Emergency thoracotomy: how to do it in 2026

Adam Chesters ,[1,2] Michael Hughes,[1,3] Erica Ley,[1] Matthew O'Meara,[1,4] Gareth Davies,[1] Anil Hormis [1,5]

Handling editor Richard Body

► Additional supplemental material is published online only. To view, please visit the journal online (https://doi.org/10.1136/emermed-2026-216110).

[1]Lincs & Notts Air Ambulance, Lincoln, UK
[2]Department of Emergency Medicine, Cambridge University Hospitals NHS Foundation Trust, Cambridge, UK
[3]Department of Surgery, Leeds Teaching Hospitals NHS Trust, Leeds, UK
[4]Department of Anaesthesia, University Hospitals of North Midlands NHS Trust, Stoke-on-Trent, UK
[5]Sheffield Hallam University, Sheffield, UK

Correspondence to

Received 25 March 2026
Accepted 2 August 2026

To cite: Chesters A, Hughes M, Ley E, *et al*. *Emerg Med J* Epub ahead of print: [*please include* Day Month Year]. doi:10.1136/emermed-2026-216110

ABSTRACT

The prehospital and emergency department practice of emergency thoracotomy has evolved since Wise *et al* published their influential 2005 'how-to' guide. Contemporary practice incorporates refined indications, clearer survival windows, improved understanding of traumatic pathophysiology and enhanced operational, human factors and safety considerations. This updated practical guide provides a modern stepwise approach to emergency thoracotomy in pre-hospital and emergency department settings. It integrates current international guideline recommendations with two decades of operational experience, offering detailed procedural steps, troubleshooting strategies and pragmatic considerations for clinicians who may rarely perform the procedure. This guide aims to support safe, timely and effective decision-making in one of the most time-critical interventions in trauma care.

INTRODUCTION

In 2005, Wise and colleagues[1] published the landmark article '*Emergency Thoracotomy: how to do it*', which described a simplified technique that could be performed by doctors in the prehospital environment or resuscitation room. That paper became a reference point for a generation of clinicians, providing a practical guide for non-cardiothoracic specialists to use in an emergency.

Two decades later, the concept has matured. The procedure is standard practice in many pre-hospital and emergency systems. More is understood about evolving pathophysiology, mechanism of injury, survival time windows, human and psychological dimensions, staff safety, transport logistics and scene management. Survival data from high-performing prehospital services,[2–4] particularly in cases of cardiac tamponade, have reinforced the potential of the procedure while also highlighting its limitations.

This paper provides a practical, contemporary "how-to" guide for emergency thoracotomy. We reflect extensive real-world experience from high-volume prehospital services and contemporary emergency medicine practice. Where evidence is limited, recommendations reflect the authors' collective operational experience across prehospital and emergency settings. The techniques and principles described apply to both emergency department and prehospital practice; where differences exist, these are highlighted. In this paper, we use the term emergency thoracotomy (ET) to encompass resuscitative thoracotomy performed in prehospital and emergency department settings.

WHO SHOULD RECEIVE AN ET?

The European Resuscitation Council (ERC)[5] recommends thoracotomy for traumatic cardiac arrest where loss of vital signs has occurred up to 15 min before. The Eastern Association for the Surgery of Trauma (EAST)[6] emphasises the presence of 'signs of life', recognising that organised electrical activity, pupillary response or spontaneous movement may indicate a salvageable situation even in the absence of a pulse. The Western Trauma Association (WTA)[7] focuses on the duration of cardiopulmonary resuscitation (CPR) and includes selected blunt trauma and penetrating injuries to the neck and extremities.

Prehospital data reinforce this guidance.[2–4] Patients with cardiac tamponade are more likely to survive if thoracotomy is performed within 15 min of witnessed loss of signs of life, whereas those who exsanguinate rarely survive beyond 5 min. These findings are consistent across published services and operational models.

In practice, we recommend using the ERC time-based threshold (≤15 min from loss of vital signs), modified if appropriate by the presence of signs of life as emphasised by EAST and by CPR duration as in the WTA algorithm. These time windows relate to established cardiac arrest; however, our experience is that the greatest benefit may be seen when thoracotomy is initiated before complete loss of cardiac output.

