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Emergency Room Thoracotomy: A Multidisciplinary Approach for Emergency, Surgical, and Critical Care Teams

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Abstract

Background: Emergency room thoracotomy (ERT) is an aggressive resuscitative procedure performed in extreme, time-critical trauma scenarios. It aims to restore circulation and oxygen delivery by addressing life-threatening intrathoracic injuries such as hemorrhage, cardiac tamponade, and traumatic arrest.

Aim: This study reviews the multidisciplinary approach to ERT, emphasizing indications, contraindications, procedural techniques, and team coordination to optimize outcomes.

Methods: A comprehensive literature-based analysis was conducted, integrating anatomical, physiological, and operational considerations. The review synthesizes evidence on patient selection, procedural steps, equipment requirements, and interprofessional roles, alongside complication profiles and survival data.

Results: ERT demonstrates its greatest benefit in penetrating thoracic injuries with reversible causes of arrest, such as tamponade or exsanguination. Survival rates remain low (7.4–8.5%), but meaningful salvage is possible when strict criteria are met. Contraindications include prolonged pulselessness (>15 minutes), absence of signs of life, and unsurvivable injuries. Key procedural elements include rapid thoracic entry, hemorrhage control, pericardial decompression, and aortic cross-clamping. Success depends on system readiness, simulation-based training, and seamless team coordination.

Conclusion: ERT is a last-resort intervention that can convert imminent death into survival when applied judiciously. Its effectiveness hinges on rigorous patient selection, technical proficiency, and integrated trauma systems.

Keywords: Emergency thoracotomy, trauma resuscitation, cardiac tamponade, hemorrhage control, aortic cross-clamp, multidisciplinary care

Introduction

Emergent thoracotomy, often termed emergency room thoracotomy, constitutes an extreme yet potentially decisive resuscitative intervention undertaken in carefully selected, time-critical circumstances. Its fundamental intent is not to provide definitive repair, but rather to achieve rapid physiologic stabilization by immediately addressing life-threatening intrathoracic processes. In this context, the procedure is performed to temporize catastrophic injuries through direct access to the thoracic cavity, enabling prompt control of intrathoracic hemorrhage, relief of obstructive shock due to pericardial tamponade, and proximal control of the aorta to mitigate ongoing exsanguination. When employed under appropriate indications and within an organized system of trauma care, emergent thoracotomy may convert an otherwise fatal clinical trajectory into one in which the patient survives long enough to reach definitive surgical management [1].

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Despite its dramatic nature and the substantial resource intensity it entails, emergent thoracotomy is not a routine maneuver and should be contemplated only when the anticipated benefits outweigh its risks and when the clinical scenario suggests a reversible cause of impending death. In those rare presentations where rapid deterioration is driven by potentially correctable pathology—particularly massive intrathoracic bleeding, tamponade physiology, or traumatic circulatory arrest with a plausible window for salvage—this intervention can be life-saving. Accordingly, the decision to proceed should be grounded in well-established criteria for candidacy and futility, emphasizing both the mechanism of injury and the patient's physiologic status at presentation. A rigorous understanding of when the procedure should be pursued, and equally when it should be avoided, is therefore essential for clinicians involved in emergency and trauma care [1].

The overarching objectives of emergency room thoracotomy are multifaceted and focused on immediate restoration or support of circulation and oxygen delivery. Chief among these aims is expedited hemorrhage control, achieved through direct visualization and compression, clamping, or temporary repair of injured thoracic structures. A second critical purpose is the rapid decompression of pericardial tamponade, a reversible cause of obstructive shock, by opening the pericardium and evacuating accumulated blood to re-establish effective cardiac filling [2][3]. In situations of traumatic arrest or profound hemodynamic collapse, the procedure also permits direct open cardiac massage as an adjunctive resuscitative measure when external compressions are ineffective or insufficient [4][5]. Additionally, emergent thoracotomy may be used to reduce the risk of air embolism by enabling control of pulmonary vascular injury and preventing further entrainment of air into the circulation. Exposure of the descending thoracic aorta for cross-clamping is another central component, serving to redistribute limited circulating volume toward the heart and brain while decreasing distal blood loss. Finally, the approach may allow immediate, temporizing repair of cardiac or pulmonary injuries, thereby stabilizing the patient for subsequent definitive operative intervention [1]. Operationally, emergent thoracotomy is most commonly executed in the emergency department during active resuscitation, though it may also be performed in the operating theatre depending on institutional logistics and the patient's clinical condition. In such settings, the emergency clinician bears crucial responsibilities beyond initiating the procedure, including early notification and coordination with surgical teams, facilitation of efficient execution, and meticulous post-thoracotomy management to address ongoing hemorrhage, ventilation, perfusion, and the transition to definitive care.

