Characteristics of those who sustained wartime cardiothoracic injuries: Yemen war casualty reports

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Context
During the ongoing Yemen war, the atrocity had produced several penetrating thoracic injuries and blunt as well, ranging from majors to minors and commonest to rarest.
Aims
The aim was to find the best way for management of wartime thoracic injuries, depending on the different war casualty reports.
Settings and design
This was a retrospective observational study that included data of patients with cardiothoracic injuries who were received, evacuated, referred, and admitted to Najran regional medical facility 'King Khalid hospital.'
Patients and methods
The authors analyzed the data of 159 patients who sustained cardiothoracic war wounds and were evacuated or referred to our hospital between January 2016 and June 2016.
Statistical analysis used
The statistical analysis for this study was performed with SPSS version 21 (IBM, Armonk, New York, United States). Continuous variable data were expressed as mean±SD. A χ^2 test was used for categorical variables. Statistical significance was set at *P* values of less than 0.05.
Results
There were 46 (28.9%) patients with pure lung injuries, four (2.51%) patients with pure cardiac injuries, and 109 (68.5%) patients with mixed injuries. The scope of management of the presented cases ranged from chest drainage only in 63 (39.62%) patients; thoracotomy, evacuation of hemothorax, and suture of the lung tear in five (3.14%) patients; lobectomy in two (1.25%) patients; and decortication in four (2.51%) patients. The mortality rate was three (1.9%), and complications were reported in nine (5.7%) in the form of empyema, wound infection, arrhythmia, and lung collapse.
Conclusion
Cardiothoracic wounds are the most serious injuries in wartime, but despite their nature, those who sustained these injuries could be managed through vigilant surgical service, with low mortality or morbidity.

Keywords:
missile injury, thoracic trauma, wartime injuries

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All authors have made substantial contributions to the conception and design, acquisition of data, and analysis and interpretation of data; have been involved in drafting the manuscript or revising it critically for important intellectual content; and have given final approval of the version to be published.

Introduction

During the past few decades, the Middle East has and is still going through many conflicts and wars. The evolving development of military trauma care for those who sustained injuries has been influenced by the principles of civilian emergency medicine. Cardiothoracic wounds represent a subgroup of war injuries that significantly have a higher incidence of morbidity and mortality. In previous reports about war casualties, especially those arising from the Middle East, its incidence varied from 6 to 8% [1–3]. We represent in our report a group of patients who mostly have penetrating chest injuries during the running war in Yemen, with various types of injuries ranging from minors to majors and commonest to rarest within the 6-month period of wartime. Our purpose was to review the results of military trauma care during the Yemen conflict, with an emphasis on medical evacuation, wound triage, and wound management, with particular focus on thoracic injuries.