In the prehospital setting, information may be limited. Recent work has suggested that the anatomical location of the wound (as a surrogate for the likely underlying pathology, tamponade vs exsanguination) and presenting cardiac rhythm (as a surrogate for arrest duration) could assist decision making.[8]

A summary of the contemporary evidence and guidance is presented in table 1. The search strategy used to identify relevant material is in online supplemental appendix 2.

HOW TO PERFORM AN ET: A STEP-BY-STEP GUIDE

The 'clamshell' thoracotomy described by Wise *et al* remains the foundation of practice in prehospital and emergency department settings. Two decades of experience have highlighted refinements that improve speed, exposure, and safety. Wise *et al* outline a set of basic equipment required to perform the initial incision and exposure. As the technique has become established, the suggested equipment has changed to allow further management of injuries, improve safety for those performing the procedure and better align with surgical practice. A list of suggested equipment is summarised in online

Table 1 Key contemporary studies and guidelines informing indications, timing and outcomes for emergency thoracotomy

Source	Year	Setting	Mechanism	N	Timing/criteria	Outcomes
Wise *et al*[1]	2005	ED/prehospital	Penetrating	N/A	≤10 min from cardiac arrest	N/A
Matsumoto *et al*[10]	2009	ED/prehospital (Japan)	Blunt	81	Undefined, physician judgement	ROSC 28%; 0 survivors
Davies *et al*[2]	2011	Prehospital (London, UK)	Penetrating	71	≤10 min from cardiac arrest	18% survival
Eastern Association for the Surgery of Trauma guideline[6]	2015	ED	Penetrating/blunt	N/A	ED signs of life OR (if absent): prehospital CPR ≤15 min (penetrating), ≤10 min (blunt)	N/A
Van Vledder *et al*[11]	2017	Prehospital (Netherlands)	Penetrating	33	Not reported	ROSC 27%; 1 survivor
Almond *et al*[4]	2022	Prehospital (Essex, UK)	Penetrating/blunt	44	Not reported	ROSC 25%; 0 survivors
Western Trauma Association guideline[7]	2024	ED	Penetrating/blunt	N/A	CPR duration ≤15 min/≤10 min	N/A
European Resuscitation Council guideline[5]	2025	ED	Penetrating/blunt ("Traumatic cardiac arrest")	N/A	Elapsed time from loss of vital signs ≤15 min	N/A
Perkins *et al*[3]	2025	Prehospital (London, UK)	Penetrating/blunt	601	≤10 min/undefined	ROSC 27%; 5% survival
Ter Avest *et al*[8]	2025	Prehospital (London, UK)	Penetrating/blunt	601	Anatomical wound location/ organised cardiac rhythm	N/A

CPR, cardiopulmonary resuscitation; ED, emergency department; N/A, not applicable; ROSC, return of spontaneous circulation.

supplemental appendix 1. A small bespoke set of specialised equipment is feasible in the prehospital setting, usually provided by agreement with a local hospital. An example is shown in figure 1. Once the chest is open, interventions should follow a structured sequence, with flexibility to deviate when a life-threatening problem is identified. Table 2 outlines a pragmatic order of priorities and summarises necessary actions, their purpose, and common pitfalls. In practice, major haemorrhage or tamponade identified at any stage should be addressed immediately before returning to the sequence.

Patient positioning and the environment

Arms should be abducted in a crucifix position before incision to allow the best possible access to the chest. This is shown in figure 2. An arm by the side of the patient will shorten the posterior extent of the incision, reduce exposure, risk iatrogenic injury to the arm, and make aortic compression more difficult. Although getting the patient in this position is not without challenge, particularly when working in a confined space, it is a simple technique, commonly used in elective surgery to maximise exposure. Lighting is often inadequate in prehospital environments; additional personnel with light sources or dedicated scene lighting should be used to illuminate the cavity, as well as the routine use of head torches.

Figure 1 Example of reusable surgical equipment for emergency thoracotomy that is suitable for use in emergency department or prehospital settings. Processes for equipment cleaning, sterilisation and restocking are essential.

