

**THE MANAGEMENT OF TRAUMATIC HAEMOTHORAX
AND HAEMOPNEUMOTHORAX BY CLOSED TUBE
THORACOSTOMY AS PRACTISED IN KENYATTA
NATIONAL HOSPITAL**

**A DISSERTATION SUBMITTED IN PARTIAL
FULFILLMENT ON THE REQUIREMENT FOR THE
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DECLARATION

I certify that this dissertation is my original work and has not been presented for a degree in any other university.

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SUMMARY

This is a prospective study conducted between tenth of February and tenth of November 2004. A total of ninety-five patients with posttraumatic pleural collections with pneumothorax and/or haemothorax were recruited. Ninety-six chest tubes were inserted in ninety-two patients. Eighty-eight had unilateral chest tubes while the remaining 4 had bilateral chest tubes. Three patients were managed conservatively.

Eighty seven percent of the patients were males and nearly 70% were in the 20-40 years age bracket. It was found that patients in slum areas were at higher risk for penetrating injuries compared to non-slum dwellers. Sixty one percent of the patients presented with penetrating injuries the majority of which were as a result of stab wounds. Two thirds of blunt injuries were due to RTA.

Nearly all the patients had chest radiographs performed prior to insertion of a chest tube. The commonest pleural collection was haemopneumothorax (48.4%), which if combined with simple haemothorax account for 72.6%. Only three different sizes of chest tubes were utilized-FG20, 24, 28-with FG-28 been the commonest tube used (57%). All tube insertions were carried out in the triangle of safety with the fifth intercostal space used in 52% of the patients. Sixty patients (62.5%) had their chest tube removed within one week. Only six patients had their tubes maintained for fifteen days or more. Two-third of patients with haemothorax had an output of 750mls or less in the first twenty-four hours.

The study showed that 54% of the patients had their tubes removed on the basis of chest radiographs. There was no significant difference on the outcome between the patients who had their tubes removed on the basis of clinical examination or chest radiographs.

The commonest complication encountered was empyema thoracis (8.4%). Empyema was highly associated with knife stabs and longer period of chest tube left in situ. Mortality was due to the initial injury and was commoner among patients with RTA and gunshot injuries,

INTRODUCTION

Definitions:

- Haemothorax is accumulation of blood in the pleural space
- Pneumothorax is accumulation of air in the pleural space
- Haemopneumothorax is accumulation of both air and blood in the pleural space.

Trauma remains a major cause of morbidity and mortality worldwide with chest injuries been sustained by a third of these patients (1,2). Both blunt and penetrating chest trauma can result in accumulation of air and/or blood in the pleural cavity resulting in respiratory and, in severe cases, cardiovascular impairment leading to death.

Pneumothorax can be primary or secondary to underlying pathology. Trauma whether iatrogenic (e.g. CT scan guided lung biopsy), non-iatrogenic like RTA and assault remains a major cause. Tension pneumothorax can be a cause of death.

Closed tube thoracostomy, using the Seldinger technique connected to the Tudor-Edward Bottle as an underwater seal is the standard practice for management of pleural collections (1,2,3). Nevertheless, other methods like needle aspiration in mild cases, thoracoscopy, video assisted thorascopic surgery (VATS) and thoracotomy may also be used in some cases (1,3,4,5).

Various complications have been encountered when managing patients with chest tubes. Some like subcutaneous emphysema, failure to drain the pleural collection and empyema thoracis are commonly seen. Others like injury to mediastinal structures and diaphragmatic eventration are rare and only appear as case reports (1,3).

LITERATURE REVIEW

Historical Background

The management of chest trauma and its link with weaponry has been recorded in ancient writing of Iliad (450 BC).

Hippocrates is said to have described techniques to cannulate the pleural space. In 1867 Hillier opened an empyema cavity under water in a warm bath.

In 1872 the underwater seal principle was introduced by Playtain. Continuous drainage with a closed under water seal system is first attributed to Hewett in 1876.

Theodore described the closure of an open chest wound while Napoleon's surgeon, Boran Larey, consolidated the sporadic observations of other surgeons on the life saving value of closing an open chest wound. The standards for management of haemothorax were developed however, by the Second World War army medical corps, and remain the standard practice to date (1).

Anatomy and Physiology of the Pleura

The pleura is a sac of serous membrane with a potential space. It consists of parietal and visceral pleura. The parietal pleura covers the inner surface of the ribs, diaphragm and mediastinum while the visceral pleura begins at the pulmonary hilum in continuum with the parietal one and covers the lung surfaces including the fissures. The potential space is lubricated by a small amount of pleural fluid providing efficient mechanical coupling between the passive elastic lung and the dynamic chest wall (2). The intrapleural space pressure is subatmospheric because of the elastic recoil of the lung tissue. During quiet respiration pressure fluctuates

between -8 and -9 mmHg during inspiration and -3 and -6 mmHg during expiration.

Under normal circumstances the pleural fluid¹ is constantly maintained at approximately 2 ml. This is unevenly distributed due to the gravity with the basal zones having more fluid than the apical zones.

Pathophysiology of collection of fluid in the pleura

Accumulation of air and blood in the pleural space can result from trauma or diseases, and results in impairment of ventilation. Positive intrapleural pressure results in loss of lung volume due to reduced elastic recoil and compression of the lungs.

A large volume of fluid leads to collapse of the ipsilateral lung and later mediastinal shift with volume loss in the contra-lateral side (partial collapse); this is seen in tension pneumothorax. This hence, leads to severe disturbances of mechanics of breathing and imbalance of ventilation and perfusion as vessels become compressed and, in severe cases, mediastinal shift, kinking and obstruction of great vessels occurs.

Consequently arterial hypoxaemia, decrease in pulmonary volumes, compliances and diffusion capacity takes place threatening the patients' survival. This necessitates early evacuation of air and blood from the pleural cavity (1,2,3,6).

Post Traumatic Haemothorax

Haemothorax can be due to the following:

1. Post traumatic
2. Post thoracotomy

3. Diagnostic procedures like CT scan guided lung Biopsy (7).

Posttraumatic haemothorax can be due to:

1. Blunt chest injury (as in RTA) that causes lung contusions or fractures a rib(s), which pierces the pleura.

Source of blood accumulation can be from:

- Intercostal vessels
- Internal mammary vessels
- Aorta
- Pulmonary vessels
- Laceration of the lung

Injuries of the great vessels are associated with a high mortality.