Patients and methods

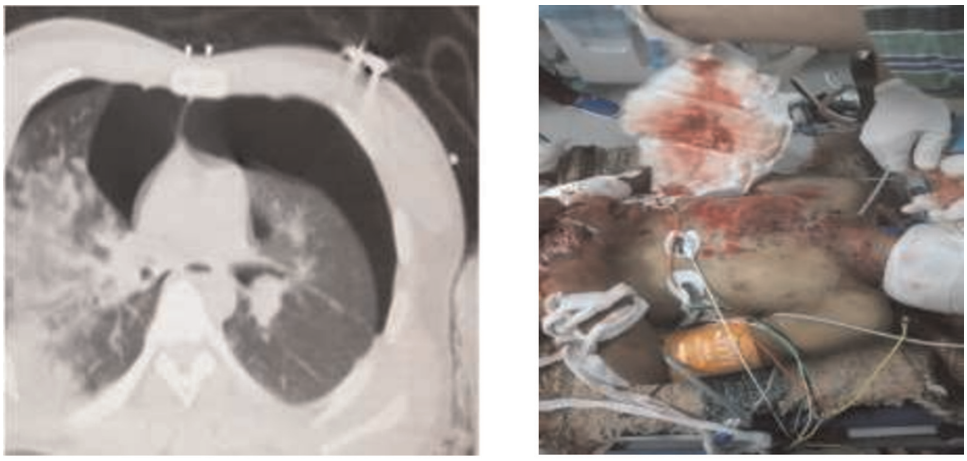
Patients' population

We collected the data of patients with cardiothoracic injuries who were received, evacuated, referred, and admitted to Najran regional medical facility 'King Khalid hospital' from January 2016 to June 2016 in a retrospective methodology. The study was approved by the Ethical Committee of Najran regional medical facility 'King Khalid hospital'. The collected data were extracted electronically from the hospital registry, and a few were extracted manually from archived files. The data included age; sex; site of injury (cardiac, thoracic, with/without other injuries); the presenting symptoms on admission; the surgical treatment received at the scene; evacuation time from the war field to the place where primary medical service was offered, and to us; symptoms upon reception and what type of missile injury; the main organ injured; and the type of primary and secondary surgical procedures. In our study, we also documented different complications that happened with various modalities of management and the mortality occurred in different forms of injuries.

Transport protocol

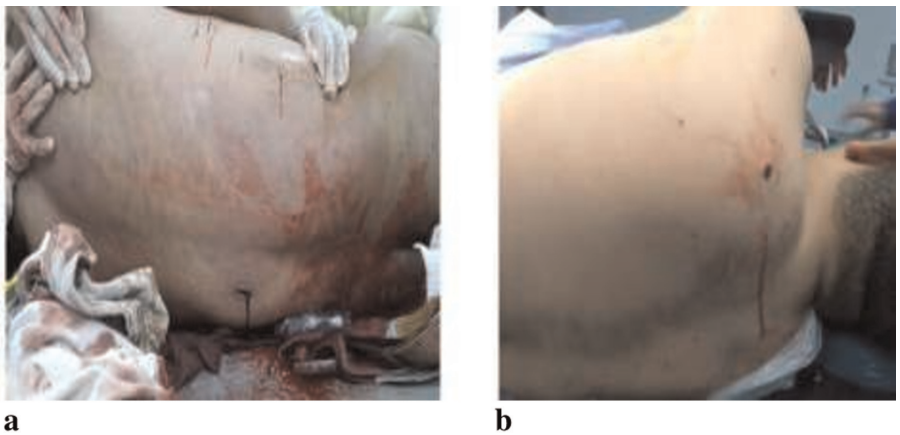
The basic historic problem facing wartime physicians has been how to transport the wounded to caregivers or transport the caregivers to the wounded within the limit of 'the golden first hour' after enduring severe injury, hoping to give them the best odds of survival. On spot, the injured soldiers did receive immediate field medical care so their conditions were stabilized, and subsequently, they were evacuated. They rapidly traveled hundreds of miles, often through medically equipped helicopters to bring them back to our hospital. This swift initial treatment and evacuation strategy contributed significantly to improved trauma outcomes (Figs 1 and 2).

Figure 1



(a,b) A 14-year-old young Yemeni civilian who experienced blast injury with bilateral pneumothorax and right upper lobe contusion.

Figure 2



(a) A high-velocity missile (bullets) directed to the chest of a militant, with the exit seen at the back of the left side. (b) The only inlet of a bullet injury in civilian mostly by artillery fire from aircraft.

Triage protocol

The process of trauma care passes through three phases [1]: the emergency phase which begins at the time of injury until resuscitation and stabilization of the patient condition, and it is essential to manage the intense pain during this phase [2]; the healing phase, which starts after early stabilization and ends when most surgical treatment is completed; and [3] the rehabilitation phase, which continues until the function is restored. Our triage protocol received by patients in phases 1 and 2 was aimed to reassess signs of life and hemodynamic stability followed by a through full and systematic examination as fast as it could be and to run for fast ultrasound and chest radiography (CXR), and then go for secondary evaluation in collaboration with other surgical specialties. Care was prioritized to be provided first for the most badly injured, without regard to the chances of survival. The design of the algorithm is based on experience obtained from civilian trauma and the Saudi National Trauma Data.

Conservative protocol

For thoracic injuries, the used criteria for conservative or medical treatment only and follow-up at the outpatient clinic or continue care under other departments' supervision were hemodynamic stability, no evident cardiac injury, noncomplicated rib fractures, non-significant pleural collection, pneumothorax, and mild to moderate nondistressing pulmonary contusion.