Ventilation during ET

A supraglottic airway device is a rapid means of establishing ventilation without distracting from the thoracotomy itself. Ventilation should be paused during the initial incision into the chest and during key manoeuvres such as opening the pericardium, inspecting the heart or applying hilar control. Positive-pressure breaths can cause the lung to move into the operative field and obscure vision or worsen haemorrhage and be lacerated during the procedure. Once cardiac activity is restored or internal cardiac massage begins, ventilation can recommence using small tidal volumes. Effective ventilation in this context relies on clear communication and a shared understanding of when the operator needs the surgical field to be still and when ventilation is required to maintain oxygenation.

Skin incision and entry into the chest

Surface landmarks can be more reliable than rib counting. In patients without significant breast tissue, sweeping the incision just below the nipple line provides a dependable trajectory across the fifth intercostal space. In patients with breast tissue, the inframammary fold offers a more consistent guide; lifting the breast superiorly avoids division of glandular tissue. Marking the incision with a sterile skin marker before the cut can be helpful, especially for clinicians who perform the procedure infrequently. The incision should pass through skin and subcutaneous tissue in a single arc. Separating the intercostal muscles as close as possible to the upper border of the rib should be performed with curved scissors (or sterile Tuff Cut scissors if necessary). The pleural space should not be breached with a scalpel. Depending on the underlying suspected pathology, thoracostomies may have already been placed, which can be joined up with the incision, taking care to ensure that they are correctly sited. If the incision inadvertently enters different intercostal spaces on each side, the operator should extend the lower side cephalad or the upper side caudad across the sternum to create a single continuous space.

Dividing the sternum can be difficult and time-consuming. Tuff-cut shears remain the most practical option outside of the operating theatre, though they require steady, firm pressure. The Gigli saw is still an important tool. When using it to divide the sternum, we would advise the assistant to place and hold a pair of Spencer Wells forceps flat across the anterior sternum. This will prevent the saw from springing up at the final stroke as it cuts through the sternum and reduce the risk of operator injury from the saw. In emergency department settings, a Lebsche knife or sternal saw may be available, but these require familiarity and should not delay progress if simpler tools are at hand.

Once the sternum is divided, the chest rarely opens as widely as expected. The sterno-pericardial ligament may obscure expected anatomy and should be released to mobilise the pericardium and great vessels. Mechanical rib spreaders, such as Finochietto retractors, should be used routinely; incorrect reassembly after sterilisation is a common cause of apparent failure. Ensuring the incisions are extended toward the posterior axillary line, while avoiding incising the vascular latissimus dorsi muscle, will allow the clam to open maximally.

Opening the pericardium

In the absence of large-volume tamponade, the pericardium appears as a glistening, fibrous sac, and lifting it gently with fine-toothed forceps creates a safe space for the initial incision. Clotted haemopericardium can cause the pericardial sac to be tense and bulging with visible clot. A small incision should be made in approximately the centre of the pericardium and then extended superiorly and inferiorly with small scissors as a continuous cut in a vertical (craniocaudal) plane, anterior to and running parallel with the phrenic nerves, to allow any clot to be evacuated. This is one continuous incision. The heart should be delivered and fully inspected for wounds.

Managing cardiac injuries

Cardiac wounds vary from small, well-circumscribed defects to large and irregular injuries that are incompatible with life. Direct pressure remains the most effective immediate measure for the former. Small wounds can be closed with interrupted monofilament or silk sutures loaded on a curved non-cutting needle. Ligation of or damage to the coronary arteries can precipitate a myocardial infarction. For wounds immediately adjacent to a coronary artery, a horizontal mattress suture placed deep to the artery or sustained digital compression to the injury (again, avoiding compressing the coronary artery) while preparing for transfer reduces the risk to the coronary vessels. Excessive suture tension risks cutting through the tissue as the heart fills. Staples or clips may provide rapid temporary control, but we favour direct pressure and sutures for the non-specialist operator. Staples are harder to place with full-thickness purchase on moving or irregular wounds and cannot be adaptably tensioned in the way a suture can. Emergency and critical care practitioners are used to placing sutures under pressure. Foley catheters, previously described as a means of plugging cardiac wounds, are discouraged by the authors because balloon inflation can enlarge the defect and reduce effective intracardiac volume. Intracardiac cannulation via the right atrium is also problematic in our experience, with a tendency to kink or dislodge during movement and transport. While some services do employ these techniques, we regard them as last-resort options and prefer alternative techniques where possible.