2. Penetrating chest wounds like stab wound or gunshot.

Haemothorax usually develops at the time of injury but can be delayed for several days. Occasionally extrapleural haematoma can burst into the pleural cavity hence being confused as a delayed haemothorax. Intrapleural blood clotting is delayed for sometime by movement of the diaphragm, thoracic structures and pleural enzymatic activity. If however, it clots, fibrous tissue invasion occurs leading to fibrothorax, which will impair ventilation seriously. (1,3)

Clinical Features of Haemothorax

The symptoms and signs of haemothorax will depend on the severity of the injury, the size of intrapleural fluid collection and whether the patient had an underlying pathology. History of the injury will reveal the nature and site of the injury.

In massive haemothorax where there is accumulation of more than 1000 ml of blood in the pleural space the patient is dyspnoeic, in shock, hypotensive, pale and

tachypnoic. Chest expansion is restricted on the ipsilateral hemithorax while the apex beat is displaced with mediastinal shift.

Percussion note is stony dull and air entry on the affected side will be absent or reduced. Plain erect chest radiograph will show haemothorax and its degree.

The management is resuscitation; ensuring patent airway, maintaining breathing and circulation and simultaneously decompressing the chest by underwater seal drainage and in continued bleeding, thoracotomy.

A small size haemothorax, less than 100ml, can be managed conservatively, while a moderate one is managed effectively by chest tube drainage. Video assisted thoracic surgery (VATS) has been tried in management of haemothoraces (1,3,8,9).

Post Traumatic Pneumothorax

Posttraumatic pneumothorax can be a resultant of:

1. Chest wall injuries
2. Disruption of tracheobronchial tree
3. Oesophageal perforation
4. Iatrogenic causes
 - Lung biopsy
 - Central venous line insertion
 - Mechanical ventilation

Pneumothorax can be a simple or a tension pneumothorax.

Simple Pneumothorax

It arises in circumstances similar to tension pneumothorax but where a one-way valve air leak does not occur. Air leakage into the pleural space stops after

sometime due to sealing of the pleural hole or pressure equilibrium on both sides.

Clinical features are subtle and include:

- Chest pain – initially pleuritic but later dull
- Dyspnoea depending on the size of pneumothorax and accordingly pulmonary collapse
- Cough, orthopnoea and haemoptysis – less common
- Diminished movement of the affected hemithorax
- Hyperresonance on percussion
- Reduced tactile vocal fremitus
- Absent or reduced breath sounds
- Cyanosis – mostly when there is an underlying lung pathology

A chest radiograph will show hyperlucent area with absent pulmonary markings. The visceral pleura will appear as a thin white line outlined by air on both sides (medially by air in the lung and laterally by pneumothorax).

Treatment

Treatment is by insertion of a chest tube in the fifth intercostal space in the triangle of safety connected to an under-water-seal-drainage system.

Aspiration using wide bore needle attached to a three-way stopcock is also successful though not very encouraged. (1,3,8,9,10)

Tension Pneumothorax

Tension pneumothorax arises when a one-way valve air leak occurs either from the lung, occasionally in open pneumothorax and positive pressure ventilation. Progressively laboured and deeper inspiration produces more accumulation of air without any means of escape. With more air entry, there is ipsilateral hemithorax collapse and mediastinal shift. Open pneumothorax allows air entry through the opening due to less resistance leading to impaired ventilation.

The clinical features are severe, may lead to death and include:

- Marked respiratory distress and chest pain.
- Distension of neck veins
- Deviation of trachea and apex beat
- Hyper-resonance on percussion
- Absent breath sounds of the affected hemithorax
- Cardiovascular compromise like shock due to reduction in venous return following the high intrathoracic pressure.
- Cyanosis

A plain erect chest x-ray will show hyper lucency of the affected hemithorax with absent pulmonary markings, lung collapse and mediastinal shift.

Treatment

Tension pneumothorax is a clinical diagnosis and treatment should not wait radiological confirmation. Immediate treatment is insertion of a wide -bore needle into the second intercostal space in the mid-clavicular line of the affected hemithorax. This converts tension pneumothorax into a simple one.

A chest tube inserted in the triangle of safety in the fifth intercostal space is the definitive treatment.

In sucking chest wounds the immediate closure of the wound with gauze to prevent further air entry is undertaken and thoracostomy tube inserted as mentioned above. Surgical toilet and closure of the wound will be frequently required. (1,2,3,11,12)

Estimation of Size of Pneumothorax

Various methods have been devised for estimation of the size of pneumothorax in adults using a plain erect posterior-anterior chest radiograph.

Small pneumothorax affects 10 – 15% of the pleural cavity and manifests radiologically by a 1cm rim of air in an adult and is usually asymptomatic.

Moderate pneumothorax occupies 15 – 50% of the volume of the pleural cavity and is seen as a rim of more than 2cm of air from the chest wall.

Pneumothorax involving more than 60% of lung volume manifests radiologically by lung collapse (13).

A similar but modified system was devised by Light and Rhea et al ⁽²⁾. In this method intrapleural space distance is measured at the apex and at the midpoints of the upper and lower zones. Taking the average of these three measurements a nomogram is used to give the percentage of the pneumothorax.

Principles of Under Water Seal Drainage

The under water seal drainage system is simply a conduit used to remove fluid from the intrapleural space while preventing re-entrance of fluid into the pleural space. This allows lung expansion and re-establishes ventilation perfusion balance.

The under water seal drainage must therefore fulfil three conditions: -

Unobstructed chest tube of adequate diameter

Collecting containers below chest level

One-way system utilizing either a water seal or a valve that prevents return of fluid into the pleural cavity (3).

For this purpose a Tudor – Edwards Bottle is used (4). Either one or more bottles are used with or without negative suction to assist drainage. The thoracostomy tube is connected to about 1.8 m of connecting tube, which leads to a bottle placed below the patients' chest level to make use of gravity in drainage. This tubing allows the patient to move about in his bed while eliminating entry of fluid into the pleural cavity especially during bouts of deep breath or cough. In an emergency situation the end of the tube can be placed in any container with water as a temporary measure (3,14).

