OF HEALTH STUDIES

DIGGS RESEARCH FELLOWSHIP PROJECT
TO DEVELOP AND EVALUATE THE SHEFFIELD MOTOR ASSESSMENT CHART

PATIENTS' INTERVIEW SCHEDULE

HEALTH CARE SETTINGCODE.....
PHYSIOTHERAPISTS' CODE.....DATE.....

SECTION A: INTRODUCTION

INTERVIEWER: I am asking people like you to talk to me about why they are in hospital and when they think they will be ready to go home again.

As you can see, I have a taperecorder so that I can record what you say and not make any mistakes trying to remember what you've said and forget important things. It is just to enable me to listen closely to what is said when we are talking so that I don't don't have to try to make notes. Anything you say that is taped will be treated absolutely confidentially.

Will you answer a few questions for me? And can we use the tape recorder? If you'd rather I didn't use it, please don't be afraid to say no.

SECTION B: PERCEPTION OF SITUATION AND STATUS

B1: REASON FOR IN-PATIENT STATUS

Q: Can you tell me why you are in hospital?
Probes: How long have you been in?
When do you think you'll be ready to go home again?

B2: COMPARISON WITH PRE-STROKE ABILITIES

Q: What were you able to do before, at home, that you can't do now?
Probes: Why do you think that in?
Can you put your finger on anything in particular?

B3: PERCEPTION OF STROKE

Q: What do your (right/left) arm and leg feel like to you?
Probes: What do they feel like when you try to move?
Do they feel as if they belong to you?
Do they hinder you doing things?

B4: PERCEPTION OF PROGRESS

Q: How much change can you see in yourself since you first came in?
Probes: Can you move any more easily?
What have you learned to do while you've been in?
Would you say that you're better than you were?

B5: READINESS FOR DISCHARGE

Q: What do you think you'll need to be able to do in order to go home again?
Probes: Is anyone teaching/helping you to do these things now?

SECTION C: PERCEPTIONS OF PHYSIOTHERAPY

C1: TREATMENT

Q: What are you doing in physiotherapy?
Probes: Can you see where it is all leading?
Do you feel it's helping you to be able to do those things that you want to be able to do again?

C2: PHYSIOTHERAPIST'S RATIONALES

Q: What has the physiotherapist told you about treatment?
Probes: What is it for?
As she explains it, is it for the same things as you want to be able to do?

C3: PROGRESS IN TREATMENT

Q: What does the physiotherapist say about how you're getting on in treatment?
Probes: Does the physiotherapist say that you've improved?
How do you think you've changed since you've been having treatment?
Have you any idea how much more treatment you'll need?
What do you think you need it for?

SECTION D: REACTIONS TO SWAC (present filled in display)

D1: DEMONSTRATION OF PROGRESS

Look at this chart. The red parts show ability just after admission and the blue parts show it after treatment.
Q: Can you tell me if it means anything to you?
Probes: Can you see the difference between the red and blue parts?
Interested in pin-men?
Interested in Activity Capability items?
Do you think they are the sorts of things you'll need to be able to do to go home again?
Any questions?

D2: PERSONAL GOALS

There's a box here for writing in a goal, like somewhere you think you must walk to, for you to work towards with the physiotherapist.

Q: What would you want to put in the box?

D3: ONSET-RECOVERY SEQUENCE

A patient just coming into hospital might have only a few box boxes filled in. The boxes are filled in as she/he gets better.

Q: Would you have liked to have seen boxes filled in as you got better?

Probes: How would it have helped you?

To know that there was an 'end' to be aimed for?

To see what the physio was aiming for?

Just to see a column filled in?

D4: RECORDING METHOD AND COMPREHENSIBILITY

This one has been filled in with numbers instead of colours.

Q: What do you think of it in comparison to the other one?

Probes: Like it as much as/more than/less than first one? Why?

SECTION E: COMMENTS AND QUESTIONS

E1: FURTHER INFORMATION

Q: Is there anything else you want to tell me or ask me?

END OF INTERVIEW

Time taken

SHEFFIELD CITY POLYTECHNIC
DEPARTMENT OF HEALTH STUDIES

DISS RESEARCH FELLOWSHIP PROJECT
TO DEVELOP AND EVALUATE THE SHEFFIELD MOTOR ASSESSMENT CHART

PHYSIOTHERAPY TEACHERS' INTERVIEW SCHEDULE

COURSE CONTEXT.....INTERVIEW GROUP CODE.....

SIZE OF GROUP.....DATE.....

SECTION A: INTRODUCTION

INTERVIEWER: I am interviewing groups of nurses, doctors, social workers and occupational therapists to collect their comments on Physiotherapy assessment of hemiplegia in general and the Sheffield Motor Assessment Chart in particular.

SMAC has been developed over the last two years with the collaboration of physiotherapists all over the country. The main objective has been to construct an assessment suitable for everyday use in the variety of settings in which hemiplegic patients are treated.

The project has been extended to enable me to investigate the links between physiotherapy assessment and assessments made by other members of the care team. The idea is to try to identify if any of the physiotherapy assessment information is also valuable to nurses, occupational therapists, social workers and doctors, if it is presented in a manner that is comprehensible to them and if it can be used to enhance the care and rehabilitation of the individual patient.

It also seems appropriate in association with this study to investigate the application of SMAC to the education of physiotherapy students. Consequently, I am very grateful that you are lending your experience to the project.

I am taping the interviews so that I can listen to what you are saying now and not make any errors in trying to recall the discussion later. Let me assure you that everything you say will be held by me in the strictest confidence. No one else but me will hear the tape. In the report, I shall list the professional groups who were interviewed but comments and opinions will not be attached to any school, hospital or individual. Where identification is necessary, it will be made by profession.

SECTION B: ROLES

B1: PERCEPTIONS OF OTHER TEAM MEMBERS

Q: As there are several health care professionals involved in the care and rehabilitation of each hemiplegic patient, can you tell me how you describe to students the roles of other carers in relation to their own?

B2: TEAM APPROACH

Q: A lot has been written and talked about "the team approach". How well do you think this works in practice?

Probes: Who is the 'every day working team'?
Is the student encouraged to enquire regularly/daily of the sister/staff nurse about patients?
Does other carers initiate discussions about patients?

B3: JOINT DECISION MAKING

Q: Do you reach joint decisions about future care of individuals with another/other team members?

Probes: Formal occasions such as ward rounds, case conferences conferences?
'Accidental' meetings?
Seek each other out as necessary?
Students participate in rounds/conferences?
How and by whom are students' patients presented to case conferences, represented at ward rounds?

SECTION C: KNOWLEDGE AND USE OF STANDARDISED ASSESSMENT INSTRUMENTS

C1: PURPOSE OF PHYSIOTHERAPY ASSESSMENT

Q: What is the purpose of physiotherapy assessment of hemiplegic patients?

Probes: Planning and monitoring of treatment?
Demonstration of change/progress?
Extra-physiotherapeutic use.

C2: ACCESS TO FORMAL ASSESSMENT

Q: Do you have a standard method of assessment of hemiplegic patients that you teach to all of your students?

Probes: Local?
Some method used by clinicians at placement?
How taught?
How recorded? Handwritten, check-sheet, etc.
In record read by other practitioners?

C3: USE OF DEVELOPED INSTRUMENT

Q: Several hemiplegia assessment instruments have been published in the Journal (Physiotherapy). Have you tried any?

Probes: For own use?
For teaching?
If not, why not?

SECTION E: SMAC PRACTICABILITIES	
E1: APPLICATION	Q: Have you used SMAC? Probes: Was the method acceptable? the recorded display meaningful? Did it agree with your subjective impression of the patient's status and progress?
E2: REQUIREMENTS UNFULFILLED	Q: Were there any motor items you wish to record which are not accommodated on SMAC? Probe: Any other explanatory items you think should be recorded?
E3: ACCEPTABILITY FOR TEACHING	Q: Would you use SMAC as a clinical teaching aid to teaching assessment and as a routine method of assessment for students? Probes: Does it emphasise the salient points for students? Have you used it with a student? Result?
SECTION F: COMMENTS AND QUESTIONS	
F1: FURTHER INFORMATION	Q: Is there anything else you want to tell me or ask me?
END OF INTERVIEW	
Time taken.....	

C4: TEACHING OF ASSESSMENT	Q: From the plethora of motor information presented by a hemiplegic patient, how do you enable students to pick out the salient points and formulate aims of treatment? Probe: What are the items you direct their attention towards?
C5: RECOVERY CRITERIA	Q: How do you measure recovery and progress towards it, or that a person is ready for discharge home? Probes: Mental check list? Written list? What items on it? Normal performance? Independent performance?
C6: COMMUNICATION OF INFORMATION	Q: Which information do you communicate to other members of the care team? Probes: What is asked for? What do you think is used? What do you want to be acknowledged?
SECTION D: SMAC	
D1: SMAC PROVISIONS	Q: Does Smac contain any of the items to which you direct students' attention?
D2: SEQUENCE OF RECOVERY	Q: Does the order of Quality of Movement Items agree with your own concept of the sequence of recovery?
D3: VALIDITY	Q: Do you think that SMAC measures and records recovery from hemiplegia?
D4: CLINICAL ACCEPTABILITY	Q: Is it acceptable to you as a physiotherapy assessment? Probe: Does it provide a means of planning and monitoring physiotherapy?
D5: TEACHING AID	Q: SMAC describes an ideal model of the sequence of recovery. Is this utilisable in teaching?

SHERFIELD CITY POLYTECHNIC
DEPARTMENT OF HEALTH STUDIES

DIES RESEARCH FELLOWSHIP PROJECT
TO DEVELOP AND EVALUATE THE SHERFIELD MOTOR ASSESSMENT CHART

PHYSIOTHERAPY CLINICIANS' INTERVIEW SCHEDULE

HEALTH CARE SETTING INTERVIEW GROUP CODE.....

SIZE OF GROUP.....DATE.....

SECTION A: INTRODUCTION

INTERVIEWER: As you know, I have been interviewing nurses, social workers, doctors and occupational therapists to try to establish what physiotherapist assessment information is utilized by them. I am also talking to patients to try to identify what they understand about their physical status and progress to see if their motivation and rehabilitation can be enhanced by the way in which information is presented to them.

I am grateful for the help you have given towards developing the chart already. If you will now answer a few questions I can complete its evaluation by collating the opinions of physiotherapists with those of other team members.