Table 2 Steps to complete once the chest is open

Step	Action	Purpose	Advice and Pitfalls
Open the pericardium	Lift and incise craniocaudally, anterior to and parallel with the phrenic nerves	Relieve tamponade and expose the heart	Single continuous incision, keep anterior to the phrenic nerve
Manage cardiac injuries	Apply direct pressure; close with sutures on a non-cutting needle, consider staples	Achieve haemorrhage control and stabilise cardiac wounds	Avoid damage to a coronary artery; excessive tension may cut through the myocardium; Foley catheters enlarge defects; digital pressure or a non-crushing clamp buys time in large or complex defects
Control pulmonary bleeding	Swabs, non-crushing clamps, or hilar manoeuvres	Control bleeding from lung parenchyma	Strict swab accounting; proximal clamp is temporary and risks tissue damage; lung twist causes ventilatory compromise, last resort
Release the inferior pulmonary ligament	Mobilise the lung	Improve access to hilar structures and aorta	Useful but not essential (eg, in cases of isolated tamponade)
Compress the descending thoracic aorta	Manual compression against vertebral column, clamp if trained	Proximal control; augment coronary/cerebral perfusion	Pinching ineffective/risks injury; the aorta and oesophagus may both be collapsed in hypovolaemia—palpate a nasogastric tube to confirm; clamping without full dissection is an acceptable temporary measure but risks oesophageal injury
Commence internal cardiac massage	Optimise technique. Strict attention to detail. Flat hands, correct force	Maintain cardiac output/organ perfusion	Plan to rotate operator—tiring within minutes. Make this the sole job of the operator to maintain task focus
Consider additional haemorrhage control	Tailor to pathology	Address residual bleeding, stabilise for transport	Plan for haemorrhage control during transport

Once the chest is open, interventions should follow a structured sequence but with flexibility to deviate as required.

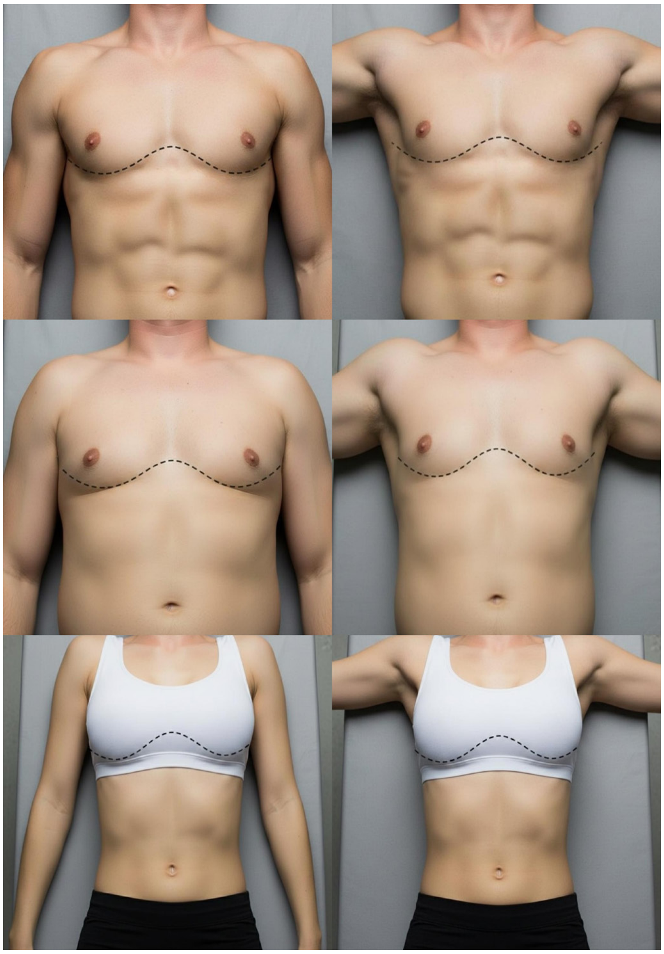

Figure 2 Examples of surgical incisions in patients of different body habitus. Exposure is vastly improved with the arms in a crucifix position. The incision must avoid breast tissue in females, achieved by superior retraction to reveal the inframammary fold. This figure was generated using an artificial intelligence–based image generation tool and subsequently edited and verified by the authors for accuracy and clinical relevance.

