

Induced Hypothermia Following Cardiac Arrest And Subsequent Neurological Outcomes: An Audit

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Abstract

Background: Survival with good neurological recovery following cardiac arrest is poor. A number of recent studies have concluded that the use of induced hypothermia can improve survival and limit the level of neurological impairment following cardiac arrest. Objective: To audit survival and neurological recovery outcomes in patients treated with induced hypothermia within the Intensive Care Unit (ICU) following cardiac arrest. Design: A two year retrospective study. Method: Data from patient notes were extracted and analysed. Conclusion: The survival rate for patients presenting with a cardiac arrest and an initial rhythm of ventricular fibrillation (VF) is 62%, with 58% of patients surviving with good neurological recovery. Of those who were treated conservatively following a cardiac arrest with an initial rhythm of VF, 20% survived with good neurological recovery.

INTRODUCTION

It is estimated that there are 92 to 189 cases of cardiac arrest per 100,000 inhabitants in industrialised countries each year^{1,2,3} and 375,000 sudden cardiac arrests in Europe every year⁴. Some 14% to 40% have a return of spontaneous circulation (ROSC) and are admitted to hospital and of those only 7% to 30% leave hospital to live an independent life⁵. Several studies have shown that the use of induced hypothermia can improve rates of survival and level of neurological function following a cardiac arrest^{5,6,7}.

AIMS AND OBJECTIVE

This audit was conducted to review the cases of cardiac arrest presenting to, or occurring in, St Peter's Hospital in 2009-10 in order to assess the neurological outcomes of patients who were cooled on the ICU, and to determine whether therapeutic hypothermia should be implemented as standard care following cardiac arrest, or, if not, in which cases it would be most beneficial.

STANDARDS

This audit has been based on the findings of two papers, both of which demonstrated a significant improvement in long term neurological outcomes for patients following induced hypothermia. Bernard et al⁶ studied 77 patients with out of hospital cardiac arrests who were each randomly assigned to care with normothermia or hypothermia (core body

temperature reduced to 33°C within 2 hours of the return of spontaneous circulation and maintained at that temperature for 12 hours). Their primary outcome measure was survival to discharge with sufficiently good neurological function to be discharged home or to a rehabilitation facility. Death or discharge to a nursing facility, ie where there was little likelihood of neurological improvement, was considered a poor outcome. They demonstrated that treatment with moderate hypothermia improved outcomes in patients with coma after resuscitation from an out-of-hospital cardiac arrest. Some 49% of their patients treated with hypothermia were considered to have a 'good' outcome (ie discharged to home or rehabilitation facility) whilst only 26% of those in the normothermia group had the same outcome (P=0.046). A multicentre study by the Hypothermia After Cardiac Arrest Study Group demonstrated a 55% favourable outcome in the hypothermia group (32°C to 34°C, as measured in the bladder, for 24 hours) compared with 39% of those treated with normothermia following cardiac arrest⁷. A Cochrane systematic review subsequently reviewed five trials. Treatment with active cooling led to patients having a better neurological outcome as measured by a cerebral performance score (relative risk 1.55; 95% CI 1.22-1.96) and more likely to survive to discharge (relative risk 1.35; 95% CI 1.10-1.65) compared to those treated with normothermia⁵.

METHOD

Records were tracked from ICU admissions during 2009-10 using the coding reference for cardiac arrest. These notes were reviewed and the following was recorded: age, gender, location of arrest (in or out of hospital), initial heart rhythm, extent of CPR required, whether the patient was treated with induced hypothermia and how soon following arrest cooling commenced. Patient outcomes were recorded in terms of whether the patient was discharged to their home, a rehabilitation facility, a nursing home or died in hospital. All patients were cooled with the use of the Arctic Sun® 2000 temperature management system (Medivance).