I am taping the interviews so that I can listen to what you are saying now and not make any errors in trying to recall the discussion later. Let me reassure you that everything you say will be kept in the strictest confidence and no one else but me will hear the tapes. In the report, comments will not be identified by hospital or individual.

SECTION B: PHYSIOTHERAPISTS' ROLES AND SKILLS

B1: ROLE EXPANSION

Q: What skills do the other members of the team you work with see you as having? What do they expect you to be able to do?

Probes: Handling and lifting skills?

As a teacher of above skills?

Problem solver, related to moving patient?

Assessment skills? Current status and ability to cope? Potential to benefit? Prediction of outcome?

B2: SKILL IDENTIFICATION

Q: Do expectations of your skills vary from team member to member?

Probes: Nurses expect handling and lifting skills?

Social workers expect prediction?

B3: SELF PERCEPTION

Q: How well do you think that physiotherapy in general and your skills in particular are recognised and utilised?

B4: PROMOTION OF PHYSIOTHERAPY

Q: Regarding enhancement of recovery and prevention of undesirable motor patterns, how well do you think patients are handled for the greater part of their day?

Probe: Do you think that physiotherapy knowledge and skills related to hemiplegia should be taught to other team members?

SECTION C: COMMUNICATION

C1: CONTEXT OF EXCHANGE OF INFORMATION

Q: Do you discuss individual patients regularly with other team members?

Probes: With whom? Where? Formally? Informally?

C2: DOCUMENTATION - PHYSIOTHERAPY

Q: Do you have a written assessment record?

Probes: Where is it kept?

Is it or summary seen by others?

Do you pass on information verbally?

What do other utilise from it? For what purpose?

C3: COMMUNICATION WITH PATIENT

Q: What do you think the patient understands about his/her status and progress?

Probes: Do they expect not to understand?

Do they want some mystique to prevail?

C4: FUNCTION OF TEAM MEETING

Q: What function does the team meeting/case conference fulfil?

Probes: How good a place is it to facilitate communication and collaboration between team members?

C5: TEAM GOALS

Q: Does the team set goals for each individual, taking assessment data from each team member?

Probe: Does it take account of the patient's goals?

C6: DOCUMENTATION - TEAM

Q: Does the team make a written record of its meetings?

Probes: A record of what? Narrative account of progress?

Team decisions? Contributions from individuals?

Does it evaluate whether or not its own goals have been achieved?

<p>D7: <u>OUT-PATIENT PROGRESS</u></p> <p>Q: What do you expect the patient's status to be at discharge with regard to the treatment they will still require?</p> <p>Probes: Is rate of progress maintained by out-patients? If not, why not? Do you see many patients re-admitted? Opinion why/nob? Does this influence your attitude towards discharge proposals?</p>
<p>SECTION E: <u>PHYSIOTHERAPY ASSESSMENT AND SMAC</u></p> <p>E1: <u>PURPOSE OF PHYSIOTHERAPY ASSESSMENT</u></p> <p>Q: What do you think is the purpose of physiotherapy assessment for hemiplegic patients?</p> <p>Probes: Planning and monitoring of treatment? Demonstration of change/progress? Extra-physiotherapeutic use?</p> <p>E2: <u>USE OF OTHER ASSESSMENT INSTRUMENTS</u></p> <p>Q: Have you tried other hemiplegia assessments besides SMAC?</p> <p>Probes: If yes, are the standardised? how do they compare with SMAC? If not, why not?</p> <p>E3: <u>SMAC PROVISIONS</u></p> <p>Q: Does SMAC contain the assessment items which you usually observe?</p> <p>Probes: What's omitted? Why do you want it/them included?</p> <p>E4: <u>VALIDITY</u></p> <p>Q: Do you think that SMAC measures and records recovery from hemiplegia?</p> <p>Probes: If not, why not?</p> <p>E5: <u>CLINICAL ACCEPTABILITY</u></p> <p>Q: Is SMAC acceptable to you as a physiotherapy assessment?</p> <p>Probes: Does it provide a means of planning and monitoring treatment? How does it compare with other methods you've used?</p> <p>E6: <u>APPLICATION</u></p> <p>Q: How many patients (approximately) have you assessed with SMAC?</p> <p>Probes: Was the procedure acceptable? the display meaningful? Did it agree with your subjective impression? Did it demonstrate the progress you thought had been achieved? Did the display aid formulation of treatment aims?</p>

<p>C7: <u>PROFESSIONAL RATIONALES</u></p> <p>Q: Do individual team members enable others to understand their treatment rationales?</p> <p>Probes: Are there any areas of potential or actual conflict?</p>
<p>SECTION D: <u>DISCHARGE PLANNING</u></p> <p>D1: <u>RECOVERY AND REHABILITATION</u></p> <p>Q: How do you define 'recovery from hemiplegia'?</p> <p>Probes: Is this your aim/are these your aims for all patients? How might they be modified? Does recovery mean the same for all team members?</p> <p>D2: <u>READINESS FOR DISCHARGE</u></p> <p>Q: Is recovery used synonymously with readiness for discharge?</p> <p>Probes: Is 'need to cope' in home environment used as a reason for limiting observation of functional activities, e.g. patient lives in flat or bungalow and ability to climb stairs is therefore disregarded?</p> <p>D3: <u>DISCHARGE CRITERIA</u></p> <p>Q: On what criteria is readiness for discharge determined?</p> <p>Probes: Spouse/daughter available to perform activities for patient or to assist? Ability to cope related to need to cope? Need to cope related to continuation/termination of in-patient care?</p> <p>D4: <u>POTENTIAL CONFLICT</u></p> <p>Q: Does your overall assessment of the patient's stage of recovery and ability to cope agree with that of other team members?</p> <p>Probes: With whose assessment does it disagree? Why do you think it disagrees? What are your criteria for concurring with proposal to discharge patient home?</p> <p>D5: <u>PLANNING DISCHARGE 'HOME'</u></p> <p>Q: Is discharge planned for each individual?</p> <p>Probes: Date set in advance and worked towards? Date set when individual's progress seems appropriate? Do you think discharges are made precipitously? Discharges to make room for other patients?</p> <p>D6: <u>DISCHARGE DECISION</u></p> <p>Q: Does any one team member have a 'final word' on discharge?</p> <p>Probes: Does person vary according to individual's needs? Is it a majority decision? Can it be swayed by an individual team member?</p>

F7: REQUIREMENTS UNFULFILLED

Q: Were there any motor items which you wished to record but are not accommodated on SMAC display?

Probes: Are there any other items, explanatory of lack of progress or achievement, which you think should be recorded?

F8: COMMUNICATION

Q: How well do you think SMAC communicates information about the patient which you think is important to other team members?

SECTION F: COMMENTS AND QUESTIONS

F1: FURTHER INFORMATION

Q: Is there anything else you want to tell me or ask me?

END OF INTERVIEW

Time taken.....

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APPENDIX IV

THE MANUAL AND THE POSTER ACCOMPANYING THE INTERIM CHART

project to develop
and evaluate

**The Sheffield
Motor Assessment
Chart**

TRIAL PACK

PROJECT TO DEVELOP AND EVALUATE
THE SHEFFIELD MOTOR ASSESSMENT CHART

MANUAL

Contents:

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1. Introduction to SMAC

The Sheffield Motor Assessment Chart, known as SMAC, is designed to do two things:

- a) To provide the physiotherapist with a clear and accurate means of collecting and recording information for the assessment of motor recovery in hemiplegia.
- b) To display the patient's status and progress so that he* and the other health care professionals will be able to see the stage he has reached at a glance.

The chart has been developed on the assumption that motor recovery from hemiplegia proceeds through definable steps. Earlier this year the preliminary version of SMAC was used by physiotherapists in treatment centres of all types in Great Britain and overseas and the charts of 63 patients were returned. They contained a vast amount of information about the sequence of restitution of normal movement patterns.

Suggestions from the physiotherapists and analysis of the chart data allowed the number of items to be reduced by half. The

*Throughout the text, 'he' refers to the patient and 'she' to the physiotherapist.

remaining 'key items' were scaled. That is, according to the recordings made by the physiotherapists at succeeding assessments, the items were arranged in rank order of presence. The key items readily divided into two groups: Physiotherapy Items (numbered) and Gross Motor Items (described in words of general interest).

Motor recovery in the arm was found to have a highly variable relationship with the key items and, apart from a single item (11), the affected arm is scored separately.

The new display has been developed with the help of a graphic designer working in the Polytechnic who was already aware of the need for such an assessment device as his wife took part in the field test of the preliminary chart.

By separate, though integrated, display of the Physiotherapy and Gross Motor Items it is hoped that physiotherapy assessment will be made more meaningful to other carers and that this will enable greater carry-over from physiotherapy sessions into the rest of the patient's day. At this stage of the evaluation it will be most important to find out if patients, their relatives, doctors, nurses, occupational therapists and others can read the chart easily and correctly and make use of the information on it in their own care and treatment. To allow this, the chart has been designed to fasten to the bed-end clipboard. Posters to explain its use and meaning are included in the Trial Pack for display in the Physiotherapy Department, Stroke Unit or ward.

- 2 Assessment date/code panel: The time interval between assessments is easily seen and the rate of progress is apparent.
- 3 Gross functional items are divided into those which the patient can perform with assistance (3a) and those which he/she can perform independently, with or without an aid (3b)
- 4 Column in which arm assessment key letters can be related to general assessment.
- 5 Physiotherapy items: These are spaced irregularly because of their relationships with the gross functional items (3) in the sequence of recovery.
- 6 Physiotherapy items crib: The method of testing each item is given on pages 9 - 18.
- 7 Physiotherapy arm assessment crib; These items are given in detail on pages 18 - 21.

3. The Display

Assessment recordings will follow a zig-zag pattern up the display as patients are able to perform some gross functional movements independently while still needing assistance to perform others.

The filling-in of the Physiotherapy Items and the Gross Functional Items should keep pace because both sets of items belong to the same recovery scale. However, individual patients may not follow the sequence exactly; they may show a 'scatter'. That is, they may be able to perform physiotherapy and/or gross functional items which are scaled above some lower items which they cannot perform. The effect of this scatter will be apparent on the display and will aid treatment planning.

Example:

The patient may be able to walk alone using an aid but requires assistance to stand up from sitting. This limits the functional use of being able to walk independently.