Managing lung injuries

The priority is haemorrhage control. Direct pressure with swabs can be effective and requires strict swab accounting. Non-crushing clamps can provide proximal control, particularly for parenchymal injuries. When bleeding cannot be controlled by these measures, hilar control can be achieved by applying direct pressure to the hilum, by clamping or by tying a catheter around the hilar structures. The 'lung twist', in which the lung is rotated 180 degrees along its hilar axis, requires release of the inferior pulmonary ligament.

Aortic occlusion

Aortic occlusion may be the primary reason for performing a thoracotomy, particularly in patients with exsanguination. It can be achieved through either a left lateral thoracotomy—if the operator is familiar with the technique—or a clamshell thoracotomy.

To improve exposure of the descending thoracic aorta, the inferior pulmonary ligament should be released. This ligament is a pleural reflection extending from the inferior aspect of the pulmonary hilum to the diaphragm and posterior mediastinum. Gentle retraction of the lower lobe helps delineate the plane between the ligament and the mediastinum, where digital blunt dissection can be used to separate the pliable connective tissue. This technique creates a corridor to the posterior mediastinum and facilitates access to the aorta. Release of the ligament will provide a more mobile left lung, but if difficult to identify, then this step is not essential.

Once the lung is mobilised, the operator can introduce the right hand—palm up—into the thoracic cavity, advancing posteriorly and medially toward the vertebral column. The first tubular structure encountered is the descending thoracic aorta, followed immediately by the oesophagus. Differentiation between the two may be difficult, particularly in patients without cardiac activity or those who are profoundly hypovolaemic, when both structures are collapsed and closely apposed. A nasogastric tube can be placed and palpated within the oesophagus to aid identification.

Initial control should be achieved through manual compression of the descending thoracic aorta as close to the diaphragm as possible, pressing the vessel posteriorly against the vertebral column with the palm or fist. Pinching or grasping should be avoided, as these manoeuvres are ineffective and risk injury to both the aorta and oesophagus. Application of a non-crushing vascular clamp requires sharp incision of the visceral pleura overlying the aorta, followed by careful blunt dissection to fully separate the aorta from the oesophagus. A clamp applied without full dissection is acceptable as a temporary measure. Although it may not achieve complete occlusion and carries a risk of oesophageal injury, it can substantially reduce distal aortic flow and improve cardiac afterload, coronary perfusion and cerebral perfusion.

Internal cardiac massage

Internal cardiac massage involves compressing the ventricles between both palms, using flat hands and avoiding fingertip pressure. A useful determination of whether the heart is empty or full can be made and can guide initial volume resuscitation. The rate should be 80–100 compressions per minute, allowing time for adequate filling. Massage with ongoing aortic occlusion can improve coronary and cerebral perfusion, particularly when hypovolaemic.

Intracardiac epinephrine

Intracardiac epinephrine can be considered when intravenous or intraosseous access is impossible. Injection into the thinner-walled right ventricular chamber reduces the risk of myocardial injury. Once the pericardium is opened, the right ventricle is immediately encountered and is the most anterior surface of the heart. Major guideline bodies make no such recommendation. In our view, this practice should be regarded as a rescue option when vascular access cannot be obtained.