RESULTS

There were 85 patients admitted to the ICU coded as having had a cardiac arrest during the study period. Nine sets of notes were unobtainable and two patients had been miscoded. Consequently 74 patients were eligible to be included in the audit. Of these 74 patients 47 (64%) were male and 27 (36%) female. 37 patients (50%) were admitted from other wards or A&E where they had suffered a cardiac arrest and were categorised as in-hospital arrests. 37 patients (50%) had suffered out of hospital cardiac arrests. In total 33 patients (45%) were actively cooled on the unit whilst the other 41 (55%) were treated conservatively. The presenting rhythms during cardiac arrests were categorised into shockable (VF/VT) and non-shockable (PEA/asystole) according to the Advanced Life Support algorithm⁸. Of the 74 patients 31 (42%) had an initial rhythm of VF. None had a presenting VT rhythm. 38 patients (51%) had a PEA/asystole rhythm and in 5 (7%) cases the presenting rhythm had not been documented. Final outcomes showed that 26 (35%) of the 74 patients survived. 22 were discharged home, 2 to rehabilitation centres and 2 to nursing facilities. The other 48 (65%) patients died, either on ICU or on a ward following discharge from the unit. Analysis was carried out to review the neurological outcomes of each patient. Those who had an out-of-hospital cardiac arrest with a VF rhythm and who were subsequently cooled had a 62% rate of survival and 57% rate of good neurological outcome (ie, 92% of those who survived had a good neurological recovery) while those who were not cooled had a 25% rate of survival, all with good neurological outcome. Patients who had a VF cardiac arrest in hospital had a 60% rate of survival, with good neurological recovery in all cases if they were cooled and a 0% rate of survival if not cooled. Patients who had an out-of-hospital PEA/asystole arrest had a 0% rate of survival whether they were cooled or not cooled.

Those who had an in hospital PEA/asystolic cardiac arrest had a 29% rate of survival, with 25% rate of good neurological recovery, when not cooled. There were no data for in-hospital PEA/asystolic cardiac arrest patients who were cooled as no patients fit these criteria within the study period.

Figure 1

Figure 1: Out of hospital arrests

	VF/VT	PEA/ASY	Not documented
Cooled	21	5	2
Survived (total)	13 (62%)	0	0
Survived with good outcome	12 (57%)	0	0
Not cooled	4	5	0
Survived (total)	1 (25%)	0	0
Survived with good outcome	1 (25%)	0	0

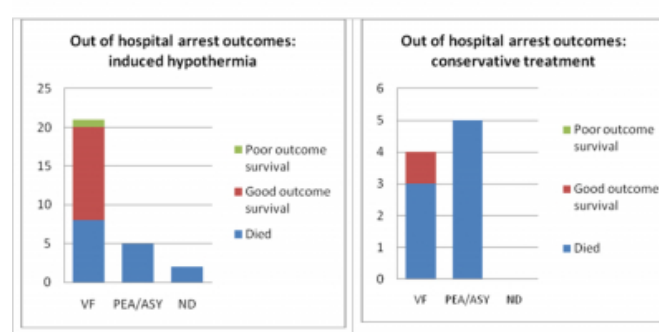


Figure 2

Figure 2: In-hospital arrests

	VF/VT	PEA/ASY	Not documented
Cooled	5	0	0
Survived (total)	3 (60%)	0	0
Survived with good outcome	3 (60%)	0	0
Not cooled	1	28	3
Survived (total)	0	8 (29%)	1 (33%)
Survived with good outcome	0	7 (25%)	1 (33%)

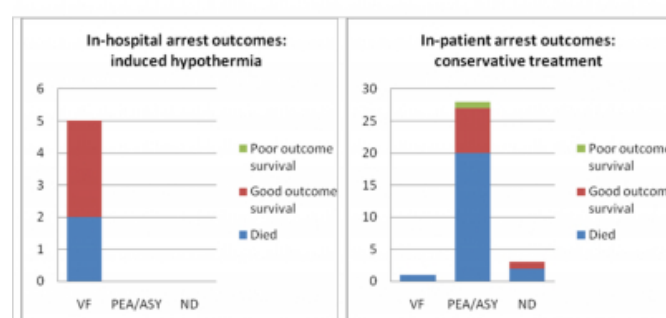
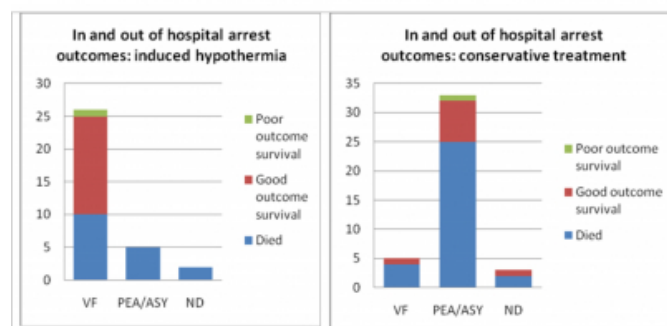