Review of the central column may show all items up to 15 filled in, except 8 which involves leaning forwards in sitting. This clearly shows that the patient is unable to get his weight over his feet in sitting and therefore he cannot reach a suitable starting position in preparation for standing up.

4. Procedure for Use

Make your first assessment on the first day that the patient is seen after onset of the hemiplegia. Thereafter, make assessments as often as you consider appropriate to the progress of the individual. Make repeat assessments for the same patient under the same or similar conditions. Do not assess the patient during or at the end of a treatment session.

Testing

**All numerically and alphabetically listed items are to be performed independently by the patient. Gross functional items may be performed with assistance, using an aid or totally independent of assistance. The categories of assistance are differentiated on the display.

**Instruct the patient verbally for each performance. If necessary, repeat the instructions and/or give a demonstration. Except for those items which are performed with assistance, do not facilitate any performance by handling a part of the body.

**If sensation is impaired you may position a mirror so that the patient can see his movements.

**Score an item as positive by marking the appropriate box when you have observed the patient perform the particular movement.

Recording

**Record the results of each assessment in a different colour so that change between assessments can be clearly seen and the patient's status at any given time is apparent to other readers. Record the colour in the date/code panel.

**Score each numerically listed physiotherapy item as positive by colouring in the appropriate box.

**Record the performance of gross functional items by drawing a diagonal line through the box in the appropriate colour.

**Score each of the alphabetically listed

affected arm items by colouring in the box alongside the key letter. Enter the key letter in the right-hand column of the display level with a gross functional item which was performed at the same assessment.

Display the chart at the bed-end or wherever it can be consulted by others involved in the patient's recovery.

5. The Physiotherapy Items

All of these items are basic movements which will be easily recalled when reading the cribs. They are described in detail to avoid ambiguity and misinterpretation in order to standardise the use of SMAC. This will also facilitate the transfer of patients between physiotherapists and aid communication between physiotherapists and others. The items are not intended to describe treatment in any way but only to standardise the assessment movements required of the patient whatever treatment method is used.

Every item is monotonic: it has a yes or no outcome. Therefore, SMAC gives a qualitative assessment of the patient on the basis of whether or not he has been observed to perform the movement in a normal manner, and not using total spastic synergies, for example.

The starting position for each performance is described in fundamental and derived positions. For SMAC users who are not familiar with these terms a glossary is appended.

The required movement is expressed as instructions to the patient with remarks when necessary.

Disqualifiers are abnormal components which, if observed, mean that the item cannot be scored positively on the display. Therefore they also indicate where treatment might need to be aimed. The list of disqualifiers is not exhaustive and observation of the individual patient may reveal others which also require treatment.

Abilities which the item demonstrates are given and the gross functional item which it precedes is named.

a. The Numerically Listed Items

All of these items must be performed independently by the patient although he may need assistance to achieve the fundamental starting position. For instance, he may need assistance to stand up from sitting to attempt turning to either side in standing (12,13)

1. Turn to AFFECTED side: lying
2. Turn to UNAFFECTED side: lying

Starting position: Lying; hands on chest, fingers interlocked, heels of hands together.

Instruction: "Stretch your arms up towards the ceiling and straighten your elbows. Keeping your hips still, turn to your AFFECTED/UNAFFECTED side as far as you can go. Turn back to face the front again."

Remark: It is not necessary for the patient to move his affected arm voluntarily but hypertonus may interfere by preventing passive movement.

Disqualifiers: i) Affected elbow cannot be extended into inner range. ii) Affected shoulder retracted. iii) No segmental rotation between shoulders and hips.

Demonstrates: Ability (a) to rotate in body axis, shoulders against hips, and (b) to cross midline of body with arms.

Precedes: Rolling to particular side unaided.

- 3. Turn to UNAFFECTED side: sitting
- 4. Turn to AFFECTED side: sitting

Starting position: Sitting, on standard (armless) chair; hands on thighs, fingers interlocked, heels of hands together.

Instruction: "Straighten your arms out in front of your body at shoulder level. Turn to your AFFECTED/UNAFFECTED side keeping your UNAFFECTED/AFFECTED elbow straight. Turn back to face the front again."

Remark: As above.

Disqualifiers: i), ii), iii) as above. iv) Trunk leaning back during rotation. Observe distance between thoracic spine and chair back.

Demonstrates: Abilities (a) and (b) as above. (c) Ability to transfer weight onto the buttock of the side to which the body is turning.

Precedes: Dynamic sitting balance.

5. Flex and extend AFFECTED leg

Starting position: Lying.

Instruction: "Keep your UNAFFECTED leg straight. Bend your AFFECTED leg and draw your heel up the support surface until it is level with your other knee. With your heel on the support, straighten your leg again slowly."

Disqualifiers: i) Foot cannot be kept on support. ii) Abduction and lateral rotation of hip joint and inversion of forefoot accompanying flexion. (Patient uses total flexion pattern) iii) Thrust into extension with foot plantarflexed.

Remark: Observe and note whether or not flexion of the lower limb causes associated flexion of affected upper limb.

Demonstrates: That movement of the lower limb is not in total flexion/extension patterns.

Precedes: Rolling to UNAFFECTED side.
Moving from lying to sitting on side of bed over AFFECTED side.

6. Bridge

Starting position: Lying; head on small pillow, or, ask patient to tuck in chin.

Instruction: "Bend both of your legs. Keep your knees together and your feet flat on the support. Lift up your hips to make a straight line between your knees and your shoulders... And lower your hips again."

Disqualifiers: i) Affected hip retracted.
ii) Head pressed back into support to get hip extension. iii) Affected knee extends as hip extends.

Demonstrates: Ability to extend hips with knees bent without extending spine.

Precedes: Standing and Walking, normal patterns.

7. Weight buttock to buttock: sitting

Starting position: Sitting, standard chair; arm reach, fingers interlocked.

Instruction: "Put all your weight through your UNAFFECTED buttock so that your AFFECTED buttock comes off the seat. Now move your weight onto your AFFECTED buttock with your UNAFFECTED buttock off the seat. And sit squarely again."

Disqualifier: Trunk side flexion and shoulder retraction on affected side as weight is transferred to that side. (Patient will start to fall to that side.)

Demonstrates: Ability (a) to transfer weight onto and off affected buttock, and (b) to lengthen affected side, when weightbearing on that side.

Precedes: Dynamic Sitting Balance

8. Weight antero-posteriorly: sitting

Starting position: Sitting, standard chair; arm reach, fingers interlocked.

Instruction: "Look at your hands. Keeping your knees together reach down towards your feet. Do not touch your thighs with your

arms. Sit up again. Lean backwards to touch the chair back. Sit upright again."

Disqualifiers: i) Not leaning far enough forwards to get weight over feet. ii) Leaning on forearms on thighs. iii) Not bending head to look at hands and keeping atlanto-occipital and cervical spine joints extended.

Demonstrates: Ability to transfer weight forwards and backwards.

Precedes: Dynamic sitting balance.

Ability to shuffle on seat (wiggle) to get to suitable starting position for standing up.

Standing up from sitting without assistance.

9. AFFECTED leg over bedside, return.

Starting position: Lying, at edge of plinth or bed; hands on chest, fingers interlocked.

Remark: Place a foot support at the bedside high enough to permit 90° of knee flexion with foot plantigrade.

Instruction: "Bend your affected leg so that your foot is level with your other knee. Put your leg over the side of the bed to rest your foot on the support. Slide your heel backwards, keeping your foot flat on the support. Straighten your leg and put it back onto the plinth/bed."

Disqualifiers: i) Lateral rotation with hip abduction. ii) Total extension pattern used to return leg to bed.

Demonstrates: Break up of total flexion/extension patterns.

10,1.

Disqualifier: Trunk leaning backwards.

Demonstrates: (a) Ability to cross midline with leg. (b) Hip and knee flexion with outward rotation and adduction at hip joint.

Precedes: Lying to sitting on side of bed and sitting to lying over AFFECTED side.
Sitting to Standing unaided.
Walking.

10. Cross AFFECTED leg over unaffected.

Starting position: Sitting, standard chair; arm reach, fingers interlocked.

Instruction: "Cross your legs, crossing your AFFECTED leg over your UNAFFECTED leg."

Disqualifier: Trunk leaning backwards.

Demonstrates: (a) Ability to cross midline of body with leg. (b) Hip and knee flexion with outward rotation and adduction at hip joint.

Precedes: Standing and Walking, normal gait.

11. Weight through AFFECTED forearm

Starting position: High sitting, on plinth or bed side; hands resting in lap.

Remark: Place your hand at arms reach at varying points to ensure that weight is taken through AFFECTED shoulder joint in different parts of the range.

Instruction: "With your elbow bent, lift your AFFECTED arm out to the side so that your elbow is level with your shoulder. Lean over

to your AFFECTED side and take your weight through your elbow and forearm. Reach with your UNAFFECTED hand to touch my hand. Sit up again."

Disqualifiers: i) Arm cannot be abducted into inner range. ii) Shoulder girdle retraction. iii) Weight bearing static.

Demonstrates: Control of weightbearing through shoulder joint with movement.

Precedes: Lying to sitting on bedside and sitting to lying over AFFECTED side.

12. Turn to UNAFFECTED side: standing
13. Turn to AFFECTED side: standing

Starting position: Standing, hip joint in neutral abduction/adduction, feet about six inches apart according to individual; hands clasped together in front of body, fingers interlocked, heels of hands together.

Instruction: "Straighten your arms out in front of your body at shoulder level. Turn to the UNAFFECTED/AFFECTED side keeping your AFFECTED/UNAFFECTED elbow straight. Turn to the front again."

Remark: It is not necessary for the patient to move his affected arm voluntarily but hypertonus may interfere by preventing passive movement.

Disqualifiers: i) Retraction of AFFECTED hip when turning to that side. ii) No segmental rotation, AFFECTED hip rotating with shoulders turning to UNAFFECTED side.

Demonstrates: Ability (a) to rotate and to cross midline (as 1,2,3,4), and (b) to transfer weight onto leg of side to which he is turning.

Precedes: Transferring independently chair to chair, seat to seat.
Walking, normal gait.

14. Tap UNAFFECTED foot.

Starting position: Close standing.

Instruction: "Lift up your UNAFFECTED foot. Tap the toes lightly on the ground."

Disqualifiers: i) Tapping slow enough to allow weight transfer onto UNAFFECTED foot. ii) Retraction of AFFECTED hip. iii) Hyperextension and locking of AFFECTED knee.

