Thoracic Trauma
Which Chest Tube When and Where?

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INTRODUCTION

Life is really simple, but we insist on making it complicated (Confucius).

Only a few life-threatening conditions in trauma surgery are potentially manageable by a simple and straightforward intervention with a good chance of success. Chest drainage, the release of murderously high intrapleural pressure caused by accumulated and trapped blood (hemothorax) and/or air (pneumothorax) is just that sort of minor surgery offering a dramatic effect. In spite of the uncomplicated clinical picture of tension hemothorax, the uncomplicated decision making and the simplicity of the procedure, missed/failed pleural decompression might be responsible for up to 33% of the preventable fatalities typically in combat and in a lesser but increasing degree in civilian environments.$^{1,2}$ Changing urban criminal/terrorist action injury profiles$^{3,4}$ and challenges of mass casualty care and disaster medical management equally warrant a more focused analysis of the seemingly simple and frequently neglected intervention of chest drainage. The rapid clinical decline caused by the compression of the underlying lung and mediastinum with profuse bleeding highlights the importance of the prehospital care and/or first medical responder treatment of these patients. However, chest injury is only an element of a complex severe clinical scenario in a good number of serious cases. Approximately 60% of multi/polytrauma patients suffer chest trauma.

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KEYWORDS

- Chest trauma
- Traumatic hemo/pneumothorax
- Emergency surgery
- Mass casualty
- Triage

KEY POINTS

- Penetrating and blunt trauma (with or without rib fracture) needs different tactics according to mechanism of injury.
- Selective conservativism and drainage surmounted pleural space control are dominating optimally invasive chest trauma management.
- Massive bleeding and/or trapped intrapleural air causing high intrathoracic pressure are the 2 main catastrophic but potentially survivable events, in which decompression by a drain offers a simple and efficient solution in 90% to 95% of all cases.
- Many failed but still existing dogmas and misunderstandings surrounding hemo/pneumothorax, ill interpretation of “horror vacui pleurae," prevents a more proactive surgical attitude toward this method among nonthoracic surgeons and allied specialists.
- Experience-based convictions and received wisdom prevails as only a limited number of statistically controlled evidence exists.
among other injuries. Thoracic injury is responsible for the death in 1 of 4 or 5 fatalities. Quick and efficient control of the pleural space by drainage plays a double role in the context of current resuscitation concept (CBABC) at least in military trauma paradigm by removing intrapleural blood (Catastrophic Bleeding) and relieving compromised breathing (B) at the same time. The evidence-based scientific approach of the state of art in hemo/pneumothorax is not a trouble-free zone due to a practically complete lack of externally controlled data. The literature is rich in audit-style retrospective reports in which the results with chest drainage for trauma cases are described and discussed. However, as usual, the devil lurks in the particulars. What insertion technique using what type and size of drain, followed by which tactics of suction treatment; these questions are considered scientifically irrelevant, too down-to-earth details, and therefore remain unreported. Chest drainage is the Cinderella in the shadow of heroic surgeries of major torso trauma. Autoreflexive reports present the success of their own method, which is excellent. Publications are ruled by an extremely high success rate: 90% to 95% of all penetrating chest wound cases are treated exclusively by intercostal chest drains (ICDs). In fact, no more than 18% to 22% of all injuries involving the thorax require chest drainage for pneumo/hemothorax and approximately 1 in 10 to 14 initially drained patients has to undergo major thoracic surgery. Sixty percent to 75% of all chest drainages are performed for penetrating injuries. Distribution of hemothorax and pneumothorax as indications are roughly equal, whereas the last third of the group consists of the combined, that is, hemopneumothorax cases.

Acute trauma–related pleural space management by chest drains is a field of received wisdom, in which the basic principles are neither questioned nor investigated in full depth. The present article is the result of an attempt of a structured review of the problems and of the annotated listing of the orthodox solutions rather than an analysis of nonexistent evidence.

A distillate of personal experience of 30 years filtered through the recent literature on chest drainage in trauma is presented. Other articles in this issue should be consulted especially where retained hemothorax and primary thoracic empyema are concerned. Chest trauma is discussed “per se,” as an acute event; therefore, the role of chest drainage in treatment of sequelae and consequences of thoracic injuries is not discussed here.