Anatomy and Physiology

The thorax constitutes the central compartment of the trunk, anatomically interposed between the cervical region superiorly and the diaphragm inferiorly. This region functions as a protective osseocartilaginous cage and as a dynamic pressure chamber essential for ventilation and circulatory performance. Within the thoracic cavity lie the principal organs of respiration and circulation, most notably the lungs and the heart, together with major vascular conduits that include the ascending aorta, the aortic arch and its branches, and the descending thoracic aorta. Understanding the spatial relationships among these structures is fundamental for emergency and surgical interventions that require rapid access to intrathoracic anatomy. In typical adult anatomy, the heart is positioned slightly left of the midline within the mediastinum, with its long axis oriented obliquely. The aortic root originates near the midline at the base of the heart, after which the ascending aorta transitions into the aortic arch. The arch characteristically courses in a posterolateral direction toward the left, forming a curved trajectory before continuing as the descending thoracic aorta. The descending aorta then travels inferiorly along the left aspect of the vertebral column, maintaining a close anatomic relationship to the spine. These orientations are clinically significant because they influence where vascular control may be achieved during thoracic exposure and explain why certain structures can be rapidly accessed while others remain relatively concealed [4][5].

The great vessels and the aortic arch occupy a relatively posterior location in the superior mediastinum, situated behind the manubrium. This posterior relationship to the upper sternum contributes to both their protection and the complexity of operative exposure in emergent settings. The principal branches of the aortic arch supply the head, neck, and upper extremities. Among these, the brachiocephalic artery is the first major branch and subsequently bifurcates into the right common carotid and right subclavian arteries. Additional branches include the left common carotid artery and the left subclavian artery, which arise directly from the arch and contribute to cerebral and upper-limb perfusion. The arrangement and branching patterns of these vessels are highly relevant to trauma evaluation and operative planning, given the potential for rapid hemodynamic collapse with injury in this region. The heart is enclosed within the pericardial sac, a fibrous-serous structure that stabilizes cardiac position and permits frictionless movement during the cardiac cycle. The intimate anatomic relationships between the pericardium and surrounding neurovascular structures carry important procedural implications. The left phrenic nerve, in particular, courses in close proximity along the lateral aspect of the pericardial sac, rendering it vulnerable during thoracic entry and pericardial manipulation. Injury to this nerve may compromise diaphragmatic function and thereby impair respiratory mechanics, an especially consequential complication in critically ill patients [5]. In contrast, the left vagus nerve follows a course that generally renders it less exposed during resuscitative thoracotomy. It travels anterior to the aortic arch in the vicinity of the left subclavian artery and gives rise to the recurrent laryngeal nerve before continuing posteriorly toward the root of the left lung. It then descends adjacent to the esophagus into the posterior mediastinum. The esophagus itself runs anterior to the vertebral column and typically remains medial to the descending aorta, reflecting a close but distinct relationship that becomes relevant during deep mediastinal dissection. Finally, the thoracic duct courses anterolateral to the spine and is frequently difficult to identify visually, a fact that underscores the risk of unrecognized lymphatic injury during thoracic procedures and the importance of meticulous anatomic awareness even under emergent conditions [3][4][5].

Indications

Emergency room thoracotomy is a highly aggressive resuscitative procedure reserved for narrowly defined clinical circumstances in which there is a realistic potential to reverse an immediately fatal thoracic process. Its indications are therefore deliberately restrictive, reflecting both the physiologic severity of the patients in whom it is contemplated and the consistently poor outcomes observed when it is undertaken outside evidence-informed criteria. In contemporary emergency and trauma practice, the strongest indication profile centers on traumatic arrest or impending arrest resulting from potentially correctable intrathoracic pathology, particularly when the mechanism of injury and the temporal window from loss of circulation suggest that meaningful salvage remains possible. A principal indication involves patients sustaining penetrating cardiac trauma in whom cardiac tamponade is identified, including cases where tamponade is demonstrated by focused assessment with sonography for trauma (FAST). In this context, the accumulation of blood within the pericardial sac can rapidly produce obstructive shock by restricting diastolic filling, precipitating profound hypotension and subsequent cardiac arrest. For such patients, emergency room thoracotomy may provide the only rapid means of decompressing the pericardium and restoring effective cardiac output when deterioration is imminent. This indication also extends to individuals who are pulseless following traumatic thoracic injury when cardiopulmonary resuscitation has been initiated promptly and has not exceeded a short duration—commonly referenced as less than 15 minutes—thereby preserving a plausible likelihood of neurologically meaningful survival [6]. The emphasis on a limited interval of arrest is central: beyond this window, the probability of irreversible hypoxic injury and refractory physiologic collapse rises sharply, while procedural benefit diminishes substantially. It is important to acknowledge that emergency room thoracotomy is associated with a high mortality rate. However, this outcome profile is largely attributable to the extremity of the clinical condition prompting its use rather than the procedure alone. Indeed, available experience indicates that there has been minimal success when emergent thoracotomy is performed beyond these established indications, reinforcing the principle that indiscriminate application is unlikely to improve survival and may instead expend critical resources without patient benefit [7]. Consequently, appropriate patient selection—integrating mechanism, elapsed time, physiologic trajectory, and evidence of potentially reversible causes—remains the most decisive determinant of whether the intervention is justified [6][7].

