Pathway to improve access to emergency angiography for comatose patients following cardiac arrest due to myocardial infarction in Cheshire and Merseyside

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**Background**

Patients who suffer a cardiac arrest outside hospital have an extremely high mortality rate. Within the group who are successfully resuscitated to achieve a return of spontaneous circulation (ROSC), those who are comatose immediately afterwards have historically had a very high mortality and neurological morbidity rate.

In 2002, a European multicentre randomised controlled trial\(^1\) demonstrated a substantial reduction in the mortality and neurological injury rate in comatose survivors of out-of-hospital primary cardiac arrest (OOHCA) by cooling these patients to 33\(^0\)C for 24 hours. The treatment group had a 55% chance of being alive and capable of independent living at six months. The NNT to save a life with this therapy in this trial was 6. Therapeutic hypothermia is recommended by the International Liaison Committee on Resuscitation (ILCOR) for comatose survivors of OOHCA with a shockable rhythm. They also state that it may be a useful therapy for comatose survivors of in-hospital cardiac arrest or with a non-shockable rhythm\(^2\). Published data from a voluntary Northwest registry\(^3\) and a recent service evaluation at Blackpool Victoria Hospital\(^4\) have both shown that using this therapy the local survival rate for this patient group is the same as in the landmark trials, i.e. around 55%. In both of these local studies, none of the patients who survived to hospital discharge had a severe neurological injury.

The most common cause of cardiac arrest in this group is myocardial infarction (MI). In the case of an ST-elevation MI (STEMI), the gold standard of treatment is emergency angiography and primary PCI to restore coronary blood flow. Currently patients suffering a cardiac arrest caused by a STEMI are being cooled on intensive care units across the region, which is the best therapy to protect their brain and improve their survival. They are also receiving medical therapy for MI but their access to PCI appears to be limited. From the Blackpool data,
between 2008 & 2011, of the 19 OOHCA patients meeting ECG criteria only 5 underwent primary PCI. During this time, only one OOHCA patient was transferred in from another hospital for PCI. There is currently no data describing practice at the other cardiac centres in the region.

The cardiac centres are developing mechanisms for integrating therapeutic hypothermia, ICU support and interventional cardiology, either informally or by establishing formal pathways. Locally, these patients are benefitting from higher rates of emergency revascularisation and specialist cardiology follow-up without compromising their cooling and critical care management. It is recognised that critical care patients in non-cardiac centres, who could benefit from PCI in these circumstances, have more limited access to this kind of service. On 5th October 2012 there was a joint critical care networks conference with consultants representing critical care and cardiology in attendance. It was agreed that it would be desirable to develop a pathway for appropriate patients to be transferred to cardiac centres to receive PCI.

Proposed pathway for comatose survivors of cardiac arrest due to MI

1. Patients suffering an OOHCA are transferred by emergency ambulance to the nearest A&E department (no change to current practice).
2. The patient is reviewed by the critical care doctor on-call and in discussion with the consultant responsible for critical care a decision regarding suitability for ICU admission +/- cooling is made (no change to current practice).
3. If 12-lead ECG suggests myocardial infarction, and the patient is suitable for critical care admission, a senior member of the A&E, critical care or cardiology teams will discuss with the cardiology registrar on-call at LHCH, using the ‘PCI hotline’ number 07769 135 883. If no answer is obtained
from the PCI hotline, the caller should call 0151 600 1817 to get a rapid answer from switchboard (when they will ask for your direct contact number) and subsequently a fast bleep to the SpR for immediate response to the number provided. As the transfer to a PCI centre involves a tangible risk and access to an expensive resource, a suitably-experienced SpR or a consultant should be involved in the decision to refer/transfer. The expectation is that patients with ST-elevation on the ECG will usually be transferred for PCI. Patients without ST-elevation, but with good ECG evidence of significant on-going ischaemia, such as widespread profound ST-segment depression, should also be considered for transfer. If there is doubt about the indication for primary PCI, and in all cases without ST-segment elevation, the ECG’s should be faxed to LHCH for discussion to avoid the situation where a patient is deemed inappropriate for PCI after arrival at LHCH.

4. The cardiology registrar at LHCH will activate the PPCI pathway at LHCH, informing switchboard that a ventilated patient is expected and that an ODP and anaesthetist will be required.

5. The cardiology registrar will contact critical care on-call at LHCH to confirm availability of a critical care bed for the patient post-procedure. If the patient is felt to be suitable for PCI but there is no critical care bed available at LHCH, then the referring hospital will be informed that the patient will be repatriated to them immediately after PCI. It will then be the referring hospital’s responsibility to arrange for a suitable critical care bed. Advice on post-procedure management including medication and access-site care will be provided. Patients will be cared for at LHCH wherever possible and in all cases where mechanical support of the circulation (e.g. by intra-aortic balloon pump) is indicated.