SURGICAL TECHNIQUE

Rudyard Kipling delineated the framework of the discussion of chest drainage technicalities in trauma. “I keep six honest serving-men. They taught me all I knew. Their names are What and Why and When and Where and Who.” The only modification required is the rearrangement of the names into a when-why-what-how-who sequence, as art of surgery has a different logic from poetry.

When

One of the beauties of chest drainage in thoracic trauma is that the decision-making process does not contain a lot of steps: in extremis no imaging is needed at all before the procedure. Vast clinical experience teaches that physical examination has an utmost importance here.

Chest drainage should be performed immediately whenever the serious suspicion of tension pneumothorax or massive hemothorax is aroused based on clinical signs in a patient who has shortness of breath or is simply hypoxic. The clinical signs are as follows: decreased deflection on one side of the chest cage, no or minimal breathing sounds are audible on the affected side, drumlike sounds with percussion in case of pneumothorax and dullness for hemothorax, and the trachea palpated in the sternal notch is pressed to the opposite side. Pulse oximetry can provide adjunctive informations, just like extended focused assessment sonography in trauma (e-FAST). Level 2 recommendation supports the use of e-FAST in chest trauma. Chest radiograph (CXR), the oldest imaging method of diagnosing pneumo/hemothorax has a reported disappointing sensitivity of less than 50%. Excluding occult and minimal (<10%) pneumothorax and if only significant pneumothoraces are counted, then this value is significantly higher. Computed tomography (CT) has a near 100% sensitivity, but it is far from being the optimal diagnostic tool in unstable patients. e-FAST has a sensitivity of 77% for pneumothorax with a negative predictive factor just below 100%.

Why

Mechanism of injury: that is, blunt versus penetrating trauma, dictates different surgical decision making. Generally speaking, penetrating injuries entering the pleural space nearly always call for a chest drain, with 2 exceptions. On one hand, there are those penetrating, usually impaled injuries, that are obvious straightforward thoracotomy cases (see later in this article) without prior
drainage, whereas on the other hand, the symptom-free patients with a stab wound whose pneumothorax is smaller than 2 cm, also can wait. There are opinions for a (nearly) immediate discharge of asymptomatic penetrating trauma cases, with negative CXR, whereas others are a little bit more cautious. Physiologic parameters and imaging are steering the decisions less aggressively in cases of blunt thoracic injuries usually complicated by rib/sternum fracture.

Drainage of the pleural space has to have definitive aims, but surgical correction of a radiologic picture is not one of them. Pneumothorax less than 10% or 2 cm and symptomless does not require a chest drain. However, these patients need to be monitored for at least 24 hours. It is worth remembering that for more than 60 years, pneumothorax was induced artificially as a sole treatment in the hope of cure of tuberculosis; so a limited amount of intrapleural air does not cause any harm. The military surgical experience during World War I saw benefit of air replacement of the tapped hemothorax, a common procedure for lung tuberculosis in the age. What is obvious in contemporary practice is that preinjury inherent reserves of the ventilatory capacities are decisive in the outcome.

Hemothorax is a different case, in which amount of original volume and tendency commands a different approach. Any hemothorax responsible for ventilatory compromise needs to be drained immediately.

An open pneumothorax (sucking chest wound), in which the pleural space is in a definite and permanent continuation with the surrounding atmospheric environment (permanent hole, destroyed/missing full-depth chest wall, sucking chest wound) needs a secure cover and a drain. Alternatively, dressings/covers with a built-in 1-way valve are available (SAM [Vented; SAM Medical Products, The Netherlands, The Hague], HALO [Halo VENT Chest Seal; Halo Automotive, USA], Asherman Chest Seal [Teleflex Medical, Coventry, CT, USA], Bolin [H&H Medical Corporation, Williamsburg, VA, USA], and Russell Chest Seal [Prometheus Medical Ltd, Hope Under Dinmore, Herefordshire, UK] and other models based on slightly different concepts). No independent comparative study is available on their performance in the clinical setting.

