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The management of shock-resistant arrhythmias: a clinical audit

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Abstract

Background/rationale – Although defibrillation has been shown to improve outcome from cardiac arrest, there is a group of patients that presents with ventricular fibrillation/pulseless ventricular tachycardia that is resistant to defibrillation. In these patients, amiodarone has been shown to improve short-term outcome of survival to hospital admission and improve the response to defibrillation. In addition, refractory ventricular fibrillation may fail to be terminated by pads placed in the standard sternal-apical position, and consideration of a pad-position change is advocated by current UK and European resuscitation guidelines.

The aim of this audit was to determine Yorkshire Ambulance Service ambulance crew compliance with current resuscitation guidelines, for adult patients with shockable rhythms that are resistant to defibrillation.

Methods – All adult (≥ 18 years) medical cardiac arrests during the audit period (1 July 2016–30 September 2016) presenting with ventricular fibrillation/pulseless ventricular tachycardia, and requiring three or more shocks, were reviewed for compliance with three standards. These standards related to the appropriate administration of amiodarone (first 300 mg dose and second 150 mg dose), and pad position change (or consideration of change) for refractory ventricular fibrillation/pulseless ventricular tachycardia after five shocks.

Results – Within the audit period dates, there were 1584 adult cardiac arrests, with resuscitation attempted in 635 incidents. The presenting rhythm was ventricular fibrillation/pulseless ventricular tachycardia in 176 of cases. In the audit sample, there were 53 documented 300 mg amiodarone administrations and 22 documented 150 mg amiodarone administrations. One patient received 150 mg amiodarone but not a first dose of 300 mg. Of the patients who received three or more shocks, 94.9% (94/99) had IV access. It was possible to determine the sequence of rhythms for 76.3% (29/38) of the cardiac arrests that received more than five shocks. Of these patients, 26 had a refractory ventricular fibrillation/pulseless ventricular tachycardia and one patient had a pad position change, or documented consideration of a pad position change.

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Conclusion – Compliance with amiodarone administration in shock-resistant arrhythmias is poor and pad position change is not being considered by clinicians for patients in refractory ventricular fibrillation/pulseless ventricular tachycardia. A review of advanced life support training provision and assessment is required within Yorkshire Ambulance Service, and strategies for increasing awareness of amiodarone administration in eligible patients and pad position change are needed.

Keywords

amiodarone; cardiac arrest; defibrillation; pulseless ventricular tachycardia; ventricular fibrillation

Background/rationale

Defibrillation is only one of two interventions that have been shown to unequivocally improve outcome from cardiac arrest (the other being basic life support) (Perkins, Handley, et al., 2015). However, there is a group of patients that presents with ventricular fibrillation/pulseless ventricular tachycardia (VF/pVT) that is resistant to defibrillation. In these patients, the anti-arrhythmic drug amiodarone has been shown to improve short-term outcome of survival to hospital admission and improve the response to defibrillation. Current adult resuscitation guidelines advocate a first dose of 300 mg amiodarone after the third shock and a second dose of 150 mg amiodarone following the fifth shock (Deakin et al., 2015; Joint Royal Colleges Ambulance Liaison Committee & Association of Ambulance Chief Executives, 2016; Soar et al., 2015).

In this audit, VF/pVT that is resistant to defibrillation is categorised into refractory, defined as VF/pVT that persists after three or more sequential shocks, or non-sequential VF/pVT, defined as three or more cumulative episodes of VF/pVT that require defibrillation but do not occur sequentially, for example are interrupted by a return of spontaneous circulation (ROSC) or non-shockable cardiac arrest rhythm (i.e. asystole or pulseless electrical activity, PEA). Note that these definitions are pragmatic modifications to the definition provided by current European resuscitation guidelines (Soar et al., 2015).

There are no high-quality studies comparing defibrillator pad positions in terms of defibrillation success and ROSC, although the most commonly used placement is the sternal-apical position (Jacobs et al., 2010). The exact mechanism by which electrical defibrillation stops fibrillatory activity in the myocardium is not completely understood, but it is thought that a critical mass of myocardium needs to be simultaneously depolarised by the shock (Wilson, 2015). In shock-resistant arrhythmias, it is possible that the standard sternal-apical position may not achieve this, and consideration of a pad-position change is advocated by current resuscitation guidelines (Soar et al., 2015). Since the guidelines do not specify the number of shocks for refractory VF/pVT after which pad position change should be considered, the authors elected to use more than five sequential shocks as the standard for this audit.

Aim

Determine Yorkshire Ambulance Service (YAS) ambulance crew compliance with current UK and European resuscitation guidelines, and the UK Ambulance Services Clinical Practice Guidelines 2016 for adult cardiac arrest patients who present with a shockable rhythm that is resistant to defibrillation (Deakin et al., 2015; Joint Royal Colleges Ambulance Liaison Committee & Association of Ambulance Chief Executives, 2016; Soar et al., 2015).