6. If the patient is not for transfer, then care will be at the referring unit as previously. If the decision is made that the cardiac arrest was due to cardiac disease but the patient is not for transfer, ongoing cardiology input and eventual follow up will be from the referring hospital.
7. Patients for angiography will be cooled prior to and during transfer, with a target temperature of 34°C. Transfer should not be delayed by referring units inserting invasive monitoring. Please ensure the right radial artery is not used for arterial blood gas sampling or line insertion and keep this area free of venous cannulae as this is the most-commonly used route of access for the angioplasty procedure.

8. Portable cooling pads (e.g. Emcool) or other devices should be used to cool the patients before and during transfer (and throughout angiography). These should be available in the A&E department of referring hospitals.

9. Transfer to catheter lab will be treated as a matter of urgency by the critical care team, as the benefits of revascularisation are time dependent.

10. Patients will be transferred by NWAS as a matter of urgency and will have an airway-trained medical escort. NWAS crews bringing a comatose survivor of out-of-hospital cardiac arrest to an A&E department should stand by for immediate onward transfer of patients to LHCH, once this has been agreed.

11. Care of the patient will be handed over to the cardiologist and the anaesthetist covering the catheter lab at LHCH.

12. After angiography and, where appropriate, PCI, the patient will be transferred to critical care under the care of the cardiology consultant.

13. Critical care staff will manage cooling and subsequent rewarming of the patient. Once normothermia has been re-obtained, the patient should be transferred back to the critical care unit of the referring hospital, provided there is not an overriding need for further urgent invasive or surgical cardiac treatment, or a continuing requirement for mechanical support of the circulation. Central to this process is early liaison with the local critical care unit that a bed will be needed for the patient approximately 48 hours after their original transfer to LHCH.

14. The cardiology team at LHCH will be responsible for referring the patient to a cardiologist in the referring trust, to whose care the patient will be transferred.
15. If the patient survives to ICU discharge, they will go to a ward under the care of the local cardiologist who will assess their need for ICD implantation, surgery, electrophysiological studies, etc. prior to their discharge.

**Cost considerations**

I have extrapolated the Blackpool data (where there were 6.3 patients per year eligible for this service) to the Cheshire and Merseyside population. We would expect 20-25 eligible cases per year. This may be inaccurate due to its extrapolation from a small area. In the year to February 2013, 17 intubated patients were treated by the primary PCI service at LHCH (HEAT PPCI study data). Once the service is established, there may be additional demand from patients who are unstable having a non-STEMI who may be felt to benefit from emergency revascularisation. Conversely there may be less transfers in due patients being too unstable to transfer.

**Costs:**

**Transfers**

This will add less than 10 emergency transfers per annum to the workload of NWAS.

Emcool pads cost £300 per patient. The network may prefer to not bear this cost and use improvised cooling methods during transfer (e.g. ice packs) on an ad hoc basis instead.
**Interventional cardiology**

Although there is no new cardiology service being offered, this pathway will encourage access for those who are already eligible to receive it. We could anticipate an additional approximately 5-10 emergency angiograms per year.

**Critical Care**

Under the PbR framework, the critical care costs will simply be shifted from the referring unit to the receiving unit, with no net additional cost to the commissioners. This will impact on the PbR income of the individual referring & receiving units.

**References**

1. The Hypothermia after Cardiac Arrest study group. Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest. NEJM. (2002); 346:549-556.
2. 2010 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. Resuscitation. (2010); 81s:e1-e330
4. Unpublished data. Contact robert_shawcross@hotmail.com for details.
Appendix 1: Management of patients transferred back to referring hospital after primary PCI for acute myocardial infarction

This documents the advice for the immediate post-procedure management of patients who have undergone emergency PCI for acute myocardial infarction and are transferred to the intensive care unit of another trust for continuing treatment, such as when the patient remains comatose or sedated after cardiac arrest.

1. Management of the arterial puncture site
   a) Radial artery.

   A ‘TR-band’ will have been applied to the patient’s wrist at the end of the procedure. This is a bracelet with a Velcro fastening, with an air-filled cushion applying pressure over the radial artery puncture site. The balloon is inflated and deflated by inserting the dedicated syringe into the inflation valve to allow air to be injected or released (similar to the cuff on an endotracheal tube). The principle of its use is to apply the minimum amount of pressure to achieve haemostasis whilst allowing anterograde flow through the radial artery. In most patients 12-15ml of air will have been injected into the balloon; injecting more than 20ml will risk rupturing the balloon.

   On arrival at the receiving unit: Ensuring the site is satisfactory and secure. If there is bleeding from the puncture site, inject 1-2ml air into the balloon until the bleeding stops. Note the volume of air in radial band. This should be recorded in the documentation sent with the patient

   From one hour after application of the TR-band, withdraw 2-3ml air every 20-30 minutes until all the air is removed. If bleeding occurs at any point, re-inject 2-3ml air and observe.