Where

The side of pneumothorax/hemothorax should be marked before the procedure, the CXR/CT/Chest ultrasound consulted and communicated to the staff, and finally checked again. There is a general agreement on the optimal location of the chest drainage, a rare exception, as so many divergent opinions coexist on this topic. The patient is lying in a mild head-up position (anti-Trendelenburg or Fowler position) with the affected side up. The midaxillary or the anterior axillary line offers an ideally thin layer of the chest wall muscles and the fifth or sixth intercostal spaces (between the fifth and sixth or sixth and seventh ribs, respectively) are mentioned more frequently. Go lower in this safe triangle and you might find your tube in the abdomen or just too close to the diaphragm; or go higher and the subpulmonary region of the pleural space will be left without effective evacuation. Chest tubes do not need to be directed posteriorly, but an upward position is advantageous. The above site recommendation is true in the relatively rare cases of thoracic mon trauma. The advice loses its relevance when either a polytrauma patient is treated by a team or prehospital resuscitation is performed. Where a multi-trauma or polytrauma patient in a supine position is considered, and the primary survey is under way, there are 2 choices of drain sites. One might follow the axillary route, detailed previously, or an anterior approach in which the second or third intercostal space is entered. The former might be somewhat uncomfortable for the surgeon from an ergonomic point of view, whereas the latter is complicated by the stout pectoral muscle mass.

No other evidence than massive expert opinion and common sense support the practice.

What

The size of tube and of hemothorax to be evacuated are equally important determinants. The material of the drain has an utmost importance, as it must be flexible and resilient but should resist the compression in the intercostal tunnel and intrapleural kinking. Silicon, an ideal component for soft abdominal drains, is unsuitable above the diaphragm. Unrevealed occluded chest drains are deceiving to the surgeon, suggesting patency falsely. The tubes must be multiholed and should be marked for CXRs. As far as size is concerned, there is a general agreement on the recommendation of between 28 and 30-French gauge (Ch) for an average adult and larger for larger body and/or massive hemothorax. A smaller diameter might work in selected cases, pigtail is not excluded, and a more flexible approach is permitted where pure pneumothorax is concerned.

How

Obtain written consent of the patient if applicable and available and document if not. Explain the
procedure to the patient and share your plans with the staff. Double-check the side. Surgical technique consists of 4 basic steps: (1) skin incision and tunneling, (2) entering the chest cavity and introducing the drain, (3) fixing the tube, and (4) finally connecting it to the suction with detailed instructions on how to manage the system.

The skin incision should allow the maneuvering of the tube through the chest wall and into the pleural space. The size of the drain defines the length of the incision in less than an inch (1.5–2.0 cm). There are 3 methods of passing the tube into the desired place and position. First, the oldest and nowadays old-fashioned way of pleural detention is using a trocar and introducing the drain through it. The second option is the application of some derivative of the mandrin, another French medical word, which is an inverted, “inside-out” trocar. The chest drain is pulled over a guiding rod or thin stylet in its full length. There is an endless list of different ready-made single-use chest drain kits on the market based on the same principle: introducing the rod-tube complex and then remove the rigid inner part. All models share the same disadvantage: as the tip of the complex enters the pleural space, no one knows exactly where it will end. 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to waiting until a thoracic surgeon shows up. As is expected, seniority helps: complication rate, even security of fixing ties, are closely related with experience. However, this fact should not limit junior staff activity. There is no such thing as too much training in the concept and exercise of chest drainage.

Again, no reliable published prospective data are available on this paragraph.

PREOPERATIVE PLANNING

Running against time: this is a decisive feature of primary treatment for chest trauma. The very first step of planning is establishing a diagnosis of thoracic injury and confirming need of relieving an acute pleural space–occupying progressive condition. Mechanism of injury (eg, weapon, circumstances of road traffic accident) offers important clues for surgical decision making. Paramedic and emergency medical service reports (written and/or oral) and pressure marks on the skin are helpful. Scars of previous chest surgeries (ie, thoracotomy, sternotomy) should warn the surgeon to expect extensive intrathoracic adhesions. Previous pleural inflammations also might pose a trap during insertion of the tube.

Second to the prior physical examinations (inspection, feeling, percussion, auscultation), basic imaging is considered. The gross pathologies requiring immediate chest drainage are obvious even on rudimentary radiological means. CXR is losing territory to CT. Emergency ultrasound and e-FAST support a decision when physical examination does not provide a clear yes/no answer for drainage. Chest CT helps, but is rarely needed for the decision on emergency draining of the thorax. When drainage is performed, it is a primary diagnostic procedure with a 90% to 95% chance that it is therapeutic as well, especially if the injury involves the periphery of the thoracic domain.

A patient with chest injury with traumatic arrest without cardiac output should need immediate decompression: bilateral drainage to exclude tension pneumothorax. The expected “diagnosis ex juvantibus” does not allow time to wait for imaging studies. A patient with penetrating chest trauma in shock and with profound hypoxemia also needs to be drained in an attempt at restoring physiologic intrapleural environment.