Demonstrates: Weight-bearing through AFFECTED leg.

Precedes: Walking, normal gait.
Climbing stairs, UNAFFECTED leg first.

15. Step with UNAFFECTED leg

Starting position: Standing

Instruction: "Make a step forwards with your UNAFFECTED leg. Take your weight on it."

Disqualifiers: As 14, ii) and iii).

Demonstrates: Dynamic weightbearing through AFFECTED leg.

Precedes: Walking, normal gait.
Climbing stairs, UNAFFECTED leg first.

16. AFFECTED knee release

Starting position: Half walk standing, UNAFFECTED leg forwards.

Instruction: "Take your weight on your UNAFFECTED leg. Keeping the toes of your AFFECTED leg on the ground, straighten the knee and let it bend again."

Remark: As weight is taken on the UNAFFECTED leg the AFFECTED knee should bend slightly.

Disqualifier: Retraction of pelvis on AFFECTED side.

Demonstrates: Control of isolated knee movement

Precedes: Walking, normal gait.

17. Step forward onto AFFECTED leg

Starting position: Half walk standing, UNAFFECTED leg forwards.

Instruction: "Step forwards with your AFFECTED leg. Take your weight on it and step through with your UNAFFECTED leg."

Disqualifiers: i) Hip hitching to step forwards with AFFECTED leg. ii) Stepping onto ball of foot with heel down last. iii) Hyperextension of AFFECTED knee. iv) Retraction of pelvis on AFFECTED side.

Demonstrates: (a) Swing phase of walking. (b) Ability to transfer weight onto and over AFFECTED leg.

Precedes: Walking, normal gait
Climbing stairs, AFFECTED leg
first.

18. Step up onto AFFECTED leg

Starting position: Standing, facing steps.

Instruction: "Put your AFFECTED foot up on the step. Step up onto it. Put your UNAFFECTED foot on the step above."

Disqualifier: Excessive hip flexion to compensate for lack of dorsiflexion to place AFFECTED foot on step.

Precedes: Climbing stairs reciprocally.

19. Step down onto UNAFFECTED leg

Starting position: Standing, facing step down.

Instruction: "Step down onto your UNAFFECTED leg."

Disqualifier: Swiftly executed drop onto UNAFFECTED foot without AFFECTED hip and knee control.

Demonstrates: Fine control of AFFECTED hip and knee.

Precedes: Descending stairs reciprocally.

b. The Alphabetically Listed Affected Arm Items

Functional Movements which these items precede will be added later in consultation

with Occupational Therapists.

'
'
C

A. Placing in Elevation

Starting position: Lying. Place the patient's arm in elevation with external rotation and elbow extension: release it.

Disqualifiers: i) Resistance to passive elevation of the arm. ii) When the arm is released, internal rotation and pronation. Some flexion in the outer range is permissible.

Demonstrates: Response to being moved.

B. Touch top of head

Starting position: Lying; arm stretch.

Instruction: "Bend your elbow and place the palm of your hand on the top of your head. Straighten your arm again."

Disqualifiers: i) Retraction of shoulder girdle. ii) Internal rotation of arm and pronation of forearm. iii) Elbow not extended into inner range.

Demonstrates: Isolation of elbow movement from total pattern.

C. Lower and raise

Starting position: Lying; arm stretch.

Instruction: "Keeping your palm facing inwards, put your arm down by your side and lift it back up again."

Disqualifiers: As B, i) and ii). iii) Arm cannot be elevated beyond shoulder level.

Demonstrates: Arm can be lowered towards spastic pattern and raised again.

D. Supination/pronation

Starting position: Sitting; forearm support.

Instruction: "Turn your forearm so that the palm of your hand faces upwards. Turn it palm downwards onto the table."

Disqualifiers: i) Side flexion of trunk on AFFECTED side accompanying supination. ii) Internal rotation of the arm accompanying pronation.

Demonstrates: Isolated supination and pronation

E. Hand to shoulder

Starting position: Sitting; hand resting on thigh.

Instruction: "Bend your elbow and place the palm of your hand on the opposite shoulder."

Disqualifiers: i) Dorsum of hand touches shoulder. ii) Protraction of UNAFFECTED shoulder to reach AFFECTED hand. iii) AFFECTED side flexion to replace hand on thigh.

Demonstrates: (a) Break up of patterns. (b) Crossing midline of body with arm.

F. Palm on table

Starting position: Sitting; hand resting on thigh.

Instruction: "Stretch out your arm and place the palm of your hand flat on the table. Replace your hand on your thigh."

Disqualifiers: i) Retraction of shoulder girdle. ii) Trunk rotation forwards of AFFECTED side to put hand on table. iii) Arm does not extend into inner range.

Demonstrates: Control of arm movements.

G. Grasp/release

Starting position: Sitting; forearm support. Object such as bean bag or cone, but not ball, placed on table at arms reach.

Instruction: "Reach out and pick up the (object). Touch it to your breast bone. Put it back on the table again in the same place and let go of it."

Disqualifiers: i) Fingers not extended before grasp. ii) Grasping with forearm in mid-prone. iii) Thumb flexed across palm. iv) Object brought towards body by trunk rotation and shoulder girdle retraction. v) Object not released onto table.

Demonstrates: Ability to reach, grasp and release.

6. Gross Functional Items

a) With Assistance

To inform whoever might be assisting the patient at any time, when recording that he can perform a particular movement with assistance you may write in the box where a and how assistance is given.

Example: ROLLING -
'To UNAFFECTED side, lift
AFFECTED leg across and push
hip forwards gently.'

This assumes that the patient
can turn his head and lift his
arm across his body with his
UNAFFECTED hand.

Although the patient may be practising movements to the affected side during physiotherapy sessions, such as lying to sitting and transferring, it is assumed that anyone other than a physiotherapist who assists him at other times will be advised to help him to move towards his unaffected side because it is safer.

b) Independently

Rolling supine to side lying to supine: The majority of patients will be able to roll onto their affected side first. The patient should not be allowed to dig in the heel of his unaffected leg and thrust himself over in one piece but rotation within the body ~~axis~~ ^{OXIS} must be apparent.

Sitting: This box should be scored off when the patient is secure in sitting and has dynamic sitting balance. This security will open up a new range of activities to be pursued by the occupational therapist.

Lying to/from sitting: The patient is able

to get from lying to sitting on the side of the bed, ready for getting up in a morning, and get back into bed at night over either or both sides.

Sitting to standing up to sitting: With aid in this respect refers to use of chair arms or leaning forwards onto a table or frame. With or without an aid, weight should be taken through both feet and, preferably, the affected foot should be slightly further back than the unaffected foot.

Chair to chair: This item indicates the patient's ability to transfer from one seat to another.

Walking: The 'walking with aid' box should be used to show that the patient is safe walking alone. The type of walking aid may be written in the box. If the patient can walk alone with an aid but needs an attendant because his gait is unsafe 'Uses (named aid). Needs supervision.' should be written into the 'walks with assistant box'.

Stairs: The 'with aid' box indicates that the patient can negotiate stairs with a rail or a step using a walking aid. The 'unaided' box shows that if he can walk without an aid he can also negotiate a kerb or step without any support.

APPENDIX

Fundamental and Derived Starting Positions

1. Lying: Supine, eyes looking upwards, arms by sides, legs neutral.

Although the patient may be unable to maintain neutral position of the affected leg this does not disqualify him from attempting trunk rotation.

2. Sitting: Arms and trunk unsupported; thighs fully supported; 90° flexion at hips and knees; femora parallel and knees slightly apart; feet plantigrade on support; heels vertically below knees.

2a High Sitting: As sitting but feet unsupported.

3. Standing: Ears level, eyes looking forwards; arms hanging loosely at sides, palms facing inwards; hips extended; heels slightly apart, medial borders of feet parallel.

This is the natural functional position of the foot used as a lever to propel the body forwards.

3a Close Standing: Inward rotation of hips; medial borders of feet touching.

This position is a progression on Standing as balance is more precarious.

3b Half Walk Standing: One foot placed forwards in Standing so that the heels are one foot length apart.

4. Arm Reach: Shoulders flexed, elbows extended, arms parallel and horizontal.

5. Arm Stretch: Arm fully elevated in outward rotation.

6. Forearm Support: Elbows flexed and tucked in to sides; forearms resting on table, pronated.

RECOVERY OF MOBILITY IN HEMIPLEGIA - WHAT *The S*

NAME _____

DATE OF BIRTH _____

SIDE OF HEMIPLEGIA _____

DATE OF ONSET _____

The Sheffield Motor Assessment Chart (SMAC) is being used to assess hemiplegic patients by physiotherapists who are taking part in the project to develop a concise means of collecting and recording information about each individual patient's progress.

SMAC is designed to allow the physiotherapist to pass on information about the patient's mobility that she finds in her assessments to everyone involved in the patient's recovery, including the patients themselves and their relatives.

Written on the chart are activities which the patient may need help to perform or he may be able to perform alone. As the patient recovers the appropriate boxes will be scored through by the physiotherapist. So that progress can be seen at a glance, assessments made on different dates will be recorded in different colours.

At an time you need to know how the patient performs any activity, such as transferring from wheelchair to lavatory (chair to chair), look it up in both the left and the right hand columns. If the activity box has been scored through only in the left hand column the patient needs the assistance of a person. If the appropriate box in the right hand column has been scored through the patient can manage alone. Specific physiotherapy information is recorded in the central column.

► The date of each assessment and its colour code is recorded in this panel.

It will be most important during this stage of the project to find out if everyone finds the chart easy to understand and to know how useful they find the information. You may be asked to answer some questions about it later. In the meantime, if you have any comments to make please give them to the physiotherapist or send them to:

Anne Parry, The SMAC Project,
Department of Health Studies,
Sheffield City Polytechnic,
Collegiate Crescent, Sheffield S10 2BP

► The patient needs assistance of A PERSON for activities scored in

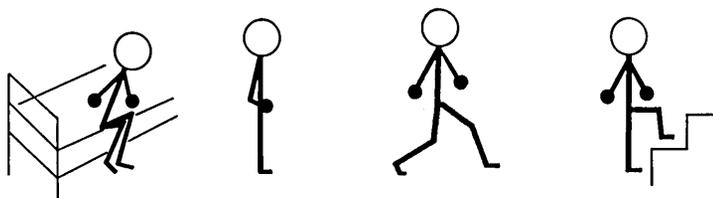
Date	Code	With Assistance
		Walking
		Chair ↔ Chair (or bed, wheelchair,
		Sitting ↔ Standing (on edge of bed or on chair)
		Lying ↔ Sitting (on edge of bed)
		Rolling (from side to side in bed)
		4
		3
		2
		1

► In this column the physiotherapist records movements which contribute to the patient's recovery. All movements which the patient performs at one assessment are recorded in one colour.