Surgical protocol

Our indications to go for surgical exploration, either urgent or semi-elective, were injuries close to the heart, moderately severe hemopericardium, moderate to severe hemothorax, and persistent lung collapse with air leak, thickened pleural peel, retained serious foreign bodies, and an internal organ injury as pleurobiliary fistula of traumatic nature. Thoracic exploration was performed after adequate resuscitation of the patient with crystalloids, colloids and blood, and sometimes inotropes. Exploration aimed at controlling any source of bleeding along with the repair of injured lung parenchyma. Sources of bleeding were thymic tissue, pericardial vessels, and internal mammary artery. After performing good hemostasis, the thoracotomy was closed classically, leaving two chest drains. We admitted our cases in the intensive care unit for observation and monitoring for at least 24 h if the patient was hemodynamically stable with an acceptable follow-up chest radiograph. CXR was performed daily to judge lung expansion and full chemistry follow-up, echocardiography, and even computed tomography when indicated. Other specialties cooperating in management were neurosurgery, plastic, orthopedics, ophthalmic, and general surgery.

Blood transfusion

One of the major issues during the Yemen war was blood transfusion protocol and the source of blood products. There have been little data looking into thoracic injury and transfusion requirements. In a cohort of war-wounded soldiers with a high percentage of blast injury and lung contusion, transfusion and resuscitation methods are very important and may directly affect mortality.

Pain management protocol

Medications for pain management during medical or surgical care are variable, but primarily, we depended on morphine. Regional and spinal anesthesia and the advanced pain management technologies were applied when needed. Patients with combat-induced injuries required many operations and had prolonged hospital stay owing to the associated injuries, which reflects the high frequency, multiplicity, and severity of injuries during the Yemen war.

Results

Our 159 patients were received and admitted with war-inflicted chest injuries. There were 157 (98.7%) males, with 136 (85.5%) militants from both sides and 23 civilians (14.4%) (20 adult males, two adult females, and one male child). The last three civilians were trapped in the wreckage of buildings during bombing and 20 male civilians experienced bomb blast injuries. The average age of our patients was 32 ±7.3 years (range from 9 to 57 years) (Table 1).

Only 54 patients (33.96%) were referred to our hospital directly from the front-lines or injury scene without receiving any previous medical service, and 105 patients (66.03%) had previously received medical service either on the field or in other hospitals and then evacuated and referred to us.

The evacuation time wasted from the time of injury to the start of medical service could be accurately

Table 1 Different classifications of our patients

	Number of cases=159 [*n* (%)]
Militants	136 (85.5)
Civilians	23 (14.4)
Males	157 (98.7)
Females	2 (1.25)
Front-line patient	54 (33.96)
Evacuated patient	105 (66)

measured in 92 patients (57.86%), and it varied from 45 min to 12 days (median 3 days).

A total of 96 patients (60.37%) required medical treatment only (Table 2, describing the scope of management).

Patients who received surgical treatment in our hospital received intercostal drainage tube (ICT) as primary management, but a few of them underwent urgent thoracotomy after observing their drainage exceeding 300 ml/h/for 3–4 h or total drainage bigger than 1000 ml.

More than 50% of the patients required packed red blood cells transfusions and more than two-thirds of the packed red blood cells were given within the first 24 h of admission.

The cause of injury was high-velocity bullets in 46 patients (28.93%), shrapnel in 86 patients (54.08%), cluster bomb particles in 24 patients (15.09%), and 14 patients without missile injury aimed directly to the thorax compartment, but their CXR showed lung contusion or aspiration.

There were 46 (28.93%) patients with isolated lung injuries. There were 26 (28.9%) of them with single lung injuries, with 16 injuries on the left side and 10 on the right side, and 20 had both lungs injured (Table 3).

The scope of management of presented cases ranged from chest drainage only in 63 (39.62%) patients; thoracotomy, evacuation of hemothorax, and repair of lung tear in five (3.14%) patients; lobe resection in two (1.25%) patients; decortication in four (2.51%) patients; and in one (0.63%) patient, we encountered pleurobiliary fistula; it seemed ambiguous on receiving that case (Table 3).