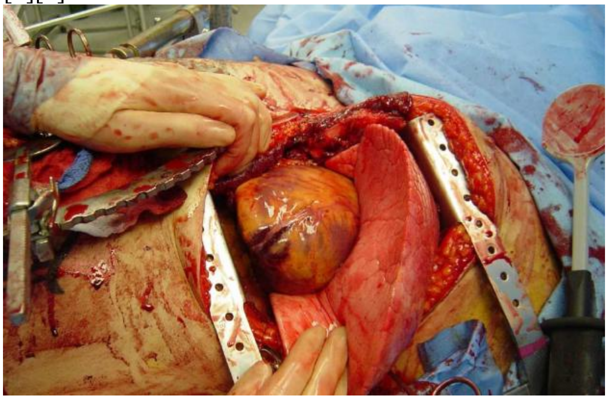

Fig. 1: Emergency Room Thoracotomy.

In selected patients with penetrating cardiac trauma complicated by tamponade who remain hemodynamically unstable but continue to exhibit signs of life, pericardiocentesis may serve as a temporizing maneuver. This needle-based decompression may be performed in the prehospital environment by emergency medical services or in the emergency department to restore partial cardiac filling and transiently improve perfusion. Nonetheless, pericardiocentesis should be viewed as a bridge rather than definitive therapy, and clinical deterioration despite the procedure—particularly progression to loss of signs of life—may necessitate emergency room thoracotomy to achieve direct decompression and facilitate immediate control of the underlying injury until definitive operative repair can be arranged. A further, more selective indication pertains to certain cases of blunt thoracic trauma, specifically in patients without unsurvivable concomitant injuries—such as massive cranial destruction—who lose vital signs yet still demonstrate signs of life [8]. Blunt mechanisms that may precipitate such a scenario include high-energy motor vehicle collisions with steering wheel impact to the anterior chest, where myocardial contusion, cardiac rupture, or major intrathoracic vascular injury may culminate in abrupt circulatory collapse [9]. In this narrowly defined population, emergency room thoracotomy may temporarily restore circulation, relieve tamponade physiology, or permit aortic control, thereby creating a brief but critical opportunity to achieve definitive management in the operating theatre. When applied to the appropriate candidate, this intervention may not only avert death but also allow the possibility of meaningful recovery and functional survival after injuries that would otherwise be fatal [10].

Contraindications

Emergency room thoracotomy is an extraordinary resuscitative intervention intended to provide immediate, temporary physiologic salvage in narrowly defined scenarios. Because it is invasive, resource-intensive, and associated with substantial morbidity and mortality, its use must be constrained by clear contraindications that reflect both clinical futility and systems-based safety requirements. Inappropriate deployment not only fails to improve outcomes but may also divert personnel, space, and equipment from other critically ill patients while exposing the patient to a procedure that cannot realistically achieve meaningful survival. A fundamental contraindication is the presence of ongoing vital signs. Patients who maintain spontaneous circulation—whether normotensive or profoundly hypotensive—do not meet the threshold for resuscitative thoracotomy, as their immediate needs are better addressed through expedited definitive management pathways, including rapid imaging, hemorrhage control strategies, and operative intervention when indicated. The procedure is designed primarily for patients in extremis or traumatic arrest, and performing it on an individual who still has detectable vital signs represents a departure from its intended physiologic rationale and risk–benefit profile. Equally important are scenarios in which the clinical circumstances strongly indicate futility. Situations regarded as futile include the absence of signs of life at the scene of injury, as well as presentation in asystole when there is no evidence of pericardial tamponade, since this combination suggests either irreversible cardiac failure or a non-correctable cause of arrest. Prolonged pulselessness is another major limitation; when the duration of pulselessness exceeds 15 minutes, the likelihood of achieving return of spontaneous circulation with neurologically meaningful survival becomes exceedingly low. In addition, emergency room thoracotomy should be avoided in the setting of massive, clearly nonsurvivable injuries, where the magnitude of tissue destruction or physiologic insult precludes recovery regardless of intervention. This includes, but is not limited to, catastrophic injuries to the head or torso that are incompatible with life. Population-specific considerations further refine contraindication thresholds. Within pediatric care, evidence indicates that outcomes for children aged 0–14 years who undergo emergency thoracotomy after blunt thoracic trauma are exceptionally poor, even when other selection criteria appear favorable, such as witnessed loss of pulse and the absence of overtly unsurvivable injury. For this subgroup, withholding emergent thoracotomy should be actively considered because the probability of benefit is minimal [11]. By contrast, adolescents aged 15–18 years with blunt thoracic mechanisms, and pediatric patients of varying ages with penetrating thoracic injuries, are not generally regarded as having the same degree of relative contraindication, reflecting comparatively different injury patterns and salvage potential [11]. Similarly, in older adults, there is evidence that the intervention becomes progressively less effective with advancing age, and consideration should be given to withholding the procedure in patients older than 57 years, as the likelihood of meaningful survival diminishes substantially [12].