APPENDIX V

THE MANUAL ACCOMPANYING THE FINAL CHART

The Sheffield Motor Assessment Chart



Handbook of
THE SHEFFIELD MOTOR ASSESSMENT CHART
for the physiotherapy assessment
of hemiplegic patients

Anne Parry
November, 1980

Copies of the Sheffield Motor Assessment Chart and Handbook
are available from:
The Head of Department (SMAC), Department of Health Studies,
Sheffield City Polytechnic, Collegiate Crescent, Sheffield S10 2BP.

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INTRODUCTION

The Sheffield Motor Assessment Chart, known by the acronym SMAC, is designed to provide a developing profile, or portrait, of the patient recovering from hemiplegia. The display shows the patient's motor status at any given time and, when he or she has been assessed more than once, the progress towards recovery of normal movement and functional abilities which has been made between assessments.

SMAC is a performance test. That is, it is a systematic procedure for observing a person's motor performance and describing it with the aid of the display categories: Quality of Movement, Functional Ability, Activity Capability and Upper Limb Assessment.

These categories demonstrate different inter-related strands of recovery from hemiplegia. Progress along one chain is partially dependent upon progress along other chains. Motor recovery is not just a link by link progress along each chain with each movement pattern or skill independent of all others. The patient may progress along one strand but reach an assessment he or she cannot "pass" until supporting patterns and skills that are links in other chains have been achieved.

The strands of recovery, or categories of assessment items, are based on the Impairment-Disability-Handicap model:

Quality of Movement items describe diminishing Impairment or resolution of the disturbance of normal movement;

Functional Ability items describe decreasing functional limitation, a contributor to Disability;

Activity Capability items describe decreasing activity restriction, the second contributor to Disability.

Upper Limb assessment items combine Quality of Movement and Functional Ability assessment.

Handicap, the disadvantage accruing from Disability and Impairment, is not assessed and recorded by SMAC. It incorporates social and psychological experiences of Disability in a personal context and is of such a precise individual nature involving self-perception which is beyond the scope of a motor assessment chart.

SMAC seeks to describe two aspects of motor performance:

the patient's *ability*: it investigates what he or she can do in a controlled environment, the test situation, and the quality of the performance;

the patient's *typical performance*: it investigates what he or she actually does in a broad class of situations, the non-test situation.

By assessing performance in the test situation and the non-test situation, SMAC acknowledges that there is often a discrepancy between what it is adjudged a patient can do and what he or she actually does in his or her living environment.

The further up the Quality of Movement and Functional Ability scales of items performed in the test situation the patient progresses, the more desirable it is as evidence of recovery. On the

Activity Capability scale, or typical performance scale, of items performed in the non-test situation there is nothing "better" about being able to walk to the lavatory than being able to walk from the bedroom or ward to the dayroom. However, there is an hierarchical element to the Activity Capability scale because the nature of recovery from hemiplegia prevents "ability" and "typical performance" from separating neatly.

It is not possible to incorporate all the qualities that individual physiotherapists consider desirable in one assessment device. A choice of features had to be made, although a design feature that improves the assessment in one respect might sacrifice another quality. For example, one chosen quality for SMAC is that it should be neither time-consuming for the physiotherapist to administer and make recordings nor fatiguing for the patient to undergo. Consequently, precise and detailed measures of, for example, spasticity and its effects have been excluded. No one assessment can possess all the desirable attributes required by every physiotherapist and different assessments may have different virtues to those of SMAC.

The attributes of SMAC are directly related to clinical practice. Throughout its development all decisions have been grounded in the requirements and opinions of the physiotherapists who participated in the Field Tests of earlier versions.

THE CHART CONTENTS

- 1 Patient Data: This information has been kept to the minimum consistent with adequate record keeping. Retrieval from a filing system is facilitated by the patient's name appearing at the top right hand corner of the sheet.

- 2 Quality of Movement items are numerically ordered in the 'ideal model' of the sequence of recovery after hemiplegia. They are items of particular importance to the physiotherapist for the planning and monitoring of treatment. They are described in full later in the handbook and summarised on the pocket crib card.

- 3 Functional Ability items are also presented as an ideal model of the sequence of recovery. Although the detail of their testing is of physiotherapeutic importance, they are represented by readily understood symbols so that the result of the assessment is available to other carers.

- 4 Activity Capability items are intended to convey information to other carers about the patient's activities in his or her everyday living environment.

- 5 Upper Limb assessment items are also represented by symbols which are explained in the handbook with summaries on the pocket crib card. These items are also ordered in an ideal recovery sequence but upper limb recovery is much more variable than trunk and lower limb recovery.

- 6 The Early Indoor Goal panel is for the recording of an objective set in collaboration with the patient.

- 7 The Assessment Record Graph is based on the notion that assessments are made when change is seen.
It shows:
 - a) The length of time the patient has been receiving treatment;
 - b) The length of time between assessments, which is related to the rate of recovery;
 - c) If the plotted points are connected, evidence of rapid change and "plateauing".

QUALITIES OF SMAC

The salient feature of each SMAC item is the detailed description of the starting position and the performance the patient must make. Structuring of the items in this way controls the performance so that all patients are judged on the same basis. The prime example of this in every day clinical use is the Medical Research Council, or Oxford scale, of muscle grading. At each grade the starting position and the performance is clearly defined. For most of the SMAC items there is only one question to be answered: *Is the performance acceptable as a normal movement?* The answer can only be "yes" or "No" with no grey areas of subjective judgment between. This elimination of subjectivity is described by a trio of qualities which SMAC possesses.

The first is OBJECTIVITY. The more objective an assessment, the more likely it is that two or more physiotherapists observing the same patient will agree about the performance and the less open it will be to subjective interpretation. Every assessor will pay attention to the same aspects of the performance and score it by the same rules and record their decisions in the same way to eliminate errors of recall.

STANDARDISATION, or the precise description of each item and the assessment procedure, ensures that the same assessment can be followed in different places and at different times.

Standardisation and objectivity are of recognised importance in research. In order to combine and compare data collected by many people over a long period of time, as in a Field Test, the same method must be used on every occasion. The current version of SMAC is the outcome from analysis of data collected by physiotherapists in the United Kingdom and overseas who all used the same method of assessment and recording.

These qualities are also clinically important within one treatment centre: they ensure consistency over time, facilitate continuity of treatment if the patient is transferred to the care of another physiotherapist, especially if the transfer is temporary, and allow assessments of the same patient by the two physiotherapists to be compared even when made several weeks apart.

It is not enough to say that an assessment is standardised and objective, it must also be dependable. This third quality in the trio, RELIABILITY, is tested to show that assessment performances are interpreted in the same way by different physiotherapists. SMAC reliability was tested by showing videotapes of four patients to 36 physiotherapists who made simultaneous recordings on the interim chart. Their agreements, and disagreements, about the performances of each patient were analysed and showed that the SMAC items are used reliably. For most items, the chance of disagreement is 100 :1.

Standardisation, objectivity and reliability are interdependent: standardisation and objectivity are confirmed by testing reliability and reliability is enhanced by standardisation and objectivity. The reliability test also showed where standardisation should be improved, which became one plank of the revision.

Such structuring suggests a rigid and inflexible assessment procedure: but this is wrong. The observational and interpretive skills of the physiotherapist are recognised and utilized by SMAC and the exercise of clinical judgment is an important feature of the procedure.

The quality which most affects the value of any test is its VALIDITY. In this case, we need to know how valid SMAC is for making decisions about future treatment and how well it monitors progress as a basis for treatment planning.

Firstly, the content, or the individual items, is a valid representation of the process of recovery. These items were selected from a longer series used in the Field Test of an earlier version. Analysis of first assessments and re-assessments of 60+ patients showed that the movements and abilities were achieved in a particular sequence. This sequence was used on the interim chart and tested against the data from assessments and re-assessments of a further 130+ patients. It is presented as an "ideal model" of the sequence of recovery. That is, it is the sequence demonstrated by a large group of hemiplegic patients considered as a group but some individuals within the group may not conform to it exactly by always "passing" a lower placed item on the Quality of Movement, Functional Ability and Upper Limb scales before a higher placed item.

A second type of validity concerns whether or not SMAC is useful for predicting performance. This links physiotherapy treatment and assessment with other decisions about the patient's care. SMAC's predictive validity for physiotherapy treatment planning is confirmed:

- a) An assessment does not have to start at the first item on the scale. Any appropriate item may be chosen. If the patient can "pass" that item and the two items immediately preceding it, all preceding items can be presumed to be "passes" without the need to assess them. From knowledge of a few items, the chart predicts the patient's performance of other items.
- b) This predictive function is also available for determining when an assessment should be stopped. If three successive items on the scale are "failed" then it can be assumed that all succeeding items will be failed too.

When a larger number of patients have been assessed with SMAC and more data has been collected it may be possible to reduce the number of consecutive items to be passed or failed before the prediction can be made.

The third aspect of validity is that the order of SMAC items presented on the display agrees with the concepts of recovery of over 70 physiotherapists who have been surveyed and it is said by them to be a valid physiotherapy assessment suitable for routine clinical use. This is the most important quality of all as SMAC's success depends on its acceptability to physiotherapists.

PROCEDURE FOR USE

Although the assessment procedure is standardised, it is not so rigidly or rigorously structured that you are restricted to a stilted, formal style of assessing. You should encourage and use the rapport built up with the patient in treatment sessions: the standardisation should ensure that rapport and familiarity do not interfere with reliability as long as you *record only what you observe during the assessment* not what you know the patient can do in treatment.

Neither is the skilled, almost intuitive, observation of the physiotherapist ignored. The 'disqualifying observations' of the assessment describe such patterns as would lead an experienced physiotherapist to fail the performance. It is not possible to describe all the patterns which might be observed but the disqualifiers will guide the less experienced physiotherapist in her interpretations of performances.

The assessor is regarded as a sensitive interpreter of performances and assessment findings and the formal objective procedure is combined with clinical judgment.