Our PBF case was a 19-year-old Yemeni insurgent who had been shot by a sniper and survived the initial injury phase and referred with the right ICT draining bile-stained fluid as shown in Fig. 3. The endoscopic retrograde cholangiopancreatography revealed biliary injury and leak. The patient underwent stenting and sphincterotomy. Later, we went to the theater where we removed bile-stained blood clots and explored the diaphragm, where an elliptical 5-cm long injury was detected after the release of thick adhesion between the

Table 2 Scope of management

	Number of cases=159 [*n* (%)]
Medical only	96 (60.37)
Surgical only	19 (11.94)
ICT only	63 (39.62)
Tear repair	5 (3.14)
Lobectomy	2 (1.25)
Decortication	4 (2.51)
Right ventricle repair	2 (1.25)
Left ventricle repair	1 (0.63)
Right atrium repair	2 (1.25)
LIMA ligation	1 (0.63)
Impacted FB removal	8 (5.03)

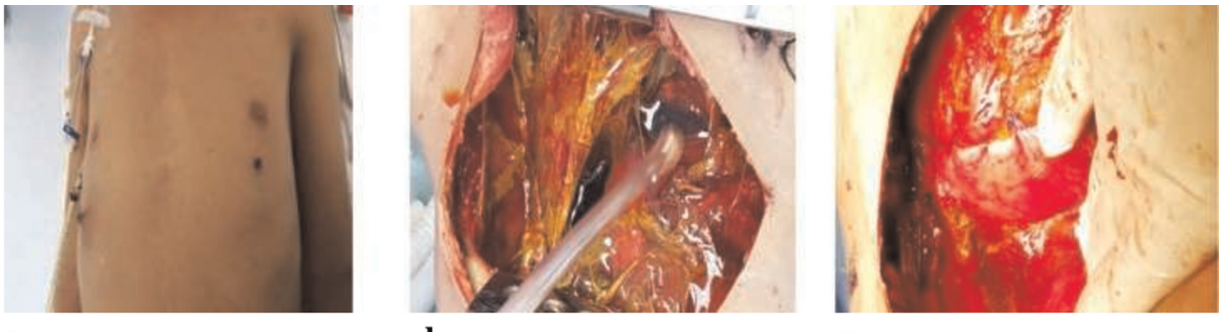
FB, foreign body; ICT, intercostal drainage tube; LIMA, left internal mammary artery.

Table 3 Scope of injuries encountered

	Number of cases=159 [*n* (%)]
Total pure lung	46 (28.9)
Right lung only	10 (6.28)
Left lung only	16 (10.06)
Both lungs	20 (12.57)
Total cardiac	4 (2.51)
Right ventricle	2 (1.25)
Left ventricle	1 (0.63)
Right atrium	2 (1.25)
LIMA	1 (0.63)
PBF	1 (0.63)
Rib fracture	3 (1.89)
Lung contusion	37 (23.27)

LIMA, left internal mammary artery; PBF, pleurobiliary fistula.

Figure 3



A 19-year-old young Yemeni insurgent. (a) Sustained transversing bullet injury from left to right side. (b) Bile-stained hemothorax via thoracotomy view. (c) Clean lung after removal of clotted blood.

right lower lobe's undersurface and diaphragm with a hepatic laceration and infected contents. We consulted a general surgeon immediately, who evacuated and irrigated what seemed to them as infected bilious collection or hepatic abscess through the diaphragmatic injury site and inserted wide bore drainage catheter in a dependent position to the exterior, and then we repaired the diaphragm.

The operative approach was through standard posterolateral thoracotomy in 14 (8.8%) cases, anterior thoracotomy in three (1.88%) cases, and median sternotomy in two (1.25%) cases (two cardiac injuries).

Postoperative care included wound dressing and gentle wall suction on drainage tube in all surgical patients; drains were removed after recording no dyspnea, no fever, less than 50 ml/24 h drainages, and CXR confirmed full lung expansion.

Complications were managed in the same way as civilians; patients with lung collapse were subjected to repeated chest physiotherapy. Three (1.88%) patients developed empyema and were treated by a chest tube. Only one case underwent delayed decortication, owing to incomplete re-expansion of the lung halted by pleural peel with a small pocket of pneumothorax. Wound dehiscence was seen in two patients (1.25%) (Table 4).