The bottle should be large enough to collect at least 1000 ml of fluid above the initial water content and should be taped to the floor or put in a box. If no suction is used one bottle will suffice. If however suction is used 2 or 3 bottles system can be employed.

In a one bottle system the bottle serves as a reservoir and water seal.

In a two-bottle system, the first serves as a reservoir and the second as a water seal.

While the third bottle in a three bottle system regulates the amount of suction.

Between -10 to -20 cm H_2O of negative suction pressure is safe and satisfactory (14).

There are also commercially available disposable kits that are convenient and effective in draining the chest.

Technique of Intercostal Tube Drain Insertion

The insertion of an intercostal tube drain is performed under aseptic conditions.

It's a simple and the basic necessary equipment is easily available. An ordinary procedure set contains:

- Trocar

- Catheter – bigger ones for haemothorax
- Scalpel
- Syringe
- Hypodermic needles
- Tissue forceps
- Haemostats
- Local anaesthetic
- Needle holder
- Suture material – silk/nylon
- Few sponges
- Bottles

One of these 2 techniques is used;

1. Trocar and canula method
2. Haemostat method

Trocar and canula method

Skin, subcutaneous tissue and pleura are anaesthetised and a 1cm incision is made in the skin and deeper tissues at the centre of selected intercostal space. Trocar and canula are passed gently but firmly into the pleura space. Canula is withdrawn and a predetermined length of a catheter held with haemostat is inserted into the space via the trocar and fixed with a suture, adhesive tape and connected to the underwater seal with or without negative suction pressure.

Haemostat Method

This is the preferred method of chest tube fixation as the trocar method has a potential to cause lung injury. Skin is prepared and incision made as above.

Haemostat is introduced by firmly and gently forcing it into the pleural cavity in the middle of the intercostal space. Withdraw the haemostat and explore the pleural space with a finger. The distal end of the catheter is then grasped with the tip of the haemostat and inserted into the cavity. You then proceed as the trocar method. In both haemostat and trocar methods it is advisable to pass a finger into the incision site and confirm that the pleural space is actually not obliterated by adhesions from previous inflammatory processes and where adhesions are present to release them or use a different site for insertion of the chest tube (1,2,3,8,14,15,16).

Other methods, which have been used to insert thoracostomy tubes, include:

- Use of laparoscopic trocars (17).
- Use of catheters as a guide for insertion (18).
- The needle-wire-dilator technique in paediatric age groups (19).

Site of Insertion and Size of Catheters.

It's important to choose the site of chest drains carefully, more so for loculated fluid. However, for most traumatic hemothorax and /or pneumothorax the space between the fourth to sixth intercostal space in the triangle of safety (that is between midaxillary and anterior axillary line) will suffice (3).

Historically, pneumothorax was drained through the second or third intercostal space just lateral to the midclavicular line while fluids were drained using the eighth or ninth intercostal space posteriorly. This was assumed to assist in drainage as fluid gravitates down while air rises up. However this is now believed to be incorrect, as fluid and air will find the drain in a free pleural cavity particularly if negative pressure suction is applied.

The position of the catheter's tip doesn't matter whether it's pointed downwards for haemothorax or upwards for pneumothorax. One thoracostomy tube in the triangle of safety is enough for haemopneumothorax though some surgeons prefer to put two. In case of an apical loculated pneumothorax posterior suprascapular approach and insertion in the first intercostal space is indicated. In an adult of seventy kilograms a wide bore thoracostomy tube of French Gauge (FG) size 28-32 is used for haemothorax while a FG 20-24 tube is effective for pneumothorax (3,4).

Care of a Patient with Under Water Seal System

Once the chest tube has been inserted and secured further adjusting and advancing of the tube into the chest should be avoided to reduce introduction of infection via the track. The wound should be sealed with a small gauze pad. Clamping of the drain when moving a patient from one place to another is unnecessary. Though it can be done safely in patients with haemothorax and hydrothorax when changing the bed, in patients with persistent air leak clamping of the tube is dangerous as it can lead to tension pneumothorax and death. And in such patients it is safer to disconnect the tube from the under water seal system in case of positioning of a patient in a bed or theatre table and reconnecting it as soon as possible. The patency of the thoracostomy tube is checked by observing the swinging of fluid in the tubing and air bubbles during respiratory phases. This can be augmented by asking the patient to cough. With good instructions patients with chest tubes inserted can be managed as out-patients (3,20).

When and How to Remove the Chest Tube

Ideally chest tube should be removed as soon as its purpose is accomplished to avoid bacterial infection utilising the drain track as a conduit. It has been observed that for posttraumatic pneumothorax and haemopneumothorax within 12 hours of chest tube

insertion the lung has expanded fully and air leak has stopped (3). Therefore removing the chest tube twenty-four hours after its insertion is usually safe. And there is no higher incidence of tube re-insertion seen compared to those whose drains were left in place for five to seven days as traditionally practiced. Though chest tubes can be left insitu for two to three weeks especially for empyema thoracis and patients with chronic air leak in obstructive airway disease, leaving it for longer periods can cause infection and erosion of intercostal vessels leading to haemorrhage. And in such cases surgical intervention is indicated.

Removal of the tube has been traditionally done with the patient holding his breath after deep inspiration inflating his lungs, the purse string is pulled and the track closed. Wound is then dressed with gauze pads.

However, recent studies show similar outcome when end expiration is used (3,21). The tip of the catheter should be sent for culture and 24 hours later plain erect chest radiograph could be done prior to discharge (22).

Complication of Chest Drains

Various complications have been encountered when managing patients with chest drains. Some are common while others are rare and only appear as case reports.

- i. Failure to enter the pleural cavity
 - Ending of the drain in the soft tissue of the chest wall
 - Insertion into the axilla and brachial plexus
 - Entrance into the mediastinum, subclavian vessels (11,23).