Timing of Assessments

The first assessment should be made on the first day that the patient is seen after onset of hemiplegia. Re-assessments should be made as often as you consider appropriate to the progress of the individual, dependent upon when you see change.

Assessment Equipment

SMAC is designed for use with standard equipment:

- a) Domestic "sit-up-and-bed" chairs and Westminster plinths (high mats) have seats at approximately the same height. It is assumed that adjustable height (King's Fund) beds are standard in most hospitals. These three items are interchangeable for "transferring" and "standing up".
- b) Physiotherapy plinths and adjustable beds appropriately raised, or non-adjustable beds, are interchangeable for "sitting balance" tests.
- c) If the patient requires support to walk he or she should use his or her usual walking aid.

Conditions of Assessment

1. Do not make an assessment at the end of a treatment session or in combination with one. In either circumstance the results may not be a true representation of the patient's status.
2. The *test situation* in which Quality of Movement, Functional Ability and the Upper Limb are assessed is any controlled environment from which hazards and hinderances have been excluded.
3. The *non-test situation* in which Activity Capability items are assessed is the 'living environment' of the patient, or a simulation of it.

The in-patient can be assessed for example, walking from his or her bed to the day room and to the lavatory. These are potentially hazardous journeys requiring negotiation of doorways and other obstacles. Similar journeys can be arranged for the out-patient but greater clinical judgment will be required regarding the security of the performance.

Instructions

The instruction of the patient is an important responsibility:

1. Place him or her so that he or she can hear your instructions and see any demonstrations clearly.
2. Create an atmosphere in which he or she is not inhibited about asking questions; but be careful that you do not supplement the Assessment Description to the extent that you create a new test!
3. Instruct the patient verbally for the performance of each item. If necessary, repeat the instructions and/or give a demonstration.
4. You may break down the instruction into the simple units of the Assessment Description and instruct the patient throughout the performance.
5. Quality of Movement and Upper Limb items are performed *independent of all help and aids*.
Functional Ability items are performed *independent of the help of a person* with or without an aid, as shown by the symbol.
Activity Capability items may be performed at one of three levels: with the help of a person; alone but with hand support on aid or furniture; totally independently.
6. If the patient's sensation is impaired you may position a mirror so that he or she can see his or her performance.
7. You must not facilitate the performance of Quality of Movement, Functional Ability and Upper Limb items by handling for any reason (e.g. receptive aphasia, proprioceptive impairment).

Recording the Assessment

1. Enter the date physiotherapy began under the Assessment Record Graph.
2. Strike off the day of the week, it will then be easier to count the weeks of treatment at each re-assessment.
3. At each assessment, enter the date beside the record graph.
4. Calculate the number of weeks since treatment was inaugurated and plot the point on the graph.
5. Score a "pass" performance by writing the assessment number in the appropriate box on the display.

In this way, it will be possible to see what was achieved at each assessment, what progress was made between assessments and, by referring to the Record Graph, the time span.

Remarks on Use of the Items

The order in which the items are displayed on the chart is not the order in which they must be performed for the assessment to be valid and reliable. nor the order in which they are described on the following pages.

On the display, the items are presented in an ordinal scale of the "ideal model" of the sequence of recovery for the purposes of recording progress. In order that the patient is not fatigued by constant changes of posture, and to make the assessment more efficient, it is better to take account of starting positions rather than scale order on the display when ordering the assessment itself.

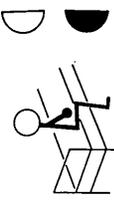
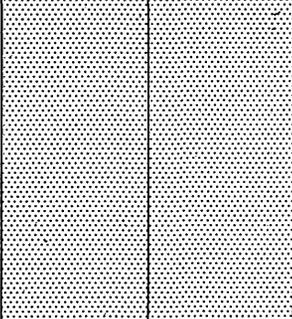
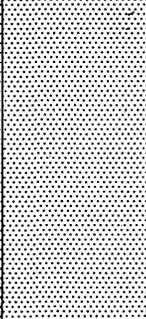
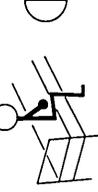
To this end, the assessment items are described by their starting positions, but the order in which they are performed is left to your discretion. You may wish to "mix and match" items from the different scales.

Note the following:

1. The base line is the same for the Quality of Movement, Functional Ability and Upper Limb scales. Quality of Movement item 1 and the first Upper Limb item can be assessed simultaneously. The first Functional Ability item is a progression from Quality of Movement item 1.
2. They are presented in the handbook with a fly sheet devoted to each starting position and "trunk rotation" is the first Quality of Movement assessment in each position. This arrangement is based on the bio-mechanical principle that postural control becomes more complex as the base on which the body rests becomes smaller and the centre of gravity is raised. Trunk rotation is the basic measurement in each position.
3. Spasticity and its effect on movement is not measured separately on SMAC, no more than hypotonia. Normalisation of muscle tone is tested within the succession of Quality of Movement items.
4. Just as the 'Early Indoor Goal' should be set in consideration of the patient's environment, with varying distances allowed for in the Activity Capability assessment, the Upper Limb scale can be extended per the two blank boxes on the display to take in functional abilities or activities appropriate to the patient at your discretion.

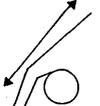
Assessment Administration

1. Start the assessment in Lying, Sitting or Standing, as appropriate to the patient.
2. For any single item, you may work from either the movement or ability you want to assess or from the display symbol.
3. Remember that for "walking" you should set the objective some 10 yards distant in collaboration with the patient.
4. Instruct the patient to perform as described and decide whether or not the performance is acceptable as normal.
5. If you are unsure about the quality of the performance, read the Disqualifying Observations before making a "pass/fail" decision.
6. After recording on the Quality of Movement, Functional Ability and Upper Limb scales, make your decision re the Activity Capability items and record it.

QUALITY OF MOVEMENT ITEMS			FUNCTIONAL ABILITY ITEMS		
MOVEMENT	TO DEMONSTRATE	SYMBOL	STARTING POSITION	ASSESSMENT DESCRIPTION	RELATED ABILITIES
Trunk rotation to AFFECTED side	Tonus of AFFECTED arm and side of trunk. Rotation in body axis, shoulders against hips. Crossing mid-line of body with arm and eyes.	1	LYING: Head on one pillow; hands clasped together on chest, fingers interlocked.	Arms forward reach; elbows straight, pelvis stationary, turns shoulders to AFFECTED side; (hands describe arc, eyes and head follow); turns to front; returns to starting position.	
to UNAFFECTED side	Protraction of AFFECTED shoulder. Lengthening of AFFECTED side of trunk. Crossing mid-line of body with arm and eyes.	2	LYING, as above.	As above, turns to UNAFFECTED side.	
AFFECTED hip and knee flexion and extension	Tonus of AFFECTED leg. Break up of total limb patterns.	6	LYING, as above at edge of plinth or bed. (Place foot support at bed-side, platform at height to permit 90° knee flexion with foot plantigrade.)	Draws AFFECTED heel up support surface until level with opposite knee; puts foot over bedside to rest on support; moves plantigrade foot backwards until toes are under knee; maintaining dorsiflexion and eversion, returns limb to starting position on bed.	
ABILITY	SYMBOL	STARTING POSITION	ASSESSMENT DESCRIPTION	JUDGMENT RE ACTIVITIES	
Rolling to AFFECTED side and back to supine		LYING	Rolls to full side lying on AFFECTED side; returns to starting position.		
Rolling to UNAFFECTED side and back to supine		LYING	Rolls to full side lying on UNAFFECTED side. (may carry AFFECTED arm over by clasping hands together as Quality 1); returns to starting position.		
Lying to sitting and sitting to lying over UNAFFECTED side★		LYING	Turns to UNAFFECTED side; supports self through UNAFFECTED arm while putting legs over side of bed and sitting up; returns to starting position.	<i>Is able to get into and out of bed safely:</i> 	
Lying to sitting and sitting to lying over AFFECTED side★		LYING	Turns towards AFFECTED side and supports self through AFFECTED arm while sitting up.		

★ These items may be performed starting in SITTING.

UPPER LIMB ITEMS

MOVEMENT	TO DEMONSTRATE	SYMBOL	STARTING POSITION	ASSESSMENT DESCRIPTION
Passive movement★	Resistance to passive movement.		LYING, as 1 above.	Arms forward reach; returns to starting position.
Placing in elevation	Control of placing and holding		LYING: AFFECTED arm supported in elevation with external rotation and elbow extension.	Ask patient to maintain the position; release the limb.
Touch top of head	Break up: isolation of elbow movement from total pattern. Control of movement, gravity counterbalanced.		LYING: AFFECTED arm stretch	Bends elbow to place palm of hand on top of head; straightens elbow again.
Arm lowering and raising	Control of movement, gravity assisted and resisted.		LYING: AFFECTED arm stretch.	Palm facing medially, elbow extended, lowers limb to rest on support at side of trunk; raises limb to starting position.

★ May be assessed with Quality items 1 or 2.

OBSERVATIONS WHICH DISQUALIFY A PERFORMANCE FROM BEING SCORED AS A "PASS".

N.B. This list is not exhaustive and you may observe other departures from normal.

GENERAL OBSERVATIONS

Item cannot be performed or controlled because of low tone. The item is not completed as described for any reason, e.g. pain in AFFECTED shoulder prevents rolling onto it; increase in extensor tone prevents sufficient flexion of AFFECTED hip to achieve sitting on bedside. The starting position is not returned to at the end of the item (where required).

MIDLINE OBSERVATIONS

No segmental rotation between shoulders and pelvis, e.g. rolls to side by digging heel into bed and thrusting body over in one block. No rotation between head and body. Cannot cross midline with eyes, i.e. cannot watch hands when turning to the side.

OBSERVATIONS OF UPPER LIMB

Holding limb or on movement: forearm pronates; arm internally rotates; elbow flexes into middle range, or cannot be extended beyond middle range; shoulder is retracted.

OBSERVATIONS OF LOWER LIMB

As limb is flexed: inversion of forefoot; heel not kept on support. As limb is lowered over bedside: lateral rotation accompanies abduction; knee flexion is not maintained as hip is extended. Foot is not plantigrade as it is drawn back on the stool. As limb is returned to the starting position, the total extension pattern, or elements of it, is used.