We had four (2.51%) patients with pure cardiac injuries. The injured cardiac chamber was right ventricle in two (1.25%) patients, left ventricular in one (0.63%) patient, right atrium in two (1.25%) patients, and one (0.63%) patient with a left-sided injury of the internal thoracic artery. The primary procedure was exploratory anterior thoracotomy, evacuation of hemopericardium and hemothorax, and cardiac sutures with pericardial pledgets in three (1.88%) patients. We did sternotomy with the removal of huge thymic hematoma and ligation of the left internal thoracic artery with extraction of the foreign body in one (0.63%) patient. Complications were pericardial effusion in one (0.63%) patient, transient arrhythmia in two (1.25%) patients, and ST-segment elevation in two (1.25%) patients. All rhythm disturbances (two patients) were controlled medically. One cardiac fatality was owing to bullet transecting right and left ventricle, which occurred after ER thoracotomy upon receiving him in cardiogenic shock.

Table 4 Postoperative complications

	Number of cases=159 [*n* (%)]
Empyema	3 (1.89)
Wound dehiscence	2 (1.25)
Lung collapse with peel	1 (0.63)
Arrhythmia	2 (1.25)
Pericardial effusion	1 (0.63)
Death	3 (1.89)

In 8 of 159 patients (5.03%), some retained metal particles were retrieved during our exploratory thoracotomy, only those in serious locations or large size. They had been identified within the chest on the same position in six (3.77%) and in two (1.25%) in a remote position from the early site of the inspection, suggesting displacement by lung movement, migration, or tissue dissection by sharp edges. The diagnosis of retained particles was done using CXR in all cases, and also intra-operative radiography was done to reveal the exact position of the retained foreign particles.

Many of our patients had associated injuries. There were 119 (74.8%) such patients. Among them, 12 (7.04%) experienced head injuries, 69 (43.3%) bone injuries, and 37 (23.27%) patients had penetrating abdominal wounds. Fewer patients had burn [nine (5.6%)], and three (1.88%) had ophthalmic injuries. In our report, many required multiple operations (mean: 2±1 surgery/patient; range 1–9) during prolonged hospital stays (mean: 25±15 days; range 2–78), which was owing to the associated orthopedic and soft tissue injuries.

Discussion

Many discussions have been ongoing regarding the best management of war injuries. The used policy in civil penetrating thoracic injuries is conservative, through applying ICT as the initial procedure in management in all cases, and then thoracotomy in case of complications [4,5].

The origin of modern military trauma care and the concept of triage dates back to Napoleonic wars [6]. Our report covered a limited period and focused on thoracic injuries; their incidence contributes to 6–8% in all war combats reports during the twentieth and twenty-first centuries since Second World War. As we could not cover all aspects of management of combat injuries, and owing to the nature of the running Yemen war, where most of these wounded soldiers were quickly restored into fight fields, our cohort of patients does not represent a homogeneous group, where some cases received primarily surgical management at our facility, whereas the majority were primarily managed then evacuated or transferred from the field or peripheral hospitals where principles of

treatment varied upon local conditions and the availability of cardiothoracic surgery services. Owing to the variability of the evacuation time, it was a significant factor in determining the type of management and eventually the final results. A set of patients were transferred from peripheral facilities where they received resuscitative measures and underwent a diagnostic radiologic examination. A few had fixed long bone fractures and others received exploratory laparotomies, but those who were referred were mostly owing to accompanying thoracic injuries where a thoracic surgeon was not available.

Our results are 'early results' and despite being a non-homogeneous group, some common features can be outlined, such as higher male dominance, a high bullet: shrapnel ratio, a higher rate of conservative or medically treated cases, lower incidence of thoracotomy as a primary or secondary method of treatment as compared to intercostal tube, and fewer lung resections. Postoperative complications and hospital mortality are also lower in our report than others reported in the Middle East [1–3].

In our report, the clinical and radiologic states would principally decide whether to go for conservative or surgical management pathways, through consultation between thoracic surgeons, ICU doctors, and fellows from other specialties. We treated them like civilians experiencing firearm injuries, starting by placing ICT and observing parameters, with the use of exploration only if persistent blood loss or air leak with lung collapse was seen. Our results are similar to other reports which show encouraging results depending on the 'conservative' approach [7,8]. In this report, surgical exploration was used as early in 19 cases and as delayed management in one patient, which is much smaller than the reports of civilian injuries [6,7] and wartime reports [1–3]. The ratio of medically treated cases to surgical cases either ICT or thoracotomy in our report is the opposite of the results of those reports recommending an aggressive surgical approach, claiming better results [5,6]. Few patients who still had mild to moderate amounts of undrained hemothorax were in an acceptable respiratory condition and followed up during their hospital stay for any progression, and actually on the third or fourth day, fewer had to be drained for a noticeable increase in amount, such as those with rib fractures. Those supporting the aggressive approach believed early thoracotomy results in better control of bleeding, complete blood clots evacuation, and foreign bodies retained inside the pleural space and better control of air leak, hence early recovery and lower hospital stay [9].