In addition to patient-centered factors, emergency room thoracotomy is contraindicated when the required resources for definitive care are not immediately available. Because the procedure is a temporizing bridge rather than a definitive solution, it should not be initiated unless rapid transition to an operating theatre and a capable surgical team can be ensured. Undertaking thoracotomy without appropriate expertise, without immediate operative capability, or in an environment lacking essential resuscitative equipment risks converting a theoretically salvageable patient into one exposed to uncontrolled hemorrhage, prolonged open-chest resuscitation, and preventable complications without a pathway to definitive repair. Accordingly, lack of necessary equipment—including, in many protocols, a manual internal defibrillator—may be considered a practical contraindication when it prevents execution of key lifesaving components of open-chest resuscitation. Finally, several clinical contexts are commonly recognized as contraindications because they imply a low probability that thoracotomy will address the primary cause of collapse or because they indicate systemic injury severity beyond salvage. These include penetrating abdominal trauma in the prehospital setting when there is no cardiac activity, severe head injury, and severe multisystem trauma, where the dominant drivers of mortality are unlikely to be reversible through thoracic access alone. In these circumstances, the procedure is unlikely to alter outcome and should generally be withheld in favor of alternative resuscitative priorities or recognition of non-survivability [10][11][12].

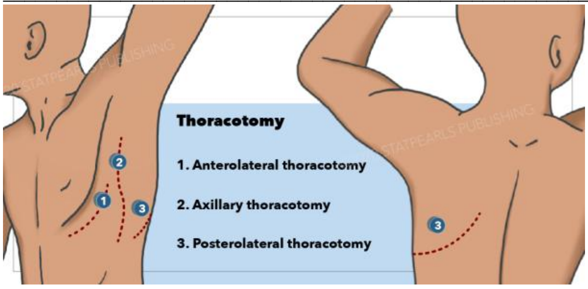

Fig. 2: Thoracotomy.

Equipment

Emergency room thoracotomy requires immediate access to a comprehensive, sterile, and purpose-designed set of instruments capable of enabling rapid entry into the thoracic cavity, effective exposure, hemorrhage control, and temporary repair. At a minimum, a sterile thoracotomy tray should be available and consistently stocked, as the procedural tempo in resuscitative circumstances leaves no margin for improvised collection of supplies. Core sterile components include drapes and towels to establish a workable field, together with laparotomy sponges to facilitate rapid packing, blotting, and temporary compression of bleeding structures. Cutting instruments are essential for swift access and controlled dissection; therefore, a scalpel with an appropriate holder and robust surgical scissors should be included. Exposure is typically achieved with a rib spreader, which must be functional and readily deployable to maintain adequate visualization once the chest has been entered. Given that a key physiologic aim of emergency thoracotomy is temporary control of catastrophic hemorrhage, a dedicated aortic cross-clamp is indispensable, along with an assortment of hemostatic clamps suitable for vascular and soft-tissue control. Tissue forceps and needle drivers are required to support rapid suturing of cardiac, pulmonary, or vessel injuries when temporary repair is feasible, and the tray should include sutures appropriate for cardiothoracic use. Teflon pledgets should be available to reinforce sutures in friable myocardium or pulmonary tissue and reduce the risk of suture cut-through during emergent repairs. An optional but valuable adjunct is a 20F Foley catheter with a 30-ml balloon, which can be used as a tamponade device to control bleeding from certain penetrating wounds, particularly when direct suturing is not immediately achievable. Environmental and support equipment meaningfully influence the efficiency and safety of the intervention. Adequate lighting and effective suction are highly advantageous, as blood and clots can rapidly obscure the operative field; however, these supports may be limited in a crowded resuscitation bay, underscoring the importance of planning for contingencies. A manual internal defibrillator should be available and functional, as the procedure occurs in the setting of active resuscitation, and once the thoracic cavity is opened, external defibrillation becomes markedly less effective. Finally, post-procedural pleural drainage is a practical requirement, and a large-bore chest tube—commonly 30F—should be prepared for prompt placement to manage hemothorax or pneumothorax and to support ongoing ventilation and hemodynamic stabilization [11][12].

Personnel

The successful execution of emergency room thoracotomy is fundamentally team-dependent, requiring clearly defined roles, parallel task performance, and immediate access to a pathway for definitive surgical care. Because the procedure is performed during physiologic collapse or traumatic arrest, resuscitation cannot pause while thoracic access is obtained. Accordingly, at least one clinician should be assigned exclusively to continuing standard resuscitative measures, including advanced cardiac life support (ACLS) and trauma-focused resuscitation principles. This individual must coordinate airway management, ventilation, vascular access, transfusion, medication administration, and rhythm assessment, supported by additional personnel who can perform compressions, manage the defibrillator, prepare blood products, and document time-sensitive events. Simultaneously, a separate operator should be dedicated to performing the thoracotomy itself. This individual should ideally possess substantial procedural competence in thoracic entry, pericardial exposure, hemorrhage control maneuvers, and aortic cross-clamping. When feasible, the thoracotomy operator should have a trained assistant to facilitate retraction, suctioning, instrument exchange, and rapid suture handling, as the complexity and speed of intrathoracic tasks often exceed what a single clinician can safely manage. Efficient communication between the resuscitation lead and the thoracotomy operator is critical, particularly when assessing signs of life, evaluating rhythm changes, coordinating internal and external cardiac massage strategies, and determining whether ongoing efforts remain appropriate. Beyond the immediate bedside team, emergency room thoracotomy should only be undertaken when a credible and immediate route to definitive care exists. This requires the availability of a surgeon and trauma team, as well as operating room personnel capable of receiving the patient without delay. Even when the initial thoracotomy is performed in the emergency department, the procedure is inherently temporizing; long-term survival hinges on rapid transition to definitive repair, hemostasis, and critical care management. Therefore, staffing considerations must include anesthesia support or airway expertise, nursing personnel trained in massive transfusion protocols, and personnel able to mobilize operative resources. In well-functioning systems, these teams operate as an integrated continuum, with emergency clinicians initiating life-saving access and stabilization and surgical teams completing definitive intervention under controlled operative conditions [12].