MOVEMENT		TO DEMONSTRATE	SYMBOL	STARTING POSITION	ASSESSMENT DESCRIPTION	QUALITY OF MOVEMENT ITEMS
Trunk rotation to UNAFFECTED side	Rotation in body axis. Crossing midline with arms. Lengthening of AFFECTED side of trunk	3		SITTING, on standard chair: knees together; hands clasped together on thighs, fingers interlocked.	Arms forward reach; elbows straight, heels of hands together, turns shoulders to UNAFFECTED side; (hands describe arc, eyes and head follow; returns to starting position.	Ability to reach suitable starting position for standing up
to AFFECTED side	Weight transfer laterally onto AFFECTED buttock	4	4	SITTING, as above.	As above, turns to AFFECTED side.	Standing balance
Trunk lowering and raising	Sitting balance Weight transfer anteroposteriorly	5	5	SITTING, on standard chair: knees together; arms reach, hands clasped, fingers interlocked.	Looking at hands, keeping knees together, reaches down towards feet (without touching thighs with arms); sits up again; leans back to touch chair back with trunk; returns to starting position.	Normal gait
Legs crossed sitting	Dynamic sitting balance Crossing mid-line with legs Break up of total limb patterns	7	7	SITTING, as 5 above.	Transfers weight onto UNAFFECTED buttock; flexes and adducts AFFECTED hip and crosses thighs; returns to starting position; repeats, crossing UNAFFECTED thigh over; returns to starting position.	Standing balance
Static sitting balance				HIGH SITTING, on side of bed or plinth; hands in lap.	Using finger tips, gently 'push' the patient forwards, backwards and to each side. Dynamic balance reactions are <u>not</u> observed.	JUDGMENT RE ACTIVITY Is safe sitting with support:
Dynamic sitting balance					"Push", as above. The patient can cope with disturbances of his/her centre of gravity by external force (push) and due to voluntary movement (QM 3,4,5)	OR, on such as bedside, needs help: Sitting balance is secure without support on variety of seats normally used:
Standing up and sitting down with support.*				SITTING, on standard chair: feet level.	Supporting self through hand(s) on furniture, walking stick or other aid, stands up; sits down again.	Is able to stand up prior to walking activities and to sit down again safely:
Standing up and sitting down without support.*					Stands up; and sits down again.	Is able to stand up prior to walking activities and to sit down again safely:
Transferring to UNAFFECTED side				SITTING, on chair with bed or plinth at UNAFFECTED side. (Place a second chair facing the patient.)	Transfers from chair to bed, then bed to second chair. (May take weight through hands.)	Is able to get into and out of bed safely:
Transferring to AFFECTED side				SITTING, on chair with bed or plinth at AFFECTED side. (Second chair facing)	Transfers from chair to bed, then bed to second chair. (May take weight through hands.)	N.B. As chair is usually placed on same side of bed, patient needs to be able to transfer in both directions.

*May also be performed Standing/Sitting Down/Standing Up.

UPPER LIMB ITEMS

MOVEMENT	TO DEMONSTRATE	SYMBOL	STARTING POSITION	ASSESSMENT DESCRIPTION
Weight bearing★	Dynamic weightbearing through shoulder joint		HIGH SITTING, on plinth or bedside; hands resting in lap. (Place object at arm's reach to ensure that weight is taken through shoulder joint in different parts of range.)	With elbow flexed, abducts AFFECTED arm; leans to AFFECTED side and bears weight on AFFECTED forearm and elbow; reaches with UNAFFECTED hand to touch object; returns to starting position.
Supination and pronation	Break-up: isolation of forearm movement		SITTING: forearm support	Supinates and then pronates forearm
Palm to shoulder	Crossing mid-line of body with AFFECTED arm. Break up and control.		SITTING: hands resting on thighs.	Arm by side and bending elbow, places palm of AFFECTED hand on UNAFFECTED shoulder; returns to starting position.
Holding with both hands	Reaching forwards with AFFECTED arm from flexed position		SITTING: hands resting on thighs. (Place 'beach-type' ball at arm reach on table.)	Reaches forwards with both arms; places one hand on either side of ball; raises ball to shoulder level, then replaces it on the table; returns to starting position.
Grasp and release	Reach, grasp and release, using power grip for gross manipulation		SITTING, at table: forearm support. (place object such as cone or bean bag, but not ball, at arm reach on table.)	Reaches with AFFECTED arm and picks up object; touches it to sternum; returns it to original place on table and releases it; returns to starting position.
Opposition	Pincer grip for fine manipulation		SITTING: arm reach; forearm supinated.	Opposes thumb to second, third, fourth and fifth digits; repeats with reverse sequence.

★ May be assessed with Functional Ability items:   See also, Functional Ability Item: 

DISQUALIFYING OBSERVATIONS

GENERAL DISQUALIFIERS

Item cannot be performed or controlled because of low tone. Starting position cannot be maintained because of poor sitting balance. Item not completed as described for any reason, e.g. transferring, rotation is insufficient to place buttocks on next seat securely.

MID-LINE OBSERVATIONS

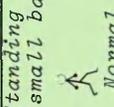
Turning to AFFECTED side and crossing UNAFFECTED thigh over: shoulder retraction; trunk side flexion to AFFECTED side; trunk leaning back. Turning to UNAFFECTED side: shoulder retraction; no segmental rotation between shoulders and hips. Side flexion accompanies supination. Trunk rotation forwards to 'reach' with AFFECTED arm. Trunk rotation backwards and shoulder retraction to bring hand to body. Standing up: weight bearing and 'pushing' on hands causes thrust back of trunk into extension.

UPPER LIMB DISQUALIFIERS

AFFECTED elbow cannot be extended beyond middle range. Pronation accompanies elbow flexion, e.g. touches UNAFFECTED shoulder with dorsum of AFFECTED hand. Fingers not extended before grasping or to release grasp. Thumb is not opposed to finger pads and/or is slid from finger pad to finger pad; movement not made in sequence.

LOWER LIMB DISQUALIFIERS

AFFECTED hip retraction and knee extension as attempts to cross AFFECTED thigh over. Feet not level at initiation of standing up, weight not over feet. Creates positive support by pushing AFFECTED foot 'into' ground causing hip and knee extension; hauls self to feet, weight on UNAFFECTED foot. Weight apparently taken through AFFECTED leg but cannot transfer weight onto it or through it. Cannot balance with feet parallel. Sitting down again with weight through hands and/or UNAFFECTED leg, AFFECTED knee usually extended.

MOVEMENT		TO DEMONSTRATE	SYMBOL	STARTING POSITION	ASSESSMENT DESCRIPTION	QUALITY OF MOVEMENT ITEMS
Trunk rotation to UNAFFECTED side	Tonus of AFFECTED arm and side of trunk. Standing balance (wide base) Rotation in body axis: lengthening of AFFECTED side of trunk Crossing midline with arm.	8	STANDING: feet six inches apart; hips in neutral ab/adduction; hands clasped together in front of pelvis.	Arms forward reach; elbows straight, pelvis stationary, turns shoulders to UNAFFECTED side; (hands describe arc, eyes and head follow); turns to front; returns to starting position.	 Standing balance (small base)  Normal gait	
to AFFECTED side	Weight transfer laterally, through AFFECTED leg. Crossing midline with arm.	9	STANDING, as above.	As above, turns to AFFECTED side.	 Standing balance (small base)  Normal gait	
Weight transfer	Mid-stance phase weight bearing through AFFECTED LEG	11	STANDING	With UNAFFECTED leg makes one normal length step forwards; takes weight on forward leg.		
AFFECTED knee release	Control of isolated knee movement Late stance phase knee release and dorsiflexion of toes with ankle plantarflexion.	10	HALF WALK STANDING: UNAFFECTED leg forwards.	Takes weight on UNAFFECTED (forward) leg keeping toes of AFFECTED leg on the ground, (AFFECTED knee should bend slightly); straightens AFFECTED knee; releases it so that it bends again slightly		
Stepping through	Late stance phase, toe off. Swing phase	12	HALF WALK STANDING: UNAFFECTED leg forwards.	Steps through with AFFECTED leg; transfers weight onto it; steps through with UNAFFECTED LEG.	 Normal gait	
Stepping up	Standing balance (small base) Stance phase: weight bearing through range of extension of hip and knee.	13	CLOSE STANDING: facing steps up.	Puts AFFECTED leg up one step; steps up onto it; carries UNAFFECTED leg through and up to next step.	 Reciprocally	
Stepping down	Stance phase: weight bearing and fine control of flexion of hip and knee.	14	CLOSE STANDING: facing steps down.	Steps down one step onto UNAFFECTED leg.	 Reciprocally	

DISQUALIFYING OBSERVATIONS

N.B. Stance and swing phase observations as described on the following page, MID-LINE OBSERVATIONS: See LYING items.

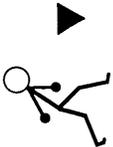
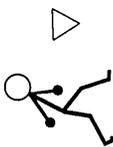
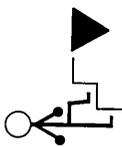
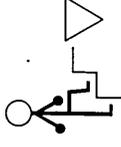
GENERAL OBSERVATIONS

Needs support to maintain starting position or to move.

Items cannot be performed or controlled because of low tone.

★Note any ASSOCIATED REACTIONS observed during performance★

Items swiftly executed to transfer weight onto UNAFFECTED leg to mask lack of control of AFFECTED leg, e.g. stepping down rapidly onto UNAFFECTED leg.

ABILITY	SYMBOL	STARTING POSITION	ASSESSMENT DESCRIPTION	JUDGMENT RE ACTIVITY	FUNCTIONAL ABILITY ITEMS
Walking with support of usual aid		STANDING	Walks with usual aid to appropriate goal. (Write in Early Indoor Goal panel)	Walking in living environment: May not be safe without help or supervision:	Walking in living environment: May not be safe in potentially hazardous situations without aid:
Walking without support		STANDING	Walks independently without aid to Early Indoor Goal.		Going up and down stairs: May be able to negotiate one step or kerb safely: but requires help for whole flight:
Climbing and descending stairs with support of usual aid or bannister		STANDING: facing at least four steps up or down.	Climbs and descends stairs reciprocally using bannister or other aid.		Going up and down stairs: May be able to negotiate one step or kerb unaided: but requires support for whole flight:
Climbing and descending stairs without support		STANDING: facing at least four steps up or down.	Climbs and descends stairs reciprocally, independent of all aid.		