The most frequent operative approach used in the management of our cases was posterolateral thoracotomy, then anterior thoracotomy, and lastly sternotomy especially for cardiac injured cases. An attempt to remove foreign body particles was done in eight patients and was successful in seven patients on elective bases. In the eighth patient, the missile had penetrated both the right and left ventricles. This case actually could not be salvaged.

We have encountered a rare and challenging case. Post-traumatic pleurobiliary fistula is a rare complication of penetrating thoracoabdominal trauma and blunt as well, with 34 cases reported in the war causalities literature from Second World War II, Vietnam, and Korea [10]. Biliary injury and then leakage and retention of bile led to the formation of an abscess. With time, the abscess will erode the diaphragm. In absence of pleural adhesions, direct contact into the pleural space is formed, and a PBF with bilious effusion is accumulated [11]. Conservative management with tube thoracostomy or drainage of sepsis, or both could be performed, along with antibiotics and somatostatin or its analogs; moreover, endoscopic cholangiography may demonstrate the fistulous tract, and sphincterotomy may be undertaken to allow free antegrade bile flow [12]. In cases of large, persistent fistulas and noneffective conservative treatment, surgery is needed. The used procedures are drainage of right subphrenic collection, biliary drainage, diaphragmatic closure, pleural drainage, decortications, or pulmonary resection [12].

Individuals with combat casualties required multiple operations (mean: 2±1 surgery/patient; range: 1–9) during prolonged hospital stays (mean: 25±15 days; range: 2–78), which was owing to the associated orthopedic and soft tissue injuries, which reflects the high frequency, multiplicity, and severity of blast injuries during Yemen War. Thus, our policy for pain control was dependent on morphine. It was much useful for pain control with an initial large dose followed by regular diluted intravenous doses due to the high incidence of multiple thoracic and orthopedic injuries and during daily dressing changes and surgical debridement. In this patient cohort, 36 continuous peripheral nerve block (CPNB) catheters were placed and used for a mean of 9.1±3.5 days (range: 1–14), which represents more than 309 patient-catheter days. Pain visual analog scale scores declined from a pre-CPNB mean of 3.7 to a post-CPNB mean of 2.2.

Our lower incidence of morbidity and mortality after enduring wartime injuries is similar to other reports

from different war-zones even in poor medical conditions [5]. We could explain that our study is influenced by the previous medical service given before referral and long evacuation time as well. Our inclination toward preservation ended in few cases with lung resection, supported by other reports [7–9] and experience obtained from similar injuries.

Civilian registry on 190 patients with penetrating chest injuries reported only 28% required surgery, without the need for lung resections, and only sewing the lung tears [13]. Another report [14] by Kish and associates reviewing 380 patients with penetrating chest trauma and found that only 12% required early operation and 4% late thoracotomy. From Texas, another report has similar data; ~20% of patients with penetrating chest trauma required thoracotomy or median sternotomy. Overall, 10% of those explored required a pulmonary resection, and ~25% had repair of pulmonary lacerations [15].

From the wartime report by McNamara *et al*. [16], only 82% of 547 patients with thoracic injuries from the Vietnam conflict were treated with chest tubes alone; most of these patients had fragment wounds, whereas thoracotomy was required in 14%. Another report from Vietnam by Wanebo and Dyke [17] on 534 patients with high-velocity gunshot or fragment wounds showed that only 104 (20%) had thoracotomies. Their indications for thoracotomy were massive hemorrhage, persistent clotted hemothorax, cardiac tamponade, extensive chest wall injury, massive air leak, need to resect the severely contused lung, and fragments in the mediastinum. In their analysis of results, they registered 2 patients with high-velocity missile injuries treated only by chest drains died of pulmonary insufficiency or sepsis, and another two patients who underwent operation got aspirated blood from the contused lung and died. Later in their series, five similar patients who experienced hemoptysis underwent pulmonary resection for severely damaged segments, and they survived and mortality reduced to 11%. Supporting a report from Lebanon, by Zakharia [1], there is some evidence that resection in severe pulmonary contusion may be beneficial.