Preparation

Preparation for emergency room thoracotomy is constrained by the reality that the procedure is performed under extreme time pressure, often within minutes of patient arrival or sudden clinical deterioration. Consequently, the most meaningful preparation occurs before the procedure is ever needed, through deliberate systems planning, equipment standardization, and clinician training. Providers who may be required to initiate resuscitative thoracotomy must know precisely where the necessary instruments are stored, how they are packaged, and how to deploy them efficiently. Familiarity with the thoracotomy tray contents and the functional setup of key tools, such as the rib spreader, aortic cross-clamp, suction, and internal defibrillator, is essential to preventing avoidable delays during a rapidly evolving resuscitation. Equally important is cognitive and procedural readiness. Clinicians should be thoroughly versed in the procedural steps, the anatomic landmarks that guide safe entry and exposure, and the clinical indications and contraindications that determine whether thoracotomy is justified. Because inappropriate performance can result in futile intervention or iatrogenic injury, preparation should include simulation-based rehearsal when possible, as well as periodic review of institutional protocols that define candidacy, time thresholds, and post-procedure transition pathways. Before initiating the procedure in a live resuscitation, all personnel required for immediate execution should be identified and positioned, and the essential equipment should be gathered, opened, and arranged in a manner that supports rapid sequencing of tasks. Even brief pre-procedural organization—assigning roles, confirming suction function, ensuring lighting, and preparing blood products—can substantially improve procedural efficiency. Infection prevention measures should be integrated into preparation while recognizing that resuscitative priorities supersede elective surgical standards. Antibiotic prophylaxis is generally recommended before cardiothoracic surgery; however, emergency thoracotomy should not be delayed while awaiting antibiotic administration, as the survival benefit depends on immediate correction of fatal physiology. Universal precautions remain mandatory, given the high likelihood of blood exposure and aerosol-generating interventions during active resuscitation. All personnel involved should don gowns, gloves, and eye protection, balancing speed with safety. Ultimately, the goal of preparation is to ensure that when the rare indication arises, the team can initiate emergency room thoracotomy without hesitation, unnecessary delay, or preventable equipment and coordination failures, thereby maximizing the chance that the procedure accomplishes its intended temporizing, life-preserving function [11][12].

Technique or Treatment

Emergency room thoracotomy is performed under conditions of extreme physiologic instability and therefore demands an approach that is both anatomically disciplined and operationally efficient. The procedure is fundamentally a temporizing intervention intended to reverse immediately lethal intrathoracic pathology long enough to permit definitive operative management. Because outcomes depend on speed, exposure, and correct prioritization of maneuvers, the technique should be executed in a structured sequence that preserves safety while recognizing that resuscitative imperatives frequently preclude ideal circumstances. The patient is positioned supine, ideally with both arms abducted and extended to approximately 90 degrees to optimize access to the lateral thoracic wall and facilitate unobstructed instrument movement. In most cases, a left-sided approach is selected because it provides rapid entry to the left hemithorax and affords direct access to the pericardium, heart, and descending thoracic aorta. A skin incision is created using a #10 scalpel blade, typically beginning near the sternum and traversing the fourth or fifth intercostal space below the nipple line. The incision is carried laterally, following the curvature of the ribs, toward the posterior mid-axillary line. In female patients, the breast tissue should be retracted superiorly to maintain anatomic accuracy and ensure that the incision is placed appropriately along the intended intercostal space. The initial incision must divide skin and subcutaneous tissue; in thin patients it may be continued directly down to the rib cage, whereas in patients with greater soft tissue thickness the operator should proceed deliberately while maintaining orientation to the rib spaces. Although the left anterolateral thoracotomy is the classic approach, circumstances may necessitate alternative exposure. If hemorrhage from the right thorax is suspected based on the injury pattern or clinical findings, a right-sided approach can be employed to address right-sided pulmonary or mediastinal sources. Moreover, the incision can be extended across the chest beneath the sternum to create a clamshell thoracotomy, thereby exposing both hemithoraces and the anterior mediastinum, including the aortic arch and great vessels. The optimal approach remains debated, and some argue that in settings where the emergency provider performs the procedure infrequently and where complete injury information is unavailable, the clamshell incision may offer a more comprehensive exposure and thus a procedural advantage [13]. This rationale rests on the premise that broader visualization may reduce diagnostic uncertainty and facilitate rapid control of bilateral intrathoracic pathology, though it must be balanced against the added time, tissue disruption, and technical complexity [12][13].