Chest drainage is equal or superior to video-assisted thorascopic surgery (VATS) exploration in acute injury in terms of providing vital information: is there a need for immediate thoracotomy to identify the source of bleeding and control? Drainage can be performed without the risks and time, staff consumption of general anesthesia, and single lung ventilation of a completely unknown patient. VATS or minimally invasive open

Fig. 1. Two in 1: how to fix the drain securely with a 2-in-1 stitch, which will close the wound at removal. (A–C) Steps of securing the drain to the skin. (D, E) Steps to be taken at removal of the drain.
thoracic surgery (MAOTS) is ideal for the stabilized patient, in an elective surgery setting, providing one has the anesthesia backup, proper experience, and hospital budget. In most acute trauma cases, no time is left for delicate minimally invasive procedures. Profuse bleeding blinds the camera, and if not, then there was no need for VATS.

**IMMEDIATE POSTPROCEDURAL CARE**

The final outcome is strongly dependent on postoperative care, which begins with the connection of the chest drain to the adjacent systems. Written instructions for the staff (suction force, CXR schedules) help in avoiding communication breakdown, especially as drained chest cases are relatively rare in trauma wards/bays. Suction systems irrespective of their type (1-way valve, Heimlich or Bülau type, passive or active suction) are extensions of the pleural surface. Force of suction in case of active suction is a question of local hospital policy. The numbers are variable between 10 and 50 cm H₂O and every thoracic and trauma consultant has his or her watertight reason for her or his own particular practice. Suction regulators and drainage systems are discussed elsewhere in this issue. It must be stated here that the simplest system is better for the outcome. There are computer-controlled mobile active suction devices available. Although their affordability and cost-benefit ratios are questionable, their advantage of freeing the patient from his or her bed is out of question. The junior staff and the nurses should understand the principle of suction applied, be familiar with the system used, and troubleshooting must be straightforward. This is extremely important in emergency ward/trauma departments where suction systems are not part of the daily routine, as they are in a general thoracic surgical unit/department. Regular control of the patency of the system, volume, and quality (hematocrit!) of evacuated fluid is also mandatory. Physical status of the chest should be checked by the junior staff at least twice a day. Intervals of CXR control are questions of debate, in which patient safety, diagnostic benefit, and the shadow of a litigation case out of the blue are struggling with each other. In the absence of any reliable guideline, the author’s practice is presented here. If anything happens (drain repositioned, removed, changed, suction tactics modified, patient’s condition deteriorated, serious complaints aroused) an erect position CXR is requested (preferably bedside) to check the situation and document. Documentation of all details is mandatory, and this is in the best interest of the staff and the patient.

The chest tube is removable when no further air escape is detected. The swinging fluid in the connecting tube is a sign of cessation of active air leakage from the pleural surface. Being that 200 to 300 mL/24-hour fluid evacuation is the universally accepted threshold in case of malignant pleural effusion, the same value also may orient the surgeon in case of chest trauma. All in all, the recommendations for patients with chest trauma drainage do not differ significantly from the tasks to be fulfilled in general thoracic surgical cases. Pain control needs increased attention, even though the patient population is younger, frequently free of underlying lung diseases, and expectations are good, especially if the poly-trauma sufferers are excluded.

**Clinical Results in the Literature**

The very nature of chest trauma and the heterogeneity of the patient pool and causes explains the lack of publications with a high degree of evidence. Declarations are ruling the field rather than crystallized consensus. The reported results are contradictory: the meta-analyses are suffering from all sorts of bias. Chest drainage in thoracic trauma is not a topic at the present time and is unlikely that it get over the top where randomized trial overwrite the ruling practice. Approximately 150 years of collective memories and experience provide the backbone of our received wisdom. The reader is referred to the reference list to find the available sources. However, this shortcoming should not disappoint, but motivate the new generation of trauma, chest, and general surgeons and emergency doctors to conduct prospective, ideally multicenter, and wherever possible, randomized trials on the questions exposed or not covered here.

An alibi comparation of incomparable data would not serve the noble aim of a review on the territory of chest drainage in thoracic trauma. References to complication and conversion rates are useful only at the population level, and have no relevance for the individual case. They can be used for quality control and litigation/malpractice lawsuits, but tell nothing to the surgeon in the middle of the night standing in a trauma bay.