Misplaced chest tubes are best localised using a CT scan (24)

ii. Penetration of the lung

- Minor lung laceration when trocar is used is common and resolves spontaneously. However, in patients with pleural adhesions secondary to previous pathology significant injury to the lungs can occur. Major lung lacerations occur in trauma patients with subcutaneous emphysema of the chest wall who are mistakenly fixed with chest drain. (25)

iii Major Haemorrhage

- Either from great vessels or the heart (11)

iv. Penetration of the peritoneal cavity

- When low intercostal spaces below the sixth are used or when there is diaphragmatic rupture, injury to abdominal viscus can be caused by the trocar. Injury to the liver, colon, stomach and spleen have been reported (3).

v. Introduction of pleural infections (26).

vi. Chest tube kinking, clogging and dislodging from the chest wall and disconnection from under water seal system.

vii. Persistent pneumothorax (21)

- Large primary leak
- Continuous leak at site
- Faulty under water seal apparatus

viii. Recurrence of pneumothorax

ix. Subcutaneous emphysema (27).

x. Allergy to skin preparation

xi. Arteriovenous fistula of intercostal vessels (28)

xii. Spinal epidural air (29)

xiii. Diaphragmatic Eventration (30)

STUDY JUSTIFICATION

Kenya enjoys the second position in the world with a poor road network and consequently one of the highest road traffic accident incidences (31). Chest injuries account for a third of all injuries sustained. In our set-up where organised and non-organised crime is exponentially increasing, chest injuries could be much higher. Records at Kenyatta National Hospital Accident and Emergency Department show an average of 130 chest tubes insertions per annum in patients with pleural collections as a result of trauma.

Studies done elsewhere have shown between 15- 64% of chest injury patients could have haemothorax, pneumothorax or haemopneumothorax (7). Chest tubes connected to an underwater seal drainage system is the standard practice of management. Studies done elsewhere have shown the effectiveness of chest tubes and pinpointed the complications that were encountered (4). No such study has been conducted in Kenyatta National Hospital.

This study therefore aims at reviewing the management of chest tubes in posttraumatic pleural collections.

AIMS AND OBJECTIVES

Main Objectives

To review the management of traumatic pneumothorax, haemothorax and haemopneumothorax by closed tube thoracostomy in Kenyatta National Hospital.

Specific Objectives

1. To document types of trauma leading to pleural collections requiring drainage
2. To quantify the degree of pneumothorax as an indication for insertion of chest tubes in simple pneumothorax.
3. To quantify the drainage from the pleural space in cases of haemothorax
4. To find out the duration a tube remains in situ
5. To identify complications arising from chest tube insertion

METHODOLOGY

Study area

The study was carried out at Kenyatta National Hospital, the country's main Referral Hospital and the teaching Hospital for the University of Nairobi.

Study population

All patients admitted to Kenyatta National Hospital trauma wards for posttraumatic pleural collections

Study design

A nine-month descriptive prospective study was conducted between 10th of February and 10th of November 2004.

Sample size

The sample size for this study consisted of patients with pleural collections seen within the study period that fulfilled the inclusion criteria.

Inclusion and Exclusion Criteria

All patients admitted to Kenyatta National Hospital various trauma wards; cardio thoracic ward, intensive care and burns units for post traumatic pleural collections whether they had chest tubes inserted or not were eligible.

Non-traumatic and iatrogenic pleural collections were excluded. Patients with trauma of more than four days duration, delayed referrals and those on anticoagulants or have a bleeding disorder were also excluded.

Data collection instruments

Data was collected using a questionnaire. The collected data included patient's age, sex, type of trauma, diagnosis and chest tube site and size. Radiographs were studied. Partial resolution of pleural collection is defined as the reduction in the magnitude of the collection in comparison to the chest radiographs performed earlier. This earlier radiograph can either be prior to insertion of chest tube or immediately after the insertion in situations necessitating insertion without prior chest radiographs. This information formed part of the questionnaire (appendix 1).

The data was collected twice daily. Repeat chest radiographs were performed whenever it was possible to monitor resolution of the pleural collection. Similarly after removal of the chest tube and prior to the patients been discharged a chest radiograph was requested. The end point of the study was the first visit to the clinic, which is normally three to four weeks after discharge. During this visit any complication, especially empyema thoracis, was looked for.

Analysis of variables

Analysis of variables was done as per age, sex, type of trauma, diagnosis, size of pneumothorax, size and site of chest tube insertion, duration chest tube remained in situ, output in case of haemothorax and any complications.

Data was entered into a computer and analysed using SPSS/PC+ for windows version 10. Analysis involved descriptive statistics like means and standard deviations for continuous data and frequency distributions, proportions and percentages for categorical data. Empyema thoracis was specifically subjected to statistical significance testing. Statistical significance was sought using Chi-square test, Fisher's exact test and Mann Whitney U tests with a confidence level of ninety-five percent. Results are presented in tabular form.

Study limitations

1. Patients in whom the diagnosis of pleural collection was missed, and not admitted.
2. Lost to follow up patient.
3. Limited financial and logistical resources.

Ethical Considerations

Authority was sought from the Ethical and Research Committee of Kenyatta National Hospital for permission to conduct the study in the institution and has been duly approved. Patients' consent was sought and all records were handled confidentially (Appendix).

RESULTS

Ninety-five patients with chest injuries were recruited during the nine-month period with various types of pleural collection. A total of ninety-six chest tubes were inserted in ninety-two patients. Eighty-eight patients had unilateral chest tubes while four had bilateral ones. Three patients were managed conservatively.

Table 1-sex distribution

Sex	Frequency	Percentage
Male	83	87.4
Female	12	12.6
Total	95	100

There were eighty-three males (87.4%) and twelve females (12.6%) in the study group. This translates into a male: female ratio of nearly 6:1.

Table 2- Age distribution

Age	Frequency	Percentage
0-20	10	10.5
21-30	45	47.4
31-40	21	22.1
41-60	16	16.8
61+	3	3.2
Total	95	100

Forty-seven percent of the patients were aged twenty-one to thirty years and nearly seventy percent were within the twenty-one to forty years age bracket.

Table 3-distribution of residence

Residence		Frequency	Percentage
Nairobi	Slums	60	63.2
	Non Slums	20	21.0
Outside Nairobi		15	15.8
Total		95	100

Eighty four percent of the patients (80) are residing in various parts of Nairobi. Fifteen patients came from outside Nairobi as referrals. Of Nairobi residence 60% were from slum areas.

Table 4- type of trauma

Trauma		Frequencies	Percentage
Blunt	RTA	25	26.2
	Non RTA	12	12.6
Penetrating	Knife	30	31.6
	Gunshot	26	27.4
	Arrow	1	1.1
	Other	1	1.1
Total		95	100

Fifty-eight patients (61%) presented with penetrating injuries compared to 37 with blunt injuries. Stab wound as a result of a knife accounted for 50% of penetration followed by gunshots. One patient sustained penetrating injury from a bull's horn. Two thirds of blunt injuries resulted from road traffic accidents.

