Prehospital thoracotomy for traumatic cardiac arrest

Standard cardiopulmonary resuscitation (CPR) is ineffective for treating traumatic cardiac arrest. The mortality of patients whose vital signs fail at the scene of injury and are brought to hospital with ongoing CPR is almost 100 %.

Prehospital resuscitative thoracotomy is a procedure that can improve the prognosis for patients with traumatic cardiac arrest, but the National Advisory Unit on Trauma and the Norwegian Surgical Association recently advised against introducing this procedure in Norway. However, we believe that resuscitative thoracotomy has a place in a specialist prehospital medical service, also in Norway.

Observational studies in Europe and the USA have shown that the mortality of patients who are without vital signs at the scene of injury after a penetrating thoracic trauma is almost 100 %, even if they receive targeted surgical treatment on arrival at hospital (1–4). Conventional cardiopulmonary resuscitation is ineffective for traumatic cardiac arrest (5, 6). Patients whose vital signs fail during transport to hospital and who are undergoing CPR on arrival at hospital therefore have a very poor prognosis, and seldom survive with their neurological function intact (7, 8). There is general consensus that resuscitative thoracotomy should not be performed on patients whose vital signs fail or are absent at the scene of injury when they subsequently arrive in hospital (1–3, 8–10).

The trauma group at Oslo University Hospital has published data on the survival after a heart penetrating injury of patients arriving at the hospital in the period 2001–10 (10). Mortality was 100 % for patients whose vital signs were absent at the scene of injury or failed during transportation if the transport time to the hospital exceeded 10 minutes. The authors proposed that these patients should be given no further treatment because of the hopelessness of their prognosis. This recommendation is consistent with the guidelines in the training programme Advanced Trauma Life Support (ATLS) (11).

Experience from London

The prehospital medical service in London has wanted to give this patient group a treatment option by offering prehospital resuscitative thoracotomy. The indication is penetrating injury to the thorax and/or upper abdomen with subsequent cardiac arrest (asystole, pulseless electrical activity or ventricular fibrillation), and the aim is primarily to counter a potential cardiac tamponade (12) (Box 1).

The procedure is counter-indicated if circulation has stopped for more than ten minutes, or in cases of blunt trauma, and must never be performed on patients with signs of preserved circulation. In the period 1993–2008, 71 resuscitative thoracotomies were performed in London outside hospitals on patients with penetrating chest injuries and subsequent cardiac arrest. Thirteen patients survived to discharge from hospital (18 %), 11 of them with good neurological function (13). With support in the guidelines of the European Resuscitation Council (14) and the aforementioned data from London, we believe that this procedure should be implemented throughout or in parts of the specialist prehospital medical service in Norway. However, the National Advisory Unit on Trauma and the Norwegian Surgical Association recently issued a statement advising against the introduction of such a procedure in Norway (15).

Who should perform prehospital thoracotomy?

The Norwegian Society of Anaesthesiology has taken the initiative to draw up national guidelines for prehospital thoracotomy. In their consultative submission, the National Advisory Unit on Traumatology and the Norwegian Surgical Association maintain that the need for the procedure is too limited to justify training in and a focus on this procedure. They are concerned that the procedure might be carried out on patients who could have survived with rapid transport to hospital, and that the risk factors associated with prehospital thoracotomy are made light of.

A knife wound or other penetrating injury to the heart is rare, but in our view frequency is not an argument for failing to use a potentially life-saving procedure. In our prehospital service we are committed to providing necessary medical aid to all, irrespective of the incidence of the condition and the prognosis. In a meaningful discussion of prehospital thoracotomy, it must be assumed that experienced anaesthetists comply conscientiously with the indication for the procedure and possess the necessary expertise to determine whether the patient is without circulation. Prehospitally, we constantly having to address clinical challenges that we have been trained to deal with, while focusing simultaneously on bringing the patient as fast as possible to the correct treatment level.