After identifying the appropriate intercostal space, a small lateral "starter" incision is made, typically one to two inches in length. This is placed laterally to reduce the risk of inadvertently injuring the heart, and it is made along the superior margin of the inferior rib in order to avoid the intercostal neurovascular bundle, which runs along the inferior border of the superior rib. The incision must penetrate the intercostal musculature and enter the pleural space, with careful attention to avoid lacerating the underlying lung. Once pleural entry is confirmed, Mayo scissors or sterile trauma shears are used to extend the incision from the initial defect. The cut is directed anteriorly toward the sternum through the intercostal muscles and then continued posteriorly toward the posterior mid-axillary line, creating a thoracotomy that is sufficiently wide to permit insertion of a rib spreader and meaningful access to the mediastinum. Upon entry, a rib spreader is inserted between the ribs with appropriate orientation: the arm directed toward the axilla and the ratchet bar positioned inferiorly. The spreader is then opened to the maximum extent that the patient's anatomy permits, as exposure is a decisive determinant of both speed and safety. Once the chest is open, airway and ventilation strategies may be modified to enhance operative visualization. Optional right main-stem bronchus intubation can reduce ventilation of the left lung, allowing the lung to deflate and thereby improving the surgical field. The operator should immediately address any obvious bleeding using direct manual pressure or laparotomy sponges. Mechanical clamps should be used conservatively and generally as a last resort, given the risk of additional tissue injury and the potential to create complex vascular tears in friable structures. Control of pulmonary vascular hemorrhage requires decisive temporizing maneuvers. Bleeding from major pulmonary vessels may be reduced by clamping the injured lung tissue or involved vessel directly when feasible. In more severe circumstances, proximal control can be achieved by clamping the pulmonary hilum, or by performing a "pulmonary hilar twist," which both reduces hemorrhage and decreases the risk of air embolism by limiting further entrainment of air into the circulation. These measures are not definitive repairs but rather stabilization techniques meant to prevent rapid exsanguination or catastrophic embolic physiology while other corrective actions are undertaken [13].

Attention then turns to the pericardium and heart, guided by the presence or absence of pericardial effusion and the apparent mechanism of injury. If there is no pericardial effusion and no visible evidence of pericardial violation, it may be reasonable to prioritize additional damage-control actions—such as hemorrhage compression and aortic control—before opening the pericardium. Open cardiac massage can be performed with the pericardium intact; however, if the myocardium cannot be adequately visualized or if tamponade or direct cardiac injury is suspected, pericardiotomy becomes necessary. The heart may then be delivered from the pericardial sac to allow direct inspection and control of cardiac wounds. Pericardiotomy should be performed with meticulous awareness of adjacent neural structures, particularly the phrenic nerve, which courses along the lateral pericardium. The nerve should be identified and protected during pericardial incision and extension. The pericardium is grasped with toothed forceps to elevate it away from the myocardium, and a small initial incision is made using scissors or a scalpel. This first opening must be created carefully to avoid iatrogenic myocardial laceration and to prevent injury to the phrenic nerve. The incision is then extended superiorly in a direction parallel to the phrenic nerve, with the objective of exposing the great vessels as well as the cardiac surface. Pericardial fluid and clots are evacuated promptly, and the great vessels are assessed for injury. The heart is subsequently delivered through the pericardial opening and palpated systematically to identify penetrating defects, tears, or areas of ongoing hemorrhage. When cardiac bleeding is encountered, the initial and most immediate hemostatic measure is direct digital pressure. If bleeding persists or is too brisk to be controlled by compression alone, escalation strategies include temporary closure with sutures, the use of surgical staples for rapid approximation in selected wound patterns, or balloon tamponade using a Foley catheter. Balloon tamponade is particularly useful for penetrating ventricular lacerations where the catheter tip and balloon can be introduced into the defect, inflated, and then gently retracted to apply internal compression against the myocardial wall. This maneuver can stabilize hemorrhage long enough to restore perfusion and permit transport to the operating theatre. Superficial myocardial lacerations or injuries involving cardiac vessels may be amenable to rapid temporary repair with sutures or staples, recognizing that these measures are bridging actions rather than definitive reconstruction [13].