Figure 3

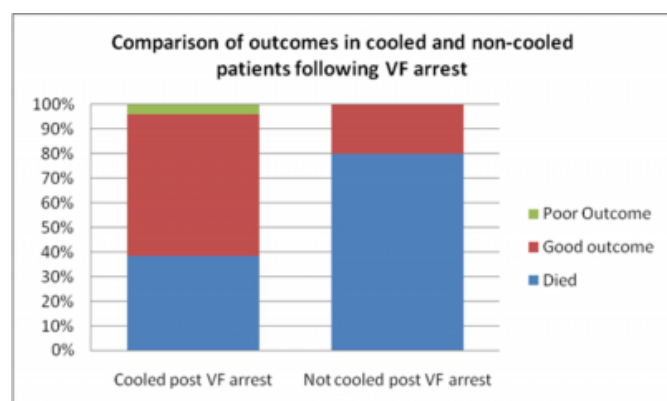
Figure 3: Combined in and out-of-hospital arrests

	VF/VT	PEA/ASY	Not documented
Cooled	26	5	2
Survived (total)	16 (62%)	0	0
Survived with good outcome	15 (58%)	0	0
Not cooled	5	33	3
Survived (total)	1 (20%)	8 (24%)	1 (33%)
Survived with good outcome	1	7 (21%)	1 (33%)



When studying in and out of hospital arrests combined it is shown that patients who had a VF cardiac arrest and were cooled had a 62% rate of survival, and 58% rate of survival with good neurological outcome. If they had a VF cardiac arrest and were not cooled they had a 20% rate of survival with good neurological outcome.

Figure 4



DISCUSSION

At rest, the brain uses 20% of total body oxygen consumption in order to allow oxidative phosphorylation of glucose to ATP. Since the brain has a high metabolic rate but a lack of substrate storage (glucose) it is extremely sensitive to hypoxia. In order to protect the brain, autoregulation ensures that cerebral blood flow (CBF) is kept constant when the mean arterial pressure (MAP) is between 50-100 mmHg⁹. When the MAP drops below 50 mmHg, the CBF initially increases to compensate for hypoxia but in a cardiac arrest scenario this compensation mechanism cannot

maintain adequate perfusion pressure and anoxic injury occurs. Damage occurs to neurones with reperfusion of the brain as transmembrane electrochemical gradients are disrupted. Intracellular glutamate levels increase during reperfusion, activating ion channel complexes, causing intracellular shift of calcium. This in turn causes reactive oxygen species to accumulate activating degradative enzymes which contribute to exocytotic cell death and cerebral injury^{10, 11, 12}. Reperfusion injury occurs in two stages¹³. Initially there is injury at the time of reperfusion itself when reactive oxygen species are released. With current practice it is very difficult to ameliorate this with therapeutic hypothermia because reperfusion remains the priority. The second stage lasts hours to days and is related to transmembrane dysfunction as outlined above. This stage can be targeted by therapeutic hypothermia in its current form.

Induced hypothermia causes cerebral metabolic rate to drop by 7% for every 1°C fall in body temperature¹⁴. This reduces cellular metabolism and cerebral oxygen demand¹⁵ and confers protection by several other mechanisms; it reduces the production of free radicals¹⁶, improves cellular ion handling and pH balance¹⁷ and reduces the inflammatory signalling which leads to cell death¹⁸. Therapeutic hypothermia is currently advised by the Resuscitation Council (UK) following a cardiac arrest, although the new guidelines recognise the lower level of evidence for its use following a PEA or asystolic arrest¹⁹. Its use is contraindicated in severe systemic infection, pre-existing coagulopathy and multiple organ failure²⁰.

STUDY LIMITATIONS

This is not a randomised trial; rather it is an audit of practice and outcomes at a single district general hospital in England.

It is important to acknowledge that circumstances of the period before cooling is commenced can vary widely between patients. This audit did not correct for other variables such as time from arrest to commencement of CPR, or time to cooling or for co-morbidities. While all patients admitted were considered to potentially have a favourable outcome, the findings of this audit do not take account of why cooling was not implemented in certain patients. Co-morbidities or contraindications to cooling may have existed, which would have made a favourable outcome less likely regardless of whether or not induced hypothermia was instigated.

CONCLUSIONS AND RECOMMENDATIONS

It was shown that patients who suffer a VF cardiac arrest have a 62% rate of survival if subsequently treated with hypothermia at St Peter's ICU. This varies only slightly whether the arrest was as an inpatient or out of hospital: 60% and 62% respectively. 92% of the survivors of out of hospital arrests and 100% of the survivors of in-patient VF arrests had a good neurological recovery. Those who are not cooled following a VF arrest have a 20% survival rate overall (25% for out-of-hospital arrests and 20% for inpatient arrests).

This audit was presented at a regional meeting of the Surrey Wide Critical Care Network and was contributory in influencing practice within all Intensive Care Units in this county. It was concluded that it was best practice to treat all patient transferred to ICU post-VF or VT arrest with therapeutic hypothermia.

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