   Once all the air has been removed, leave the radial band in situ for a further 15-20 minutes then remove using an aseptic technique and apply a clean dressing.
The patients hand may be pink due to the chlorhexidine used as skin prep for the procedure.

Whilst the TR band is in-situ ensure the hand can be observed for any colour changes (do not cover it with a sheet). If the hand becomes purple / blue the band may be too tight, leading to venous congestion. The band should be loosened by carefully releasing and reattaching the Velcro. A white, cold hand may result from too much pressure being exerted on the radial artery and a couple of ml of air may need to be removed to improve perfusion.

b) Femoral artery (sheath removed).
If the sheath has been removed, a closure device such as an Angioseal will have been deployed to aid haemostasis and a dressing will usually have been applied. The site should be checked every 30 minutes for the first two hours and hourly for the next four hours. If bleeding occurs, apply manual pressure and seek medical advice. Observe for haematoma formation around the site. If this occurs apply manual pressure. Check pedal pulses each time the site is checked to ensure adequate perfusion of the leg.

If the patient is conscious, advise them to apply firm pressure to the puncture site if they cough, laugh, sneeze or pass water, as all of these things can result in a bleed.

Ask the patient to inform staff if:
- The leg feels warm / wet and they think it may be bleeding
- The leg feels numb
- The patient feels dizzy / sick / sweaty

c) Femoral artery (sheath in-situ)
If the patient has received heparin or bivalirudin during the procedure, the activated clotting time should be checked two hours after the procedure, and, if it...
is less than 150 seconds, the sheath can be removed. If an ACT test is not available, an APPT ratio of less than 1.8 should be used. If low molecular weight heparin has been used, clotting tests are unhelpful. The sheath should be removed four hours after the procedure, or six hours if a GpIIb/IIIa-inhibitor infusion is running, e.g. abciximab (ReoPro), tirofiban (Aggrastat) or eptafibitide (Integrellin), or if abciximab was used during the procedure.

To remove the sheath, an aseptic technique should be used. The area around the sheath should be infiltrated with local anaesthetic if the patient is conscious. Vagally-mediated bradycardia and hypotension may occur, so intravenous fluids and atropine should be available. The suture retaining the sheath should be cut, then the sheath withdrawn whilst pressure is applied over the arterial puncture site (this is usually a centimetre or so above the skin incision). If you are pressing in the correct place, you should usually be able to prevent bleeding with one or two fingers. Pressure should be applied for 10 minutes, or longer if further bleeding occurs. If a venous sheath is also present the arterial sheath should be removed first and haemostasis secured before removing the venous sheath in a similar fashion. Once haemostasis has been secured a dressing should be applied and the site observed as above.

2. Post-procedure investigations

The following are recommended, more frequent tests may be performed as required:

FBC: after 4 and 12 hours if abciximab has been used. Daily until stable.

U&E: daily until stable

CKMB: 6 and 12 hours after presentation or Troponin 12 hours after presentation
CXR: as per local protocol for intubated patients.

ECG: on arrival on receiving unit, 12-24 hours after presentation and pre-discharge.

Echocardiogram: 24 to 48 hours post-procedure. Repeat at 6 weeks if initial echo shows poor LV function.

3. Medication
Dual anti-platelet therapy (aspirin plus one of ticagrelor, clopidogrel or prasugrel) is vital and should be given via the nasogastric tube from admission:

Aspirin 75mg o.d.

Ticagrelor 90mg b.d. /clopidogrel 75mg o.d. / prasugrel 10mg o.d.

Other antithrombotic/antiplatelet medication: heparin and LMWH are not usually continued after the procedure. If given, abxicimab should be continued to complete a 12-hour infusion and other GpIIb/IIIa infusions are usually given for 12-24 hours.

Betablockers – if the patient is not bradycardic or hypotensive, or requiring inotropic support:

Bisoprolol 2.5mg stat, then 2.5 mg o.d, increasing as tolerated to 10mg o.d.

ACE-inhibitor – if the patient is not hypotensive or in renal failure:

Ramipril 2.5mg at night starting the day after admission, increasing to 2.5mg b.d. the next day then 5mg b.d. as tolerated.
Statin

Atorvastatin 80mg o.n.

Other medication, such as eplerenone, may be required if LV function is poor, on the advice of the local cardiologist.

4. Continuing cardiology care
The cardiologist at LHCH will be happy to provide further information and advice as necessary.

Your local cardiologist should be involved in the care of the patient as soon as is practically possible and will provide additional advice. When ITU is no longer deemed necessary, the patient should be transferred to the coronary care unit or ward under their care.