Objectives

- Identify all adult patient episodes between 1 July 2016 and 30 September 2016 where three or more shocks were delivered.
- Determine the number of patients who received three or more shocks and had 300 mg amiodarone administered.
- Determine the number of patients who received five or more shocks and had 150 mg amiodarone administered.
- Determine the number of patients in refractory VF/pVT who received more than five shocks, and had a documented change of defibrillator pad position or consideration of pad position change.

Standards/criteria/guidelines/evidence base

- Resuscitation Council (UK) 2015 Resuscitation Guidelines: Pre-hospital Resuscitation.
- European Resuscitation Council Guidelines for Resuscitation 2015. Section 3. Adult advanced life support.
- JRCALC, AACE 2016 UK Ambulance Clinical Practice Guidelines. Advanced Life Support (Adult).

Sample

All adult (≥ 18 years) out-of-hospital cardiac arrests entered onto the YAS computer aided dispatch (CAD) system between 00:00:00 on 1 July 2016 and 23:59:59 on

30 September 2016. Incidents were included if the patient was resuscitated, and the cause of the arrest considered to be medical in origin (i.e. not trauma).

Data sources

- Direct reporting of cardiac arrests by paramedics.
- CAD system data stored in the YAS data warehouse.
- Monthly Ambulance Clinical Quality Indicator (AQI) reports generated by business intelligence (BI) relating to cardiac arrest.

Audit type

Local clinical audit.

Methods

The audit was conducted by the lead author in January 2017. The following methods of data collection were employed to maximise data completeness:

- Patient care records (PCRs) relating to adult patients in cardiac arrest, from 1 July 2016 to 30 September 2016, were reviewed, having been identified from one of three sources:
 - Direct reporting from paramedics to a research paramedic within the Trust.
 - Review of records identified using custom CAD system query.
 - Review of monthly CQI reports generated by BI.
- PCRs were considered relevant to the audit if:
 - the presenting rhythm was VF/pVT;
 - the patient was an adult and the presumed cause of the arrest was medical (i.e. not traumatic); and
 - the sequence of cardiac arrest rhythms was determined (where possible), and the number of shocks and administration(s) of amiodarone recorded.

Table 1. Adult medical cardiac arrests occurring between 1 July 2016 and 30 September 2016 where resuscitation was attempted.

Presenting rhythm	Number	% of all rhythms
Asystole	298	49.26
PEA	131	21.65
pVT	4	0.66
VF	172	28.43
Total	605	100.00

PEA: pulseless electrical activity; pVT: pulseless ventricular tachycardia; VF: ventricular fibrillation.

Caveat

It was not always possible to determine the sequence of cardiac arrest rhythms from the patient record due to insufficient detail on the PCR. In addition, the time that vascular access was obtained is not routinely recorded.

Results

Within the audit period dates there were 1584 cardiac arrests, with resuscitation attempted in 635 incidents (note that there were five incidents where the PCR could not be located). After removal of ineligible patients (29 were traumatic in origin and one was an in-hospital resuscitation), 605 incidents remained. Of these, the presenting rhythm was VF/pVT in 176 of cases (Table 1).

In the audit sample, there were 53 documented 300 mg amiodarone administrations and 22 documented 150 mg amiodarone administrations. One patient received 150 mg amiodarone but not a first dose of 300 mg. Of the patients who received three or more shocks, 94.9% (94/99) had IV access. It was possible to determine the sequence of rhythms for 76.3% (29/38) of the cardiac arrests that received more than five shocks (Table 2). Of these patients, 26 had a refractory VF/pVT and one patient had a pad position change, or documented consideration of a pad position change.

With regards to the audit standards, 59.6%, 37.9% and 3.8% met Standards 1, 2 and 3 respectively (see Table 3).

Table 2. Documented interventions performed for patients in shockable rhythms.

No. shocks	300 mg AMO	150 mg AMO	IV access	No IV access	Pad position change	Rhythm sequence present	Refractory rhythm	No. patients
< 3	0	0	4	73	0	5	0	77
3	1	0	23	3	0	20	0	26
4	5	0	12	1	0	10	0	13
5	13	2	22	0	0	18	0	22
> 5	34	20	37	1	1	29	26	38
Total	53	22	98	78	1	82	26	176

300 mg AMO: number of patients who received the first dose of amiodarone; 150 mg AMO: number of patients who received the second dose of amiodarone; IV access: number of patients who had vascular access obtained (note that the intraosseous route is also included).

Table 3. Standards 1, 2 and 3.