TEAM DYNAMICS AND HUMAN-FACTOR CONSIDERATIONS

Emergency thoracotomy is one of the most demanding procedures in emergency and prehospital care, and several of its technical and non-technical challenges are specific to the procedure rather than generic to resuscitation. A minimum of two clinicians should be involved, with roles allocated to the specific tasks of thoracotomy: one clinician performs the incision, internal cardiac massage and haemorrhage control while remaining exclusively focused on the surgical field; the second manages ventilation timing, hands instruments, maintains a continuous count of sharps and swabs in an open, bloody cavity and controls the wider scene. Internal cardiac massage is physically tiring within a few minutes, so teams should plan in advance for the operator to be relieved without interrupting compressions. The

Table 3 Post-thoracotomy scenarios and recommended management

Scenario	Recommended action	Key considerations
Injuries incompatible with life	Cease resuscitation; remove and account for equipment; support the team in recognising futility	Massive cardiac destruction or non-survivable thoracic injuries; survival in exsanguination is <2%; avoid prolonging efforts due to emotional momentum
No return of spontaneous circulation	Stop resuscitation after adequate volume replacement and aortic occlusion have been attempted	End-tidal carbon dioxide and assessing cardiac filling directly can help guide decision-making; remote senior advice is valuable in prehospital settings; recognise cognitive bias towards continuing
Fibrillating heart	Optimise coronary perfusion through haemorrhage control, aortic compression and internal cardiac massage; attempt external defibrillation after partial closure of the thoracotomy	Internal paddles may be used in emergency department settings; avoid placing external pads across the incision; fibrillation usually reflects inadequate coronary flow rather than primary arrhythmia
ROSC after tamponade release or haemorrhage control	Control internal mammary bleeding; partially close the clamshell; leave the retractor in situ but loosened to allow rapid re-entry	Temperature management becomes critical; ensure haemostasis before transport; maintain access to the thoracic cavity during transfer
ROSC with ongoing aortic compression	Continue manual or clamp occlusion; titrate blood products carefully; prepare for rapid transfer to definitive care	Minimise distal ischaemia; consider intermittent occlusion (eg, 45 s on and 15 s off); avoid over-resuscitation in isolated tamponade

ROSC, return of spontaneous circulation.

person allocated to internal massage should have this as their only task—this is a part of the procedure where attention to detail and task fixation is desirable. The open chest also carries a specific sharps and blood-exposure risk from Gigli saws, Tuff-cut shears and rib edges in a confined, often poorly lit space and gowning, glove selection and instrument handling should reflect this. Clinicians and bystanders unfamiliar with the procedure can find the sight of an open chest and exposed heart acutely distressing; briefing new team members before the event, and debriefing afterwards, helps manage this specific psychological load. Teams should train together in advance using the equipment they will actually use in the field, verbalise mental models, and maintain a flattened hierarchy to encourage communication, with anticipatory planning—stating what is expected to happen next—used to maintain concurrent activity and reduce delays. Training should extend beyond technical rehearsal: team members must understand their stress responses and practise strategies to maintain performance under pressure. Simulation and mental rehearsal can prepare teams to manage the dynamics of the scene, ensuring that when the procedure is required, it is performed to the best of their technical and non-technical ability.

WHAT HAPPENS NEXT?

Injuries incompatible with life should prompt rapid cessation of resuscitation. Massive cardiac destruction, for example, leaves little room for meaningful intervention, and the balance swings towards physical and psychological risk to responders. In some patients, despite adequate volume replacement and aortic occlusion, no cardiac activity is identified. Large case series confirm that survival in patients with exsanguination is extremely rare (1.9%),[3] and there are no survivors when tamponade and exsanguination coexist. The team may be heavily emotionally invested in the operative course of action. This is recognised as a source of bias toward continuing resuscitation beyond the point of benefit. The use of a senior remote advice system is encouraged to provide objective decision-making.

In trauma, ventricular fibrillation most commonly reflects critically impaired coronary perfusion rather than a primary arrhythmia. Management should prioritise haemorrhage control, aortic compression, volume replacement and effective internal cardiac massage to restore myocardial blood flow. In prehospital settings, internal defibrillation is rarely feasible due to equipment limitations and environmental constraints; external defibrillation may be attempted by partially closing the thoracotomy with the pads applied in approximately the usual anteroposterior positions once closed. The anterior pad should not cross the incision and should be applied to best achieve a transcardiac vector. Major guideline bodies (ERC, EAST and WTA) do not provide specific recommendations on internal defibrillation during emergency thoracotomy; however, Advanced trauma life support 10th edition[9] describes defibrillation with internal paddles at low energy as an acceptable option in the emergency department, typically at an initial energy of 10–20 J, increasing to a maximum of 40 J if the first shock is unsuccessful.