**Alternatives to Chest Drainage**

Special circumstances and shortcomings in trained hands dictate need for alternatives to chest drainage in certain situations and cases. Limitations in competence and extremely dangerous/hostile (care under fire) and contaminated environments favor needle decompression, preferred by the military. In spite of suboptimal results (mainly for too
When Not to Attempt to Drain the Chest at All
(Exclusion Criteria)

There are scenarios when chest drainage for thoracic trauma is only a waste of time. Extensively destroyed chest wall/lung or impaled objects might call for immediate open surgery. Penetrating wounds, either from a projectile or stabbing, in the projection of the heart anteriorly or posteriorly, demand surgical exploration of the chest. A cardiothoracic surgeon with capacity of an immediate intervention at any time and ruling all necessity facilities might decide otherwise (focused diagnostics, special monitoring devices) but generally this is not the case. As a rule, suspicion of heart/great vessel injury is amenable to immediate surgical intervention. An unnecessary exploration is the lesser evil and the judgment is always “a posteriori.” A thoracic exploration is a highly survivable procedure, whereas a missed penetrating heart or major vascular injury is definitely not.

When to Convert Chest Drainage to Thoracotomy

There is an ongoing wrestling with the numbers of milliliters where the drainage/thoracotomy threshold is concerned. As usual, it is a multifaceted, multifactorial question to answer. The key players are volume, time of evacuation, age, physiologic reserves, circumstances, and other factors are to be considered. Thoracotomy has its own inherent mortality of 0.25% to 0.5%. More than 1500 mL loss of blood at once or 300 mL per hour for more than 4 hours are the universally accepted values as indications for thoracotomy. Unfortunately, systemic hemostatics (eg, factor VII, tranexamic acid) are usually not considered as adjunct to the treatment. One should keep in mind during transfusion, that what the patient is losing and might need to be replaced is fresh full blood.

POTENTIAL COMPLICATIONS/MANAGEMENT

No intervention is without risks and chest drainage in trauma, typically under stress of time, multitasking, and relative individuality of the challenges is not an exception. It is not uncommon that problem solving becomes the problem itself. Scapegoating does not help: one never can forget that it is the trauma itself that is the origo of complications; surgical mistakes only follow. In an age in which the pseudo culture of complaints and Damocles’ sword of litigation hangs above us, this basic truth is too frequently forgotten. It is a misconception to suppose that all complications are avoidable. Saying that, one has to emphasize, that it does not exempt us from paying the utmost attention and concentration during chest drainage and beyond in thoracic injury.

All imaginable and even unimaginable types of complications of drains in chest trauma, not a few with fatal outcomes, are described and many more never saw paper. These procedures are performed in a rush against time in a desperate situation in a hope of stopping the complete fall of the dominoes. A varying number and severity of complications can be avoided or at least reduced with proper protocols and training, but a complete pre-emption is a logical impossibility. It is the trauma that kills at the end and not the attending surgeon/emergency doctor.

As ICD is a lifesaving procedure in a great number of cases, the risks cannot be balanced against the benefits if the slightest suspicion for the need for ICD would arise. The only mistake is the one that ICD (or alternatives: ie, needle decompression, decompressive thoracostomy in an intubated patient) was not performed when it was needed. A missed tension pneumothorax or massive hemothorax are nonforgiving killers. The complication rate varies between 2% and 10%. Most complications are minor ones, like kinking or displacement, slipping out, or surgical emphysema. Only 2% to 3% of all chest drain mistakes result in serious collateral damage, like perforation, with a mortality of 20% to 25%.

Immediate Complications

Vascular

The process of insertion of the tube might cause further bleeding by vessel injury. Intercostal artery and/or vein (60%-75% of all serious complications) can suffer tangential rupture. Injury of the subclavian artery, either by the tip of the inserting rod or the tube itself, is rare: 5% to 7% of all major perforations. Any other intrathoracic vessel can be injured, of course. Minor vascular traumas are self-healing (the drain is tamponading), whereas
massive bleeding requires immediate exploration. The author prefers open but muscle-sparing exploration (axillary thoracotomy, minimal access open thoracotomy [MAOT]) to VATS.

**Cardiac complications**
The heart is involved in 16% of all serious collateral damage incidents.\(^\text{33}\) Immediate thoracotomy should be attempted, and mortality is high. Dysrhythmias pose either as immediate or late complications, depending on the onset of the drain-caused myocardial irritation. Solution: withdrawing the tube or changing the site of the drain.