Standard (1)	Standard set	Standard achieved
100% of adult patients in cardiac arrest who have received three shocks will have 300 mg of amiodarone administered. Exception: No IV/IO access available (n = 5).	100.0%, n = 89	59.6%, n = 53
Standard (2)	Standard set	Standard achieved
100% of adult patients in cardiac arrest who have received five shocks will have 150 mg of amiodarone administered. Exception: No IV/IO access available (n = 1).	100.0%, n = 58	37.9%, n = 22
Standard (3)	Standard set	Standard achieved
100% of adult patients in refractory VF/pVT who have received more than five shocks will have a documented pad position change or consideration of pad position change. Exception: Cannot determine whether refractory rhythm present (n = 9).	100.0%, n = 26	3.8%, n = 1

Observations

The incidence of shockable rhythms in this audit (29.1%) is slightly higher than reported elsewhere (22% in the PARAMEDIC study), although this audit period (three months) is considerably shorter than PARAMEDIC (over three years) (Perkins, Lall, et al., 2015).

Compliance with amiodarone administration in shock-resistant arrhythmias is poor. Even to reach 50% compliance, it is necessary to include cases that received between

three and seven shocks. Compliance with second dose administration of amiodarone is even lower than first dose compliance (Figure 1). Amiodarone administration and vascular access in the audit sample, stratified by total number of shocks, is provided in Supplementary 1.

Although there were only 26 patients identified as being in refractory VF/pVT, pad position change (or consideration of change) is not a management option being contemplated by clinicians on scene at these arrests, even allowing for omissions due to poor documentation of this decision.

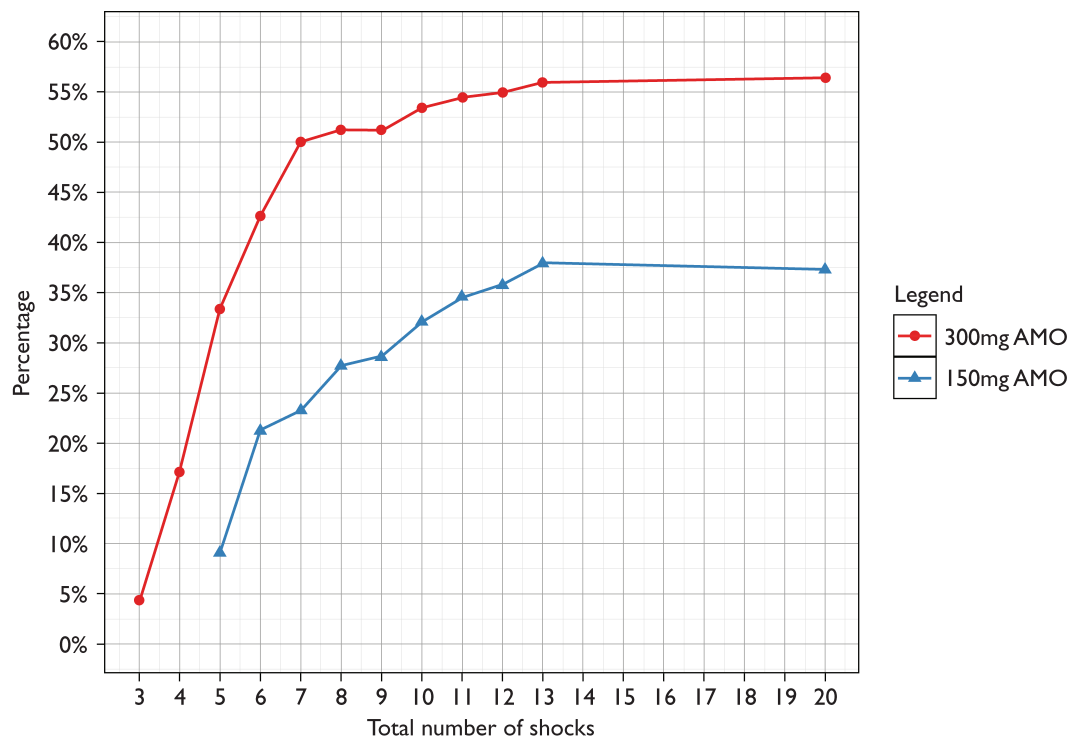


Figure 1. Cumulative amiodarone administration as a proportion of eligible cases and stratified by total number of shocks delivered.

Note that the y-axis maximum is 60% and not 100%, for clarity.
AMO: amiodarone.

This audit has highlighted the limitations of the current patient clinical record in including important aspects of cardiac arrest management, such as the sequence of arrest rhythms and timings of interventions such as vascular access.

Recommendations

The following actions should be taken within the next 12 months:

- Review cardiac arrest-related statutory and mandatory training for all operational staff.
- Introduce assessment of advanced life support for all paramedics to occur at least annually.
- Increase utilisation of low fidelity cardiac arrest simulation when staff work with clinical supervisors.
- Increase awareness of amiodarone administration and pad position change using the YAS clinical update, YAS TV, etc.
- Utilise Red Arrest Teams (RAT) to drive compliance with both amiodarone and pad position change during shock-resistant cardiac arrests.
- Consider using a specific data capture form for cardiac arrests to facilitate accurate auditing.

Learning points

With the introduction of post-cardiac arrest debriefing that utilises data downloaded from the monitor-defibrillators within the Trust, a future audit could consider incorporating this additional data into the audit.

Conflict of interest

RP is editor of the *BPJ*.

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None.

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