From reviewing both civilian and wartime reports, we believe that thoracostomy tube should remain the principal method of treating patients injured by high-velocity weapons of the chest. Only around 15–30% of patients should require thoracotomy. Every patient must be considered on an individual basis, and thoracic surgeons should reserve emergent thoracotomy and pulmonary resection for certain indications.

Conclusion

The basic procedures such as tube thoracostomy, exploration thoracotomy, and surgical critical care will allow treating most soldiers with thoracic injury. The need for advanced thoracic surgical procedures is rare and could be done at referral centers and so, these findings can be used by military planners to properly allocate thoracic surgeons and associated assets.

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Conflicts of interest

There are no conflicts of interest.

References

1 Zakharia AT. Cardiovascular and thoracic battle injuries in the Lebanon war. J Thorac Cardiovasc Surg 1985; 89:723–733.

2 Ramasamy A, Harrison SE, Stewart MP, Midwinter M. Penetrating missile injuries during the Iraqi insurgency. Ann R Coll Surg Engl 2009; 91:551–558.

3 Ramasamy A, Hinsley DE, Edwards DS, Stewart MP, Midwinter M, Parker P. Skill sets and competencies for the modern military surgeon: lessons from UK military operations in Southern Afghanistan. Injury 2010; 41:453–459.

4 Roostar L. Indications for surgery in penetrating chest injuries. Ann Chir Gynaecol 1993; 82:177–181.

5 Blades B, Dugan DJ. War wounds of the chest. J Thorac Surg 1994; 13:294–306.

6 Mollberg NM, Wise SR. Appropriate use of emergency department thoracotomy. J Am Coll Surg 2012; 214:870–871.

7 Molina EJ, Gaughan JP, Kulp H, McClurken JB, Goldberg AJ, Seamon MJ. Outcomes after emergency department thoracotomy for penetrating cardiac injuries: a new perspective. Interact Cardiovasc Thorac Surg 2008; 7:845–848.

8 O'Connor JV, Adamski J. The diagnosis and treatment of non-cardiac thoracic trauma. J R Army Med Corps 2010; 156:5–1410.

9 Dominguez F, Beekley AC, Huffer LL, Gentlesk PJ, Eckart RE. High velocity penetrating thoracic trauma with suspected cardiac involvement in combat support hospital. Gen Thorac Cardiovasc Surg 2011; 59:547–552.

10 Kajal NC, Lal B, Gupta S, Attri R, Gupta O, Kajal N. Conservative management of post traumatic thoracodiaphragmatico biliary fistula. Lung India 2010; 27:242–243.

11 Prodromos P, Condilis N. Thoracobiliary fistula. A rare complication of thoracoabdominal trauma. Ann Ital Chir 2009; 80:67–70.

12 Andrade? Alegre R, Ruiz? Valdes M. Traumatic thoracobiliary (pleurobiliary and bronchobiliary) fistula. Asian Cardiovasc Thorac Ann 2013; 21:43–47.

13 Oparah SS, Mandal AK. Operative management of penetrating wounds of the chest in civilian practice. J Thorac Cardiovasc Surg 1979; 77:162.

14 Kish G, Kozloff L, Joseph WL, Adkins PC. Indications for early thoracotomy in the management of chest trauma. Ann Thorac Surg 1976; 22:22–28.

15 Franz JL, Trinkle JK. Initial assessment and management of penetrating chest wounds. In: Trinkle JK, Grover FL, (editors): Management of Thoracic Trauma Victims. Philadelphia, PA: Lippincott 1980. 21–26

16 McNamara JJ, Messersmith JK, Dunn RA, *et al*. Thoracic injuries in combat casualties in Vietnam. Ann Thorac Surg 1970; 10:389.

17 Wanebo H, Dyke J. The high-velocity pulmonary injury: relation to traumatic wet lung syndrome. J Thorac Cardiovasc Surg 1972; 64:537.