Aortic cross-clamping is commonly performed as part of the resuscitative sequence to augment coronary and cerebral perfusion by redistributing circulating volume and limiting ongoing distal hemorrhage. The intention is often to improve intracranial blood flow during profound shock or arrest. However, cross-clamping carries significant physiologic consequences and should be avoided in normotensive patients because abrupt elevation in afterload may compromise cardiac function and coronary perfusion [14]. When aortic control is indicated, the left lung is retracted superiorly to expose the posterior mediastinum, and the pulmonary ligament is divided to improve access. The esophagus must be distinguished from the aorta to prevent catastrophic iatrogenic injury; one practical method is palpation of a nasogastric or orogastric tube within the esophagus, which can help differentiate it from an empty, collapsible aorta. The pleura overlying the descending aorta is opened, and the aorta is mobilized away from the esophagus, the vertebral column posteriorly, and adjacent tissues until sufficient space is created to permit secure placement of the clamp. The clamp should ideally be applied in an intervertebral space to reduce the risk of injuring intercostal vessels. Optimal placement is just above the diaphragm, although clamping may also be performed just inferior to the left pulmonary hilum when necessary. After cross-clamping, resuscitative efforts can continue with the combined application of trauma life support principles and advanced cardiac life support measures, including open cardiac massage and internal defibrillation as indicated. Throughout the procedure, hemorrhage repair is conducted with the explicit understanding that these interventions are temporary measures intended to bridge the patient to definitive operative repair. Active bleeding from the heart may be managed with sustained digital pressure, rapid suturing, or stapling, depending on wound characteristics and operator expertise. When defects are large or bleeding is not readily controlled, balloon occlusion using a Foley catheter provides a rapid, pragmatic hemostatic option: the catheter is inserted into the defect, the balloon inflated with saline, and the device withdrawn gently until tamponade is achieved. Additional thoracic bleeding sources should be addressed with direct pressure, packing with laparotomy sponges, or proximal vascular control maneuvers as needed. In parallel, the resuscitation team should maintain aggressive transfusion and physiologic optimization, recognizing that successful emergency room thoracotomy is not a single action but a coordinated sequence of exposure, temporary hemostasis, restoration of perfusion, and immediate transition to definitive surgical care [13][14].

Complications

Emergency room thoracotomy may offer a narrow but critical opportunity for survival in otherwise fatal traumatic scenarios; nevertheless, the potential benefit must be judiciously balanced against a substantial burden of complications. These adverse events include risks to both the patient and the clinical team, and they arise from the extreme physiologic instability of the patient, the invasive nature of the intervention, and the operational constraints of performing major thoracic surgery in a resuscitation environment. As such, complication awareness is not merely academic; it directly informs patient selection, procedural execution, and post-procedure transition to definitive care. Among the most frequently encountered complications is injury to the operator and assisting staff. The procedure is performed under conditions of massive hemorrhage, hurried instrument exchange, reduced visibility, and crowding around the patient, all of which increase the likelihood of percutaneous injury and blood exposure. Occupational risk is particularly relevant because emergency room thoracotomy commonly entails direct hand contact with blood-filled spaces and sharp bony surfaces. While occupational exposures to human immunodeficiency virus and other blood-borne pathogens are only slightly higher than average, strict adherence to appropriate personal protective equipment (PPE)—including impermeable gowns, double gloves, eye and face protection, and protective footwear—substantially mitigates this risk [15]. In this setting, PPE should be regarded as an essential component of procedural readiness rather than a discretionary precaution. Iatrogenic injury can also occur at the moment of entry. If ribs are inadvertently transected during the initial incision, sharp bony edges may be created that can puncture or lacerate personnel, particularly when hands are inserted into the thoracic cavity for rapid exploration or compression. A curvilinear incision that follows the rib contour helps reduce the probability of rib fracture and limits the development of jagged rib margins. In addition, if a scalpel is advanced too deeply and used to enter the thorax directly, it may damage the pericardium, myocardium, or adjacent structures at precisely the moment when the operator has the least tactile feedback and the patient has the least physiologic reserve. For this reason, many techniques emphasize controlled pleural entry and extension with Mayo scissors to separate intercostal musculature and soft tissues more safely, thereby reducing the risk of uncontrolled deep injury. During pericardiotomy, complications may involve critical structures that are anatomically adjacent to the pericardium. Coronary arteries may be inadvertently compromised, either by accidental ligation or by traumatic manipulation during attempts at rapid repair. More commonly, the phrenic nerve may be injured or transected, given its close course along the lateral pericardium. Such injury can result in diaphragmatic paralysis, impaired ventilation, and prolonged respiratory morbidity in survivors. These hazards underscore the necessity of a functional, procedural understanding of thoracic anatomy and a deliberate technique even under emergent conditions. Aortic cross-clamping introduces additional risk. Incomplete exposure of the descending thoracic aorta can lead to improper clamp placement, including partial occlusion, simultaneous clamping of the esophagus with the aorta, or, in the most dangerous circumstance, clamping the esophagus alone. Beyond technical misplacement, aortic cross-clamping can produce distal organ ischemia by abruptly interrupting perfusion to abdominal viscera, kidneys, spinal cord, and lower extremities. Moreover, recurrent bleeding may arise from the chest wall, including injury to the internal mammary artery or intercostal vessels, particularly if retraction is forceful or if incision extension disrupts vascular structures. Collectively, these complications highlight that emergency room thoracotomy is not a singular act but a sequence of high-stakes maneuvers in which each step carries distinct and consequential risks [14][15].