Table 5-chest radiograph prior to chest tube insertion.

Chest radiograph	Frequency	Percentage
Performed	91	95.8
Not performed	4	4.2
Total	95	100

Ninety-one patients had a chest radiograph performed before chest tubes insertion. Only four patients who had severe dyspnoea had chest tubes insertion prior to chest radiographs. Three of these had tension pneumothorax while one had severe pneumothorax

Table 6-type of pleural collection

Diagnosis	Frequency	Percentage
Mild Pneumothorax	12	12.6
Moderate Pneumothorax	10	10.5
Severe Pneumothorax	1	1.1
Tension Pneumothorax	3	3.2
Haemothorax	23	24.2
Haemopneumothorax	46	48.4
Total	95	100

A total of 69 patients had haemothorax or haemopneumothorax. Of these 46 (48.4%) /had haemo-pneumothorax. The remaining 26 patients had pneumothorax. Twenty-three had simple pneumothorax (12 mild pneumothorax, 10 moderate pneumothorax and one severe pneumothorax) while three had tension pneumothorax.

The magnitude of pneumothorax is assessed radiologically. A small pneumothorax manifests radiologically by a 1 cm rim of air from the rib cage, while a moderate one shows by a 2cm rim of air. A severe pneumothorax shows as a lung collapse.

Table 7- site of thoracostomy tube

Site of Catheter	Frequency	Percentage
4 th Intercostal	40**	41.7
5 th Intercostal	50**	52.1
6 th Intercostal	6	6.3
Total*	96	100

* Three patients were managed conservatively

**4 patients had bilateral chest tubes

A total of 96 chest tubes were inserted in 92 patients. Eighty-eight patients had unilateral tubes while the remaining 4 had bilateral ones. Three patients were managed conservatively without resorting to insertion of a chest tube. Two of these were having mild pneumothorax and one had haemopneumothorax. In 94% of the patients either the fifth or the fourth intercostal space of the triangle of safety was utilized. In no patient the midclavicular or posterior positions were used.

Table 8- size of thoracostomy tube

Size of Catheter	Frequency	Percentage
Pneumothorax 20-24	17**	18.3
Pneumothorax >24	12	12.9
Haemothorax <28	22	23.7
Hemothorax 28-32	41**	44.1
Hemothorax >32	1	1.1
Total*	93	100

*Three patients were manage conservatively, three had unknown catheter sizes

** 4 patients had bilateral chest tubes

The thoracostomy tube used in nearly all the patients was either FG 20, 24, and 28. Majority of patients with pneumothorax had FG20 while 44% of patient with haemothorax had FG28

Table 9 duration tubes remained in place

Duration (days)	Frequency	Percentage
1-7 days	60**	62.5
8-14 days	30	31.2
More than 14 days	6**	6.3
Total*	96	100

*Three patients were managed conservatively

**Four patients had bilateral chest tubes

More than 62% of tubes were removed within one week while only 6% were maintained for more than 14 days.

Table 10 outputs from haemothorax in the first 24 hours.

Output from haemothorax (in milliliters)	Frequency	Percentage
1-250	17	29.8
251-500	15	26.3
501-750	5	8.8
751-1000	5	8.8
1001-1250	3	5.3
1251-1500	7	12.3
1501-1750	2	3.5
1751-2000	2	3.5
More than 2000	1	1.8
Total*	57*	100

* Twenty-six patients had pneumothorax, the output of twelve others was not documented

Out of 69 patients with haemothorax, 57 had their output documented. The output of twelve patients was not documented as some were referrals while others had nongraduated bottles. One patient was managed conservatively without a chest tube. Fifty-six percent (32) of the patients had an output of less than 500mls in the first 24 hours. Nearly 90% of the patients had an output of less than 1500mls while close to 10% had output of more than 1500mls in 24 hours.

Table 11-chest tube removal basis

Tube removal basis	Frequency	Percentage
Clinical	38	44.7
Chest radiograph		
Fully resolved	28	32.9
Partially resolved	18	21.2
Removed by patient	1	1.2
Total	85	100

Thoracostomy tubes were removed either on clinical basis or after a chest radiograph. In 54% of the patients tubes were removed on radiograph basis, two-thirds of which had fully resolved. One psychiatric patient pulled out his tube and did not require re-insertion.

Table 12-post removal chest radiograph

Post removal chest radiograph	Frequency	Percentage
Full resolution	40	60.6
Partial resolution	26	39.4
Total*	66	100

*Twenty nine patients had no post removal chest x-rays

More than 60% of the patient's pleural collection had fully resolved compared to 40% partial resolution. None of these required re-insertion.

Table 13-additional surgical intervention

Operation	Frequency	Percentage
Thoracotomy	1	1.1
Laparotomy	7	7.4
No operation	87	91.6
Total	95	100

Only 8.5% (8) of the patients underwent additional operation. Seven had laparotomy for injury to abdominal viscus while one patient underwent thoracotomy for removal of a bullet.

Table 14-complications

Complications	Frequency	Percentage
Empyema thoracis	8	8.4
Fallout	5	5.3
Abnormal position	1	1.1
Death	8	8.4
No complication	73	76.8
Total	95	100

Empyema thoracis occurred in eight patients (8.4%). Five patients had their tubes fallout and were re-inserted. One patient had tube inserted on the wrong site initially and subsequently rectified. Eight patients died due to severity of their initial injury.

Table 15-status at the first visit to the clinic

Status at first clinic visit	Frequency	Percentage
Normal	51	58.6
Empyema	3	3.4
Not attended clinic	33	37.9
Total*	87*	100

***Eight patients died before discharge**

Thirty eight percent of the patients did not attend the out-patient follow up clinic after they were discharged from the wards. Among the remaining 62% of the patients who attended the clinic, 3(3.4%) presented with empyema thoracis.

Table 16-cross tabulation of type of trauma and age

Age		Type of trauma				Total
		Blunt		Penetrating		
		No	%	No	%	
0-30	0-20	2	20	8	80	10
	21-30	13	29	32	71	45
	31-40	9	43	12	57	21
More than 30	41-60	10	63	6	38	16
	More than 60	3	100	0	0	3
Total		37	39	58	61	95

Chi square p=0.006

This table shows that there is statistical significance between penetrating injuries and those aged 30 years and below.

