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Citation:

PHELAN, Ivan (2022). How virtual reality can reduce pain and aid rehabilitation. ITNOW, 64 (3), 22-23. [Article]

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How VR can reduce pain and aid rehabilitation

Ivan Phelan, Director of the Impact VR Lab at Sheffield Hallam University, explains how virtual reality is outperforming different therapies across different areas of medicine.

The Impact VR Research Lab from Sheffield Hallam University (SHU), has explored how virtual reality technology can support burns survivors, amputees and children undergoing limb rehabilitation. To improve accessibility and compliance of clinical therapies, they design fun games that execute mechanics designed to reproduce clinical interventions adapted to the specific needs of the users. Their leading work on physical rehabilitation incorporates fully immersive and interactive in-game elements that replicate physiotherapy exercises.

A suite of projects has succeeded in developing a set of immersive and interactive virtual reality games which have considerably improved the health, well-being and life styles of children and adults affected by neurological and musculoskeletal conditions, orthopaedic trauma and chronic pain.

The impact achieved by these innovations has been fourfold:

- physically and psychologically enhancing the health, life styles, and well-being of patients;
- promoting [more effective practitioner standards](#) and services;
- improving public awareness and understanding of such technology and entering a related debate on social policy;
- and establishing commercial and medical collaborations to improve healthcare and the NHS's cost-effectiveness.

VR for pain distraction during burns dressings changes

Most burn-injured patients undergo painful repetitive therapeutic processes, such as wound debridement and dressing changes. In addition, the perception of pain associated with burn injuries has been reported as one of the most intense types of pain. Therefore, the pain that accompanies the burn injuries treatment presents a critical challenge, to be met not only by the patients but also by the clinical staff.

The Impact VR Lab designed an immersive virtual basketball game to help burn adult victims cope with the pain of medical treatments, including wound dressing. In their clinical trial, the burn-injured patients experienced considerably less pain and anxiety (according to score-ratings of 0 to 100) than

in conventional dressings sessions. Those immersive scenarios possessing high degrees of patient presence and engagement proved the most effective. That could help [burns survivors](#) cope with pain during their treatments and speed up the healing process.

VR training system for amputees

Myoelectric-powered prosthesis are driven by the muscle strength of the patient, but with the aid of electric power. A biochemical process generates electrical tension in the microvolt range every time a muscle contracts. With myoelectric arm prostheses, muscle tensions from the residual limb are usually read by two electrodes. The low myoelectrical impulses that lie in the microvolt range are then amplified and forwarded to the electronics of the prosthesis in the form of control signals.

The myoelectric-powered prosthesis can be more functional and advantageous than passive or body-powered prostheses. However, extensive training is required to take full advantage of the myoelectric prosthesis' usability.

The Impact VR research lab designed a VR experience that lets [amputees practice](#) using a prosthetic limb before they are fitted. Their preliminary findings suggested that myoelectric-powered training enhanced with VR can simulate a pain-free, natural, enjoyable and realistic experience for the patient. It was also found that VR can complement prosthesis training by improving the functionality of the missing body part. Finally, it was shown that VR could resolve one of the most common challenges for a new prosthesis user, which is to accept the fitting of the prosthetic device to their own body.

VR physical rehabilitation

Children with limb motor impairment often undergo repetitive therapeutic physiotherapy sessions to minimise functional disabilities of the affected area. Even though therapeutic processes can improve functional outcomes and minimise persistent disabilities, patients often neglect to participate fully in physical therapies due to the associated procedural pain. Over recent decades, there has been a growing interest in designing non-pharmacological interventions which aim to minimise pain during physical therapies and [improve functional outcomes](#).

The Impact VR Lab has developed virtual reality climbing and archery games to help children with [upper limb impairment](#) realise their rehabilitation exercises. The games, which require the user to reach behind their back to grab arrows, or reach upwards to climb a castle wall, are designed to help children complete their vital recovery exercises. Their feasibility clinical trial has demonstrated that compared to their usual rehabilitation experiences, children reported finding rehabilitation exercises more enjoyable and found movement easier and less painful using VR. Pain and difficulty were rated

overall as lower than usual, and enjoyment was rated as much higher than usual. It was found that VR could:

1. Improve functional disabilities;
2. Alleviate perceived pain;
3. Reduce the perceived difficulty of rehabilitation exercises;
4. Increase exercise duration;
5. Produce positive emotions toward the physical therapies.

Following this work, they developed the upper limb VR rehabilitation system for home use. Given that home-based therapy with VR can offer greater accessibility, delivery and early rehabilitation to [optimise functional outcomes and quality of life significantly](#).

Impact VR has also created a novel interactive VR gaming environment specifically aimed at young people aged 11-16 undergoing rehabilitation following surgery for lower leg and knee injuries. Virtual activities have been developed to encourage young people to perform the exercises necessary for effective rehabilitation after surgery. This system is currently being tested at Sheffield Children's NHS Foundation Trust.

More to come

The Impact VR work with VR doesn't stop there. They are working on projects to support dysphagia patients, to help children diagnosed with the rare muscle-wasting disease Duchenne (DMD), and to support the CBT (cognitive behavioural therapy) in children with social anxiety (SAD).

Dysphagia patients, for example, often report the traditional treatment as challenging to complete. The programmes can last many months and include postural changes when swallowing, strategies to alter specific aspects of the swallow or intensive exercise programmes. Impact VR is working to create a new VR scenario being developed for dysphagia rehabilitation. It is anticipated that the VR system will enhance the re-education of the muscles and make swallowing safer and more effective again.

Duchenne muscular dystrophy is a paediatric genetic disease that causes muscles to deteriorate and break down. It affects 2,500 children in the UK, and there is currently no cure. Children with DMD are encouraged to undertake a daily stretching programme for maximum muscle extensibility; however, it can be difficult to maintain engagement. This can lead to complications, reduced function and a poorer long-term prognosis. Impact VR is developing a VR platform to improve the physiotherapy of children living with DMD muscular dystrophy, which will be the first of its kind for lower-limb rehabilitation in DMD patients.

Elsewhere, VR can help with seasonal affective disorder. SAD is a long-term and overwhelming fear of social situations affecting 8 - 10% of children and youth, usually adolescents. The current COVID-19 pandemic may increase the number of schoolchildren suffering with this after confinement. Early intervention is key to minimising the need to use medications because it is more difficult to reverse when older. Impact VR is developing and demonstrating that an VR game supported CBT with bespoke gamified scenarios for early intervention of social anxiety in children can prove more beneficial than the conventional standard of care. Using VR for social anxiety disorders in children and home use has not been done before.

Further reading

Phelan et al. (2021). Designing effective virtual reality environments for pain management in burn-injured patients. *Virtual Reality*. DOI: <https://doi.org/10.1007/s10055-021-00552-z>

Phelan et al. (2021, May). Designing a Virtual Reality Myoelectric Prosthesis Training System for Amputees. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*. <https://doi.org/10.1145/3411763.3443454>

Phelan, I., Furness, P. J., Matsangidou, M., Carrion-Plaza, A., Dunn, H., Dimitri, P., & Lindley, S. A. (2021). Playing your pain away: designing a virtual reality physical therapy for children with upper limb motor impairment. *Virtual Reality*, 1-13. DOI: <https://doi.org/10.1007/s10055-021-00522-5>

About the author: Ivan Phelan, Director of the Impact VR Lab, Sheffield Hallam University is a researcher whose pioneering virtual reality technology in healthcare has supported amputees, burn victims and those with upper limb injuries to rehabilitate.