Clinical Significance

Over the last four decades, the practice of emergency room thoracotomy has undergone substantial refinement as trauma systems have accumulated more robust outcome data and clarified which patients are most likely to benefit. This evolution has led to more restrictive, mechanism- and physiology-based indications aimed at maximizing meaningful survival while minimizing futile interventions. In carefully selected patients, particularly those with penetrating thoracic injury and potentially reversible causes of traumatic arrest such as tamponade or exsanguination amenable to immediate control, emergency room thoracotomy has demonstrated its greatest value as a bridge to definitive operative care. Yet even with optimal selection, overall morbidity and mortality remain high, reflecting the profound physiologic derangement and anatomic severity that characterize the cohort for whom the procedure is considered. Reported survival following emergency room thoracotomy varies according to mechanism of injury and institutional context, with published estimates commonly ranging from 7.4 to 8.5 percent [16]. These figures, while modest, are clinically significant given that the alternative for many of these patients is near-certain death. Importantly, survival is not uniformly distributed across patient groups; rather, it is strongly modulated by factors such as the mechanism and magnitude of injury, the anatomic location of the primary insult, the duration of pulselessness, and the presence of signs of life. These determinants function as practical predictors of whether the procedure is likely to reverse the immediate cause of collapse and permit neurologically meaningful recovery. Mechanism-specific outcomes are particularly influential. Survival is generally lower in pediatric cases and in blunt thoracic trauma when compared with penetrating injuries [17]. Blunt mechanisms often produce diffuse tissue disruption, major vascular injury, cardiac rupture, or concomitant multisystem trauma that is less amenable to rapid, localized correction, thereby reducing the probability that thoracotomy will meaningfully alter outcome. Consistent with this, there remains no strong consensus regarding whether emergent thoracotomy should be attempted in most blunt trauma cases, as survival rates in this subgroup are low and the potential for futility is substantial [18][19]. The absence of consensus does not imply a lack of utility but rather reflects the heterogeneity of blunt trauma presentations and the difficulty of identifying a narrow subset in whom reversible pathology is present and time to intervention is sufficiently short. Given these realities, maintaining up-to-date knowledge of indications, contraindications, and procedural technique is essential. Accurate, current understanding supports appropriate utilization of resources, reduces performance in clearly futile circumstances, and may decrease preventable complications through better technical execution and system preparedness [20]. Thus, the clinical significance of emergency room thoracotomy is inseparable from the rigor of its selection criteria and the maturity of the trauma system in which it is deployed [16][17].

Enhancing Healthcare Team Outcomes

Emergency room thoracotomy is inherently interprofessional and cannot be performed safely or effectively in isolation. It represents a last-resort attempt at life-saving treatment in a narrowly defined patient population, and its success depends on seamless coordination among emergency clinicians, nursing staff, technicians, respiratory therapists, and, when available, trauma surgeons and operating room teams. Even when a surgeon is not immediately present at the bedside, the procedure must be executed with a continuous pathway to definitive care, as thoracotomy is a temporizing maneuver intended to restore or support perfusion only long enough to permit operative repair and critical care stabilization. At a minimum, the resuscitation requires a dedicated emergency provider to direct overall care, including airway management, hemorrhage resuscitation, and rhythm-based interventions. Nursing staff and assistants are required to implement massive transfusion protocols, administer medications, manage lines and tubes, and support continuous monitoring. When thoracotomy is initiated, additional personnel become essential to maintain chest compressions when indicated, coordinate defibrillation and ventilation strategies, and provide instrument handling and exposure assistance. The presence of a trauma surgeon and their support staff can further enhance outcomes by enabling immediate definitive surgical decision-making and accelerating transfer to the operating room for repair of cardiac, pulmonary, or major vascular injuries. Clear, defensible criteria for proceeding with emergency room thoracotomy are central to improving team outcomes. Definite indications reduce the likelihood of prolonged resuscitative efforts in hopeless cases with unsurvivable injuries, thereby limiting staff exposure, conserving critical resources, and focusing attention on patients with realistic salvage potential. Moreover, shared familiarity with the procedural steps and anticipated next actions—such as pericardial decompression, temporary hemorrhage control, aortic cross-clamping, internal defibrillation, and rapid operative transfer—improves interprofessional communication at precisely the time when cognitive load is highest. Structured role assignment, closed-loop communication, and rehearsed workflows can shorten time to key maneuvers and decrease errors in equipment use, exposure, and transition planning. In aggregate, team-based optimization does not merely support technical performance; it directly strengthens the probability that emergency room thoracotomy achieves its intended purpose: brief physiologic rescue followed by immediate definitive treatment within an integrated trauma care continuum [20].

Conclusion:

Emergency room thoracotomy remains one of the most dramatic and resource-intensive interventions in trauma care. Despite its high mortality rate, its clinical significance lies in its ability to salvage patients who would otherwise face certain death. The procedure's success is not determined by technical execution alone but by adherence to strict indications, rapid deployment, and immediate transition to definitive surgical care. In penetrating thoracic injuries with tamponade or exsanguination, ERT offers a narrow but critical window for survival, whereas its utility in blunt trauma is markedly limited. Optimal outcomes require a well-prepared system: standardized equipment, rehearsed workflows, and interprofessional coordination. Simulation-based training and clear institutional protocols are essential to minimize delays and prevent futile interventions. Furthermore, understanding contraindications—such as prolonged pulselessness, absence of signs of life, and catastrophic injuries—protects patients and conserves resources. Ultimately, ERT exemplifies the intersection of surgical skill, emergency medicine, and critical care within an integrated trauma system. When performed under appropriate conditions, it transforms an otherwise fatal trajectory into a survivable one, underscoring its enduring role as a cornerstone of advanced trauma resuscitation.

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