Table 17-relation between sex and trauma

Sex	Frequency	Percentage
Male	83	87.4
Female	12	12.6
Total	95	100

Kolmogorov-Smirnov $p < 0.01$

Chi square $p < 0.01$

There is statistical significance between male sex and trauma.

Table 18- Cross tabulation between sex and type of trauma.

Sex	Type of trauma				Total
	Blunt		Penetrating		
	No	%	No	%	
Male	32	38.6	51	61.4	83
Female	5	41.7	7	58.3	12
Total	37	38.9	58	61.1	95

Chi square $p = 0.536$

There is no statistical significance between the sex of the patient and type of trauma sustained

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Table 19-residence versus trauma

Place of residence	Type of trauma				Total
	Blunt		Penetrating		
	No	%	No	%	
Nairobi	25	31.3	55	68.8	80
Outside Nairobi	12	80.0	3	20.0	15
Total	37	38.9	58	61.1	95

Chi square $p = 0.01$

This table shows statistical significance between Nairobi residence and penetrating trauma. However, this is due to the majority of patients been from Nairobi. It's also possible that patients from outside Nairobi might be going to private hospitals.

Table 20- Nairobi residence and trauma

Place of residence	Type of trauma				Total
	Blunt		Penetrating		
	No	%	No	%	
Slum	18	30.0	42	70.0	60
Non Slum	7	35.0	13	65.0	20
Total*	25	31.3	55	68.8	80*

*Fifteen patients live outside Nairobi

Chi square $p=0.438$

There is no statistical significance between where the patients reside in Nairobi and type of trauma sustained.

Table 21-type of trauma and diagnosis

Diagnosis	Type of trauma				Total
	Blunt		Penetrating		
	No	%	No	%	
Pneumothorax	17	65.4	9	34.6	26
Haemothorax	20	29.0	49	71.0	69
Total	37	38.9	58	61.1	95

Chi square $p=0.001$

There is a high statistical association between penetrating injury and haemothorax.

Table 22-post removal Chest radiographs against diagnosis

Diagnosis	Post removal chest radiographs				Total
	Fully resolved		Partially resolved		
	No	%	No	%	
Pneumothorax	14	77.8	4	22.2	18
Haemothorax	26	54.2	22	45.8	48
Total*	40	60.6	26	39.4	66*

*Twenty-nine patients had no post removal CXR

Chi square $p=0.069$

No statistical association between type of collection and its resolution on post removal chest x-ray.

Table 23-duration tube remained in place and basis for removal

Tube removal basis	Duration (days)			Total
	1-7	8-14	More than 15	
Clinical	28	9	1	38
Chest radiographs	17	10	1	28
Full resolution	5	11	2	18
Partially resolution	1	0	0	1
Removed by patient	1	0	0	1
Total	51	30	4	85

Tube removal basis	Duration (days)		
	Frequency	Median	Range
Clinical	38	6	16(min3, max9)
Chest x-ray	46	8	33(min3, max36)

Mann Whitney U-test=0.042

The table shows early removal of tubes on a clinical basis in contrast to radiological basis with statistical significance.

Table 24-tube removal basis vs. post removal Chest radiograph

Tube removal basis	Post removal Chest radiograph				Total
	Fully resolved		Partially resolved		
	No	%	No	%	
Clinical	18	64.3	10	35.7	28
Chest radiograph	21	56.8	16	43.2	37
Total	39	60.0	26	40.0	65*

*Twenty-nine patients had no post removal chest radiograph, one patient removed it on his own

Chi square p=0.361

No statistical relation between resolution of collection and basis for removal.

Table 25-complications vs. diagnosis

Complication	Diagnosis		Total
	Pneumothorax	Haemothorax	
Infection	1	7	8
Fallout	4	1	5
Abnormal position	1	0	1
Death	2	6	8
No complication	18	55	73
Total	26	69	95

Higher incidence of empyema thoracis among haemothorax patients is noted. This is statistically significant as shown in the next table (table 26).

Table 26- Risk factors for empyema thoracis.

Variables	Empyema	No empyema	P-value
Age; <30 years	8	40	0.012
>30	0	33	
Diagnosis; Haemopneumothorax	4	38	0.042
Haemothorax	3	17	0.032
pneumothorax	1	18	0.062
Duration (days)	11.38	7.19	0.021
Post removal Chest radiograph (partial resolution)	8	0	<0.01
Haemothorax mean Output (mls)	1160	586	0.039
Trauma type; Penetrating	7	45	0.144
blunt	1	28	

The subsequent development of empyema thoracis is statistically associated with diagnosis of haemothorax, haemopneumothorax, partial resolution of the collection, longer duration of tube placement and output from haemothorax.

DISCUSSION

Chest injuries are a common cause of morbidity and mortality. Luckily in the majority of patients with post traumatic pleural collections tube thoracostomy is all that is needed (1,2,3,32).

Between February and November 2004, ninety-five patients with posttraumatic pleural fluid collections were recruited.

Eighty seven percent of the patients were males. Saidi in his dissertation reported similar results (31). The age distribution of patients in this study is predominantly third and fourth decade. Bailey in his study reported 74% of the patients were males with a mean age 43 years (32). There is a statistical significance ($p < 0.006$) between those below 30 years and those above 30 years in relation to trauma. This younger male predominance can be explained on the basis of propensity of this group for aggression, violence and boldness.

The majority of patients are from Nairobi area with few referrals from other parts of the country mainly from the adjacent towns. Fifty-eight percent of the injuries were as a result of penetrating injuries mainly stabs and gun-shots. This is in contrast to Bailey study in which only 6% of his series were penetrating while 90% were blunt chest injuries (32). In Nairobi slum dwellers were found to be at higher risk for chest injuries in the form of stab wounds and gunshots compared to non slum areas. This could be explained by overcrowding, illicit brews, domestic violence and organised and non organised gangs that operate within these areas. However, the fact that people from non slum areas could be attending private health institutions with better facilities could also be a contributing factor (31).

As a standard practice all the patients except four had their pleural collections confirmed on a chest x-ray prior to insertion of chest tube. The four patients who had chest tubes inserted on clinical basis had severe pneumothorax (three patients) and tension pneumothorax (one patient).