The trauma surgery milieu has defined the limits for appropriate use of resuscitative thoracotomy in hospitals. This delimitation is well-founded and supported by repeated observational studies from different coun-

BOX 1

Procedure for prehospital thoracotomy

Here is a proposal for performing the procedure in the manner the authors regard as correct (12, 16)

1. A bilateral thoracotomy is performed between the 4th and 5th ribs in the midaxillary line, and a finger is inserted in the pleural cavity. If circulation is restored at this point because of a released tension pneumothorax, the procedure is halted.
2. The two thoracotomies are linked up via deep cutaneous incisions. The intercostal musculature is cut on both sides from the thoracotomies towards the sternum. The lungs are kept deflated with an open endotracheal tube, and a finger is kept between scissors and lung. The sternum is cut through with scissors.
3. After the thoracotomies have been extended dorsally, the thorax is opened so that heart and lungs are exposed.
4. The pericardium is opened with a longitudinal incision in the central line to release a tamponade.
5. If spontaneous circulation is not restored, internal cardiac massage is started. In a situation with persistent ventricular fibrillation, the thorax is closed, and external defibrillation is performed according to standard guidelines.
6. The descending aorta is compressed manually. In the event of hypovolaemia and difficulty in establishing intravenous access, the heart may be filled directly.
7. In the event of haemorrhaging holes in the heart muscle after the restoration of spontaneous circulation, a finger can be kept in the hole. Suturing may be an option both before and after spontaneous circulation.
8. The four internal thoracic arteries are compressed on the way to the hospital.

tries and trauma systems (1, 2, 7, 8, 13). Direct transport to hospital is only appropriate in a situation where it is believed that the procedure can be performed inside the hospital within ten minutes of circulatory arrest (4, 9, 13). The question of which specialist group performs the procedure is secondary to the time aspect. The real risk lies in transporting these patients during ongoing CPR, and then performing the procedure outside the time limit that offers a chance of survival. Patients who meet the criteria for prehospital resuscitative thoracotomy do not have any real treatment alternative.

The London Air Ambulance Service has over 20 years of experience of performing prehospital thoracotomy, and in a health service that resembles ours in many ways, anaesthetists have demonstrated that they can perform a procedure of this nature safely and effectively (13). We acknowledge that a successfully performed procedure and restored circulation still leaves a highly demanding situation with respect to haemorrhage control and further stabilisation, but this scenario is preferable to the alternative.

Training

Training must be mandatory for anaesthetists who might conceivably find themselves in a situation outside hospital where resuscitative thoracotomy is indicated. Training in resuscitative thoracotomy demands relatively limited resources, as it can be included in existing courses where medical staff practise accepted and highly important procedures associated with haemorrhage control and management of airways.

The Air Ambulance Department at Oslo University Hospital has arranged a number of these courses, and uses a specialised pig model. The learning curve is steep, and this is clearly illustrated in a recently published cadaver study, where both anaesthetists and medical students were found to be capable of performing a resuscitative thoracotomy as swiftly and surely as surgeons after a short period of training and practice on a cadaver model (17). There are of course evident weaknesses associated with such a study, but a cadaver model is relevant, and the transfer value is high as this procedure is performed exclusively on patients without circulation. Practice on dummies can also be a valuable supplement to regular practice in standard operating procedures.

What is ethically correct?

A consultative statement from the National Advisory Unit on Trauma and the Norwegian Surgical Association found prehospital thoracotomy to be ethically questionable. At the same time, it is maintained that establishing a surgical airway is a valid procedure that does not present ethical challenges. It is difficult to understand why it is ethically legitimate to make an incision on the neck of a patient with blocked airways, but unethical to make a larger incision in the patient's thorax in the absence of circulation. Is it the size of the incision that determines whether this is ethically justifiable? The underlying question here is in our view one of aesthetics. Prehospital thoracotomy is unaesthetic, but this is unfortunately confused with the overriding ethical issues. We find it ethically challenging not to offer a treatment that may save lives in a situation where the alternative is to terminate treatment.

A place in Norway too

For the past 20 years, prehospital resuscitative thoracotomy performed on selected patients with traumatic cardiac arrest has contributed to higher survival with intact neurological function. This procedure should therefore have a place in a specialist prehospital medical service in Norway. We hope that training, practice and the development of procedures for Norwegian conditions may be strengthened through dialogue and cooperation with the trauma surgery milieu. Prehospital resuscitative thoracotomy is a procedure that can save lives in a situation where other treatments have proved futile.

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Received 19 September 2016, first revision submitted 30 October 2016, accepted 14 November 2016. Editor: Ketil Slagstad