**Lung parenchyma**
In 10% to 12% of all serious injuries, collateral damage involves pulmonary parenchyma. The author’s impression is that lung parenchyma is more vulnerable if mandrins are used. Previous adhesions, intrapleural strings can be disrupted, resulting in tears on the lung surface or bleeding (see previously). Bronchopleural, pleurocutaneous fistulas can be produced by prolonged tubes, especially if the drain material is too rigid. On some occasions in which subsequent surgery is needed, tubes are mistakenly reported as being tunneled into the depth of the lung parenchyma. Actually, lung parenchyma tends to embrace the tube, surrounding it and giving the false impression of a deeply penetrated tube into the pulmonary tissue itself. CT images can be misleading in this aspect. Solution: at first, shortening the intrathoracic part of the tube might help. Complete removal of the tube with leaving the drain site open in a thoracostomy fashion is another option. By this time, the adhesions that have developed usually prevent collapse of the lung. Surgical exploration (MAOS, VATS) and closure of the fistula or limited resection of the involved part of the lung might be needed as a last resort.

**Other organs**
Diaphragm laceration (30% of all major complications), perforation, and consequences of abdominal cavity penetration can result in injury of stomach (20%), colon (2%–3%), spleen (10%–30%), or liver (5%–7%). Esophagus (3%–5%) and kidney (1%) are rarely involved. Solution: exploration of the abdomen either laparoscopically or via open access. Solving the life-threatening chest condition has a priority, and the abdominal phase follows only in a stabilized patient.\(^\text{33}\) Two of 3 perforations require exploration and surgical correction (laparoscopy, laparotomy, VATS, MAOT, open thoracotomy).

**Pleural shock**
Vagal reflex can produce cardiac arrest in extremely rare occasions. Solution: resuscitation, intensive care.

**Expansion edema**
The pathology described after relieving of long-standing pneumothorax or pleural fluid accumulation is, theoretically speaking, a possibility after trauma, also. However, the danger posed by the intrapleural compression far exceeds the distant dangers of a too-quick lung expansion; therefore, no staged decompression is advised in the chest trauma setting.

**Drainage on the wrong side**
This is the only complication that must be absolutely avoided. This is a rare, but serious mistake, originating only in negligence.

**Complications in the Early Phase**

**Surgical emphysema (subcutaneous emphysema)**
Collected air in the subcutaneous region in the vicinity of the tube or more extensively in the upper torso and head (Michelin-tire figure) is the sign of a blocked tube and a still-active air escape from the pleural surface. Malposition of the Heimlich valve, blocking air escape, causing massive pneumothorax and surgical emphysema is extremely rare.\(^\text{43}\) Always consider gas-producing bacteria also, but in most cases the chest tube is blocked usually by a clot. Either the patient lies on it, or a tube kinking or dislocation occurs, the drain slips out a bit and the last side-hole (most distal from the tip) crawls into the muscle layers of the chest wall. Ask the nurse, if she or he clamped the tube for a while. Solution: control the patency of the tube (clot) and put the patient on high-value suction. Aiming at quick symptomatic relief, the skin might be incised or a small-caliber subcutaneous short-tube insertion can speed up the resolution. Explanation and reassurance to the patient, relatives, their lawyers, and the nursing staff on the harmless nature of the condition are essential.

**Sudden onset of severe pain, shortness of breath**
Listen to the lung, check pulse oximeter. Reduce the power of suction and give analgesia. If there is no relief in 30 to 60 minutes, consider changing (withdrawing) the drain a bit.

**Content of collection bottle**
Sudden change of volume, appearance of fluid in the collection bottles: that is, chyle, gastric/esophageal contents indicates late onset of viscus
perforation. Following a fast-track investigation, identify and treat the complication.

**Late Complications**

Pleural fistulas with prolonged air escape can originate in the original injury itself (inward tip of fractured rib) or rather commonly in a longstanding, irritating tip of tube.

Thoracic, empyema usually in stage II and III is the most commonly reported postdrainage complication. Paradoxically enough, undrained, retained clotted blood is made responsible for another, non insignificant portions of secondary (posttraumatic) thoracic empyemas. Posttraumatic empyema developing after drainage is attributed quite unanimously to the procedure rather than a complication of insufficient evacuation or even pneumonia due to suboptimal aftercare (lack of incentive spirometry, inhalation, patient position, extended bed rest). Reality is more complex: usually a combination of the 3 is responsible for the adverse outcome. The condition, if it develops, is better treated by a dedicated thoracic surgical unit/department in an “a frois” phase. Empyema thoracis is a manageable condition with good chances, whereas a tension pneumothorax or a massive intrapleural bleeding kills.