The study clearly depicted the use of triangle of safety as the sole route for evacuation of pleural collection and the exclusive use of the fourth and fifth intercostals space as the preferred sitting for chest tube. This trend is consistent with practice elsewhere (2, 3, 33). In nearly all the patients tube sizes F'G20, 24 and 28 were used. This was dictated mainly by the available tube at that moment rather than the preference of the operator. This is however, within the guidelines of ATLS. Never the less, while a small size tube is effective in draining the fluid collection, more so for pneumothorax, and is more comfortable for the patient, in acute haemothorax it is still recommended that F'G 28-32 be used as its less likely to block and provides better monitoring of the blood loss (32,33).

The output from haemothorax in 56% of the patients was less than 500 mls in the first 24 hours, while 90% of the patients had drained less than 1500mls in 24hrs. Only five patients had an output of more than 1500mls. In my search I did not come across a study that looked into the amount of blood drained.

Sixty three percent of the patients had their tubes removed within one week. Only 6% had their tubes maintained for more than two weeks. The duration of tube placement ranged from 3-36 days with a mean of 6 days. Bailey R C had a duration of 2-9 days with a mean of 4days (32). Chan L et al reported a mean of 6.5 days (34).

In their study on pneumothorax Weilsberg and Refacley had the chest tube removed in 81% of patients in one week and only 3% had tubes maintained for more than ten days (4).

All these studies clearly show that they remove their tubes earlier than the findings of this study. This could be explained on the basis of aggressive physiotherapy, adequate analgesia and continuous monitoring using x-rays. Forty five percent of the patients had their tubes removed on clinical basis compared to fifty four percent who had it removed on chest radiograph basis. Most of these patients had to wait for days to get a check chest radiograph. This also contributed to longer period of chest tube maintenance. However, there was no significant difference ($p=0.361$) in the post removal chest radiographs between the two groups. Further more post removal radiographs did not make any difference in the management of patients with partial resolution as none of them had chest tube re-insertion. This finding is consistent with research done elsewhere (22).

Complications of tube thoracostomy are categorised into three main groups. These are insertional (for example, lung or other organ laceration or perforation, haemorrhage), positional (for example, extra thoracic placement, persistent haemothoraces or pneumothoraces), or infective (for example, empyema thoracis) (32). Insertional and positional complications are rare and are diagnosed by additional imaging like Computerised Tomography Scan and in case of death at autopsy.

The positional complications observed during this study were tube dislodgement and insertion of a chest tube on the wrong site. Five chest tubes (5.3%) dislodged spontaneously while one psychiatric patient pulled his tube out. These five patients had their tubes reinserted. The psychiatric patient had pneumothorax and his collection had resolved on chest radiograph and, hence, did not require repeated tube thoracostomy. In one patient with pneumothorax as a resultant of blunt trauma the chest tube was inserted on the wrong site. This was discovered immediately and the situation rectified. Bailey RC, in his series of forty thoracostomy tubes reported two (5%) tubes dislodgement that were treated with reinsertion with out further complication (32).

Emergency thoracotomy is occasionally performed on patients with chest injuries. It's reported that fewer than 10% of blunt chest injuries and 15-30% of penetrating injuries require thoracotomy (32-39). This could be due to initial massive bleeding or continued bleeding as observed from continuous monitoring of the drainage tube. An injury to the mediastinal structures is another indication for thoracotomy. In this study none of the patients underwent emergency thoracotomy and only one patient underwent an elective thoracotomy for removal of a bullet lodged in the chest.

Kifayat et al (37) reported no single thoracotomy in a series of 172 paediatric chest injuries, and only 2 patients underwent elective thoracotomy. One for pyothorax and the other for organised haemothorax. Fir and colleagues had 30 patients (7.1%) in a study of 424 patients (38). Similarly Bergammelli et al reported 6.8% (13 patients) in their study involving 191 patients (39).

Complication of empyema thoracis was recorded in 8% of the patients in this study. The incidence of empyema thoracis after tube thoracostomy reported in the literature varies widely, from 1% to 25%, with most studies quoting figures of less than 3% (32-36). Millikan et al found 2.7% incidence of empyema thoracis. Ptoch et al reported 1.5% while Bailey recorded 2% incidence of empyema. Kinyanjui (29) in his study of empyema thoracis attributed an overall 11.5% of empyema to post traumatic pleural collection managed with chest tube. Though our figures indicate some improvement, it's still high compared to figures of less than 3% reported in the literature (1,3,5,32-36). Of the eight patients who developed empyema thoracis seven had haemothorax and only one had pneumothorax. All of these patients had partial resolution of their collections on post removal chest radiographs. Likewise seven of the empyema group had penetrating chest injuries.

In this study, patients who developed empyema thoracis had a mean duration of chest tube placement of 11.38 days compared a mean of 7.19 days in those who did not develop empyema. Similarly, the mean output from haemothorax among empyema group was 1160mls compared to 586mls among those who did not develop empyema thoracis. Empyema thoracis has been found to occur more among patients with haemothorax as a result of penetrating stab injuries compared to those with pneumothorax and blunt trauma. Also of significant risk is a patient with partial resolution of haemothorax and longer duration of chest retention (32-36). Factors that could explain the high level of infection in our set up include poor analgesia, lack of proper chest physiotherapy and possibly lapse in sterile precautions at the time of insertion of the chest tube. Lack of physiotherapy and inadequate analgesia tend to contribute to poor lung expansion and thus longer duration of chest tube retention.

All the patients who died suffered major chest^t injuries and/or multiple system injuries. Nearly all of them had either road traffic accidents or gunshots. Six of the eight patients (75%) who died had haemothorax compared to fifty five of the seventy three patients (75.3%) who had no complication. This shows that patients with haemothorax are not at a higher risk of death compared to those with pneumothorax.

In summary, majority of post traumatic pleural collections can be managed effectively with a tube thoracostomy. This study compares well with studies done elsewhere in effectiveness of tube thoracotomy. However, higher incidence of penetrating chest injuries and longer duration of thoracostomy tube placement has been found. This could explain the higher rate of empyema thoracis.

CONCLUSION

Chest injuries are a common cause of morbidity and mortality. However in majority of cases tube thoracostomy is life saving and is all that is required.