When circulation returns after tamponade release or haemorrhage control, brisk bleeding from the internal mammary arteries is common and can be controlled with artery forceps or direct pressure. The clamshell can be partially closed, with the retractor left in situ to allow rapid re-entry. Attention should be paid to heat preservation using techniques such as cling film, heated blanket devices, traditional blankets and environmental temperature control.

Consideration should be given to patient positioning during transport. In road ambulances in the United Kingdom, one suggested approach is to load the patient in reverse, rotating the scoop stretcher 180 degrees on the trolley so that the left side of the chest is positioned away from the offside wall of the vehicle. This orientation facilitates access to the thoracotomy site but may compromise the function of the standard patient restraint system. In some circumstances, air transport may be preferable. Services should assess whether modified loading configurations are compatible with flight regulations and operational practicality before adoption.

In patients requiring continued aortic compression, time to definitive care is critical. Every minute of compression leads to worsening distal ischaemia and metabolic burden once compression is released. Intermittent occlusion (45 s on and 15 s off) and/or partial occlusion should be considered to mitigate the effects of total occlusion. Blood products or volume replacement should be titrated carefully to resuscitation targets. In isolated tamponade, patients may be euvolaemic and require minimal fluid replacement.

Post-thoracotomy scenarios and recommended management are summarised in table 3. Post-return of spontaneous circulation actions are listed in online supplemental table 1.

GOVERNANCE, SAFETY AND OVERSIGHT

ET should be embedded within a wider governance framework for high-acuity, low-occurrence procedures. We recommend four foundation components.

1. A written checklist, structured in three sections for use before, during and after the procedure: a preprocedure section confirming indication, team roles and equipment availability; an intraprocedure section prompting the key decision points described in table 2; and a postprocedure section covering haemostasis, transfer readiness and staff welfare. Services should design the checklist locally, aligning it with the World Health Organisation Surgical Safety Checklist and NatSSIPS (in England) or equivalent local frameworks.
2. A service-specific standard operating procedure (SOP), aligned to national and international guidelines and adapted to local circumstances. Including authorisation criteria and prospective training requirements to define who may perform ET and under what supervision.
3. Immediate access to senior clinical advice, mandatory debrief of every procedure and audit of every case (including record-keeping and SOP compliance).
4. Agreed equipment governance, for example, and agreement with a local Central Sterile Services Department, including a tested process for rapid exchange or replacement of used equipment.

CONCLUSION

The emergency thoracotomy procedure described by Wise *et al* in 2005 was foundational for emergency department and prehospital practice that followed. This guide updates that technique with two decades of published data and operational experience. We describe a systematic approach that maximises the chance of reproducible success: crucifix positioning, a carefully sited incision and rapid division of the sternum. Once the chest is open, the procedure flows in sequence—pericardium, cardiac injuries, pulmonary bleeding, aortic occlusion and internal cardiac massage—prioritising major haemorrhage or tamponade before returning to the sequence. Wound management, aortic occlusion and effective two-handed internal massage are described. Prehospital services must tailor indications to mechanism and suspected pathophysiology, recognising the importance of short survival windows and embedding safe, well-governed processes that facilitate rapid delivery of the intervention. Future practice is likely to focus less on extending post-arrest thresholds and more on considering intervention or novel procedures before complete loss of signs of life.

Contributors AC conceived the work and acts as guarantor. All authors contributed to the design of the work, the acquisition and interpretation of data and the development of the manuscript. All authors were involved in drafting the article and revising it critically. All authors approved the final version to be submitted. Figure 1 was generated using an artificial intelligence-based image generation tool and subsequently edited and verified by the authors for accuracy and clinical relevance.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

ORCID iDs

Adam Chesters https://orcid.org/0009-0004-6006-5110

Anil Hormis https://orcid.org/0000-0001-5510-7639

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