Intercostal/drain site pain is a nuisance for the patient and doctor alike, healed by time in a good number of cases. The prognosis is highly unpredictable. Local anesthetics are advised, but success is not guaranteed. Referral to a pain clinic might help.

**SPECIAL CONSIDERATIONS**

Chest trauma is rarely limited to the well-fed urban populations with high-tech medical facilities at arm stretch and not only is the civilian population involved. Chest drainage offers hope for many who are seriously injured in extreme situations in peace, disasters, and war alike.

**Chest Trauma in Multiple Casualty and Mass Casualty Situations**

A mass casualty (MASCAL) situation is marked by an acute discrepancy between the actual treating facilities/capacities and the number and the severity of the injuries of those who are in need as the flow of the patients is too high. Unsaturated MASCAL or multiple casualty scenarios (typically urban terrorist attacks) are less demanding in this aspect. The rate of chest injuries in these situations varies from event to event, but its high frequency usually as part of multi/polytrauma rather than a thoracic montrauma is nondisputable. Simple detention of life-threatening intrapleural pressure relieves not only the individual patient, but the providing system under extreme stress also. Chest drainage is not a panacea, but is a procedure taking no more than 5 minutes that can reclassify a patient from T1 to T2 or T3 triage group. Chest drainage is a cornerstone in the management of torso injuries in damage control surgery. There is a pendulumlike shift in the preferred procedures for chest trauma. From the Korean war (1950–1953) onward, there is a trend to perform too many unnecessary thoracotomies instead of drainage alone at the beginning of the treatment of the victims of armed conflicts. As experiences are collected, and evaluated, chest drainage regains its proper place in the protocols. The progress restarts at the start of the next war, as surgical dogmas are hard to change.

**Prophylactic Drainage**

There are institutional protocols for inserting preventive chest drains in the case of serial rib fractures (suspected underlying lung injuries) if the need for artificial ventilation is expected: either for emergency surgery (abdominal, skeletal) or for intensive care. The numbers vary, usually from 3 or 4 broken ribs and up, and there are other factors to evaluate also. Flail chest, spatial relation of bone edges, exact location of the fractures (the lower the better), and nontrauma-related condition of the lung (CT image) are also to be considered. No particular recommendation can be given, but the concept is worth considering.

**Limited Pneumo/Hemothorax in the Old and Fragile Patients**

With the almost endemic antiplatelet therapy, the frequency of hemothorax cases following very minor trauma reaches heights never seen before in the same manner as subdural hematoma cases are accumulating. These patients need extra attention and a more proactive surgical attitude might be considered. The advice is based purely on personal experience, as no reliable data are available as the question seems to be the holy cow of contemporary medicine.

**Extemporaneous Means: Chest Surgery in War and/or Remote, Rural Regions**

There are some minor tricks that make chest drainage possible in challenging environments with limited or no access to the blessings of the tools of modern surgery:

a. In a shortage of proper chest drains, industrial rubber tubes (sterilized in hot water) with
improvised multilocular side holes can be used with acceptable effect.

b. In a shortage of drainage systems/sucking bottles and prefabricated Heimlich valves, the holed rubber gloves or condoms fixed to the external tip of the tube provide an improvised but safe 1-way valve.

c. von Bülaü’s bottle can be improvised from simple jars. The patient’s drain should be connected to the upper end of an underwater tube. When another Bülaü bottle is used, the air-pipe tube (space above the water) connected to a mouth piece and sucked by the patient makes an improvised incentive spirometry tool. The inhaled air should come against pressure controlled by the depth of the tip of the other tube positioned below water level. Length of the underwater part can be adjusted to the capacities of the patient.

SUMMARY

The Hamlethian question in chest trauma is to drain or not to drain. The answer is that drainage is always to be considered, except with an unstable patient injured in the projection of the heart where straightforward surgery should be performed, just like in obviously extensive thoracic destruction. If drainage cannot control bleeding/air escape, then an immediate open surgical approach should follow. Preinterventional investigations should be minimized, as detention has priority. Without strict written and regularly reviewed institutional protocols and continuous training, there is no chance to avoid complications, exposing patients to unnecessary collateral damage and beyond.

REFERENCES