Majority of pleural collections resulted from penetrating chest injuries, with a smaller number resulting from blunt trauma.

Male gender and low income residence areas are at increased risk of penetrating chest injuries

The degree of simple pneumothorax did not matter as patients with mild pneumothorax were managed with tube thoracostomy except two patients who were managed conservatively.

The output from haemothorax in the majority of patient was less than 1500mls in the first twenty four hours.

Ninety four percent of the patients had their tubes removed within two weeks. This however is a longer duration compared to other studies.

The incidence of post traumatic empyema thoracis in our set up still remains high. Haemothorax, partial resolution of pleural collection, longer period of chest tubes placement and penetrating stab wounds are associated with higher risk of empyema thoracis compared to gunshots or blunt trauma.

The value of chest radiograph after removal of thoracostomy tube has not been demonstrated as its outcome rarely forms a basis for patient management.

RECOMMENDATION

1. There is an urgent need to curb violence, as it's the main cause of chest injuries.
2. Patient with mild pneumothorax to be managed by observation and/or needle aspiration in the wards and chest tube resorted to in cases where patients deteriorate.
3. Further study to evaluate the morbidity in terms of pain, blood transfusion and infection.
4. Further study to assess the role of adequate analgesia and aggressive chest physiotherapy in enhancing full resolution of pleural collections and hence complete lung expansion.
5. Prompt availability of chest radiographs for patients with chest tubes as delay in having it preformed contribute to longer duration of tube placement.
6. Sterile precautions to be enhanced and through surgical toilet of the penetrating wounds to be done as a measure for reducing empyema thoracis.

APPENDIX 1

DATA COLLECTION FORM

1. PATIENT PROFILE

- Name: _____ I.P.No: _____
- Age: _____ DOA: _____ DOD: _____
- Sex: _____ Ward: _____

2. Type of Trauma:

- Blunt - RTA;
- Non-RTA;
- Penetrating - Knife
- Gunshot
- Others

3. Chest radiograph performed/not performed prior to thoracostomy

4. Diagnosis:

- Simple pneumothorax Yes No
If yes: Mild Moderate Severe
- Tension Pneumothorax Yes No
- Haemothorax Yes No
- Haemopneumothorax Yes No

5. Site of catheter

- Mid- clavicular 2nd intercostal other
- Safety triangle 4th, 5th, 6th, 7th
- Posteriorly
- Number of catheters 1 2

6. Size of catheter

Pneumothorax

< 20 20-24 > 24

Haemothorax

< 28 28-32 >32

7. Out put from haemothorax in the first 24hours. — (mls)

8. Any form of operation performed other than chest tube insertion

1-laparotomy 2-thoracotomy 3-other (specify)

9. Indication for operation.

1-massive haemothorax 2-abdominal viscus injury 3-other (specify)

10. Duration it remained in situ (days):

<7 7 –14 > 14

11. Post removal CXR

- Yes No
- If yes
 - Fully resolved
 - Partially resolved
 - Same as pre chest tube

12. Complications

- None
- Infection
- Fall out
- Abnormal position
- Other (specify)

13. Review after thirty days in the clinic

APPENDIX 2

Consent Explanation Form

I am Dr M S Omar, a postgraduate student in the Department of Surgery, Faculty of Medicine of the University of Nairobi. I am conducting a research study on the management of intercostal chest tubes in the Kenyatta National Hospital in posttraumatic pleural fluid collections. The study is supervised by Professor S W O Ogendo. This is a hospital based study to be conducted over a nine month period (February 2004-November 2004) at Kenyatta National Hospital and has been duly authorized by the Hospital Ethical committee. The study aims at reviewing the management of chest tubes in patients who developed air and/or blood accumulations in the chest as a result of injury to the chest and had chest tubes inserted. Chest tubes normally cause only some discomfort, but can occasionally fall out, fail to evacuate the accumulated blood and/or air or even be a cause of infection. I am in the process of soliciting for volunteers for this study. If you agree to join this study, you will be asked some questions and examined. You are free to answer or not to answer these questions. In addition I will review your investigations and monitor your progress. I will not influence your management in any way. This study will not benefit you at the moment but its result could influence the management of patients with similar conditions like yours in future. Your identity and all information regarding you will be treated confidentially.

Your consent to participate in this study or lack of it will not jeopardise your treatment whatsoever. You can withdraw from the study if you wish at any time without providing any explanation and without any adverse consequences on your management. You are free to ask any questions or seek clarifications on any issues pertaining to this study at anytime by contacting Dr Omar on telephone number 0722 600991.

CONSENT FORM

Dr M S Omar has given me details of this study in a language that I clearly understand. I am clear about my role in this study. I understand the risk and benefits of participating in this study. I also understand that participation or otherwise in this study will not adversely affect my medical care, and that I can withdraw from the study anytime, again without any adverse consequences. I also understand that all information about me shall be treated in the strictest confidence.

I do hereby freely consent to participate in this study.

Signed (patient) _____

In-patient no _____

Witnessed _____

Signed (researcher) _____

Date _____

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Ref: KNH-ERC/01/2141

Date: 4 February 2004

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University of Nairobi

Dear Dr Omar,

RESEARCH PROPOSAL "THE MANAGEMENT OF INTERCOSTAL CHEST TUBES AS PRACTISED IN KENYATTA NATIONAL HOSPITAL IN POST TRAUMATIC PLEURAL FLUID COLLECTIONS"
(129/11/2003)

This is to inform you that the Kenyatta National Hospital Ethics and Research Committee has reviewed and **approved** the revised version of your above cited research proposal for the period 4 February 2004 – 3 February 2005. You will be required to request for a renewal of the approval if you intend to continue with the study beyond the deadline given.

On behalf of the Committee, I wish you fruitful research and look forward to receiving a summary of the research findings upon completion of the study.

This information will form part of database that will be consulted in future when processing related research study so as to minimize chances of study duplication

Yours sincerely,

PROF. A N GUANTAI
SECRETARY, KNH-ERC

Cc Prof. K Bhatt, Chairperson, KNH-ERC
The Deputy Director (C/S), KNH
The Dean, Faculty of Medicine, UON
The Chairman, Dept. of Surgery, UON
Supervisor: Prof. S W O Ogendo, Dept. of Surgery, UON
CMRO