DISQUALIFYING OBSERVATIONS

These patterns cause, then compensate for, inability to transfer body weight onto and over the standing AFFECTED leg.

EARLY STANCE PHASE DISQUALIFIERS	MID-STANCE PHASE DISQUALIFIERS	LATE STANCE PHASE DISQUALIFIER	SWING PHASE DISQUALIFIERS
No heel strike; toes/ball of foot first to ground or entire sole; inversion of fore foot; hyperextension of knee.	Knee hyperextended or fixed in slight flexion; pelvis retracted; trunk flexed forwards; UNAFFECTED leg swung rapidly with short step.	Inability to plantarflex ankle with toes dorsiflexed and to flex knee with hip extended.	Plantarflexion; inversion; hip-hitching; circumduction. Exaggerated hip and knee flexion, with or without ankle dorsiflexion; pelvis tilted backward and trunk flexed forward to 'swing' leg through/up. Pelvis retracted on AFFECTED side, thigh laterally rotated, with or without eversion of forefoot; short step taken. Hypotonic drag or swing of leg.

★See also, SITTING

FUNDAMENTAL AND DERIVED STARTING POSITIONS¹

- LYING: Supine, eyes looking upwards, arms by sides, legs neutral.
Although the patient may not be able to maintain neutral position of the AFFECTED leg this does not disqualify him or her from attempting trunk rotation.
- SITTING: Arms and trunk unsupported; thighs fully supported; 90° flexion at hips and knees; femora parallel and knees slightly apart; feet plantigrade on support; heels vertically below knees.
- HIGH SITTING: As sitting, but feet unsupported.
- STANDING: Ears level, eyes looking forwards; arms hanging loosely by sides, palms facing inwards; hips extended; heels slightly apart, medial borders of feet parallel.
This is the natural functional position of the foot used as a lever to propel the body forwards.
- CLOSE STANDING: As standing, but with inward rotation of hips and medial borders of feet touching.
This position is a progression on standing as the base is smaller and balance is more precarious.
- HALF WALK STANDING: One foot is placed forward in standing so that the heels are one foot length apart.

POSITIONS AND MOVEMENTS OF LIMBS

- ARM REACH: Shoulder flexed, elbow extended, palm facing medially; limb horizontal if trunk upright; if both arms reach, they are parallel.
- ARM STRETCH: Arm elevated and outwardly rotated, elbow extended, palm facing medially; if both arms stretch, they are parallel.
- DRAWING UP OF HEEL: Moving heel towards hip in sagittal plane.
- FOREARM SUPPORT: Elbows flexed and tucked into sides; forearms resting on table, pronated.

1. Descriptions are taken from:
GARDINER, M.D. (1960) The Principles of Exercise Therapy, 2nd ed; London: Bell and Sons.

Name MRS R.
 Address _____
 Hospital No. _____ Age/D.of B. 54
 Date of Onset 28.12.79
 Admission Date (NOT KNOWN)

Hospital/Unit _____
 Referring Doctor _____
 Physiotherapist _____
 OP/IP Ward _____

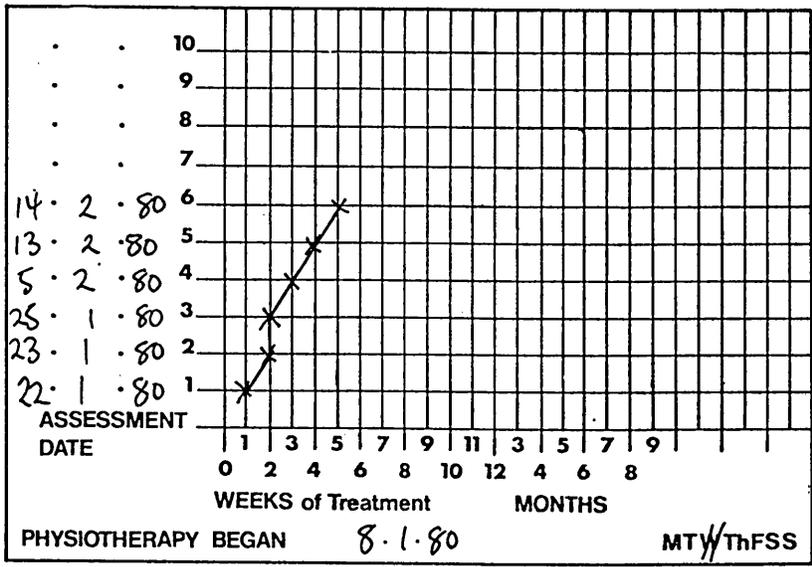
Left Right HEMIPLEGIA
 Left Right HANDED

QUALITY OF MOVEMENT		FUNCTIONAL ABILITY in test situation	
14			
13			
12			
11			
10			
9	5		
8	4		
7	3		
6	3		
5	3		
4	1		
3	1		
2	1		
1	1		

ACTIVITY CAPABILITY in non-test situation					
CAN WALK SAFELY:	OVER SLOPE/RAMP				
	DOWN FLIGHT OF STAIRS				
	UP FLIGHT OF STAIRS				
	& NEGOTIATE STEP/KERB				
	TO/FROM LAVATORY				
CAN GET OUT OF/INTO BED SAFELY					
CAN STAND UP/SIT DOWN SAFELY		1	2		
CAN SIT SAFELY ON BED-SIDE, LAVATORY, CHAIR etc.		1	2		

UPPER LIMB	

Early Indoor Goal
 (NOT KNOWN)



	WITH SUPPORT OF FURNITURE OR WALKING AID
	TOTALLY INDEPENDENTLY
	WITH HELP OF PERSON
	HOME VISIT
	TO AFFECTED SIDE
	TO UNAFFECTED SIDE

Hospital/Unit _____

Hospital No. _____

Age/D.of B. 58

Referring Doctor _____

Date of Onset 6.1.80

Physiotherapist _____

Admission Date 6.1.80.

OP/IP 3 Ward _____

Left **Right**
HEMIPLEGIA

Left **Right**
HANDED

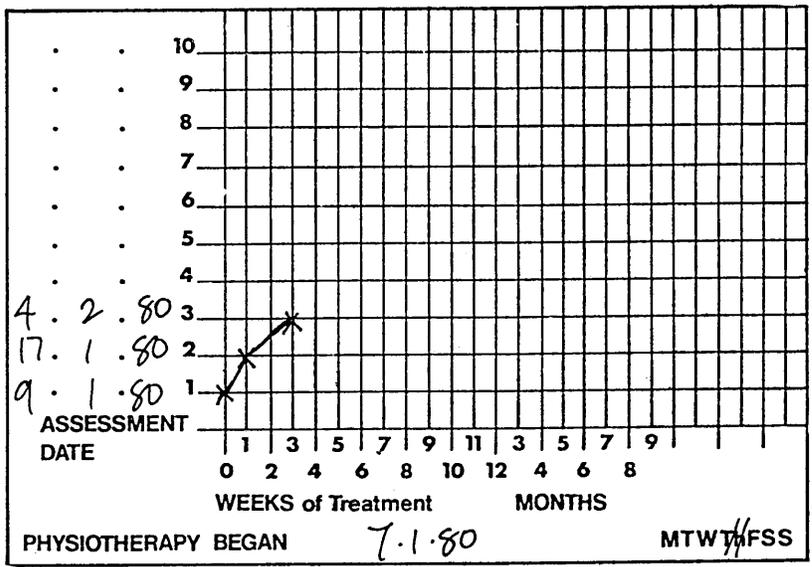
QUALITY OF MOVEMENT		FUNCTIONAL ABILITY in test situation		
14	3			
13	3			2
12	2			1
11	3			1
10	2			1
9	1			1
8	1			1
7	1			1
6	1			1
5	1			1
4	1			1
3	1			1
2	1			
1	1			

ACTIVITY CAPABILITY in non-test situation					
CAN WALK SAFELY:	OVER SLOPE / RAMP				
	DOWN FLIGHT OF STAIRS	2	3		
	UP FLIGHT OF STAIRS	2	3		
	& NEGOTIATE STEP / KERB	1	2		
	TO / FROM LAVATORY		1	2	
	BEDROOM TO / FROM DAYROOM		1	2	
CAN GET OUT OF / INTO BED SAFELY			1	2	
CAN STAND UP / SIT DOWN SAFELY			1	2	
CAN SIT SAFELY ON BED-SIDE, LAVATORY, CHAIR etc.			1	2	

UPPER LIMB	
	2
	2
	2
	1
	2
	1
	2
	1
	1

Early Indoor Goal
Plinth → chair (10yds)

	WITH SUPPORT OF FURNITURE OR WALKING AID
	TOTALLY INDEPENDENTLY
	WITH HELP OF PERSON
	HOME VISIT
	TO AFFECTED SIDE
	TO UNAFFECTED SIDE



Name MRS A.
 Address _____
 Hospital No. _____ Age/D.of B. 60

Hospital/Unit _____
 Referring Doctor _____
 Physiotherapist _____
 OP/IP Ward _____

Date of Onset 30.1.80
 Admission Date (NOT KNOWN)

Left Right HEMIPLEGIA
 Left Right HANDED

QUALITY OF MOVEMENT		FUNCTIONAL ABILITY in test situation	
		Left	Right
14			3
13			3
12	3		2
11	3		
10	3		
9	2		1
8	2		1
7	2		1
6	3		1
5	1		1
4	1		1
3	1		1
2	1		
1	1		

ACTIVITY CAPABILITY in non-test situation					
CAN WALK SAFELY:	OVER SLOPE/RAMP				
	DOWN FLIGHT OF STAIRS	2	3		
	UP FLIGHT OF STAIRS	2	3		
	& NEGOTIATE STEP/KERB	2	3		
	TO/FROM LAVATORY	1	2	3	
	BEDROOM TO/FROM DAYROOM	1	2	3	
CAN GET OUT OF/INTO BED SAFELY		2			
CAN STAND UP/SIT DOWN SAFELY			1		
CAN SIT SAFELY ON BED-SIDE, LAVATORY, CHAIR etc.			1	2	

UPPER LIMB	
	1
	2
	2
	2
	1
	1
	1
	1
	1

Early Indoor Goal
 (NOT KNOWN)

	WITH SUPPORT OF FURNITURE OR WALKING AID
	TOTALLY INDEPENDENTLY
	WITH HELP OF PERSON
	HOME VISIT
	TO AFFECTED SIDE
	TO UNAFFECTED SIDE

