Indications and Complications of Tube Thoracostomy with Improvised Underwater Seal Bottles

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ABSTRACT

Background: Tube thoracostomy is a lifesaving and frequently performed procedure in hospitals where the expertise and necessary tools are available. Where the ideal drainage receptacle is unavailable, the underwater seal device can be improvised with bottled water plastic can especially in emergency situations. **Aims and Objectives:** To determine the frequencies of the various indications and complications of tube thoracostomy with improvised underwater seal. **Materials and Methods:** A cross-sectional study with a structured proforma was used for assessment over a 3-year period (May 2010-April 2013). The proforma was filled at the time of the procedure by the performing surgeon and patients were followed up with serial chest X-rays until certified cured. A 1.5 L bottled water container was used as the underwater seal receptacle. The data was analysed with SPSS 15 software program. **Results:** A total of 167 patients were managed. There were 106 (63.5%) males and 61 (36.5%) females. The mean age was 34.85 ± 16.72 with a range of 1-80 years. The most frequent indication was for malignant/paramalignant effusion, 46 (27.5%). Others were trauma, 44 (26.3%), Parapneumonic effusion, 20 (12%), postthoracotomy 14 (8.4%), empyema thoracis 12 (7.2%), heart disease and tuberculous effusion 11 (6.6%) each, pneumothorax 8 (4.8%) and misdiagnosis 1 (0.6%). A hundred and one (60.5%) of the procedures were performed by registrars, 41 (24.6%) by consultants, house officers 15 (9%) and senior registrars 10 (6%). The overall complication rate was 16.8% with the more frequent complications been empyema (5.6%) and pneumothorax (3.6%). The average duration of tube placement was 13.02 ± 12.362 days and range of 1-110 days. **Conclusion**: Tube thoracostomy can be a relatively safe procedure with acceptable complication rates even with improvised underwater seal drainage bottles.

KEYWORDS: Complications, indications, improvisation, tube thoracostomy

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INTRODUCTION

Tube thoracostomy (TT) is a life-saving and frequently performed procedure in hospitals where the expertise and necessary tools are available. It is performed whenever there is an accumulation of fluid within the pleural considered significant enough to warrant drainage. This is to prevent possible complications like infection of the fluid or to prevent respiratory compromise when excessive. Where the ideal drainage receptacle is unavailable, the underwater seal device has been improvised in our setting with bottled water plastic can especially in emergency situations [Figures 1 and 2].

AIMS AND OBJECTIVES

The aim of this study is to document the frequencies of the various indications and complications associated with TT using improvised underwater seal drainage bottle occasioned by necessity (inability of patients to procure conventional drainage bottles or when such bottles are unavailable).

MATERIALS AND METHODS

A cross-sectional study with a structured proforma was used for assessment over a 3-year period from May 2010 to April 2013. The proforma which was designed to provide data on the patients' diagnosis, cadre of personnel performing the procedure, complications encountered and outcome were filled at the time of the procedure by the performing surgeon. The procedures were either done by the bedside under local anesthesia, or the tubes were inserted during a thoracotomy before chest closure in theatre. A volume of 1.5 L bottled water container was used as the underwater seal receptacle [Figure 1]. Two perforations are created on the cap approximately 0.4 cm and 0.5 cm, respectively. Through the 0.4 cm perforation is

Figure 1: Chest drain improvised from 1.5 L bottled water container. Observe the white plaster tape indicating the underwater seal level. Furthermore, note the tube drain with blue cap, improvised from urine bag tubing and the vent jutting above the summit also strapped with the white plaster tape

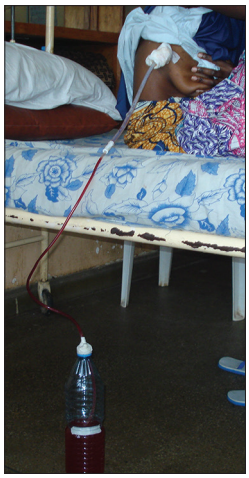

Figure 2: Improvised chest drain in action draining hemorrhagic pleural effusion

passed the cap of a hypodermic needle the covered end of which has been excised so that both ends are open to serve as a vent. Through the 0.5 cm perforation, the tubing of the urine bag (having excised the bag) is passed such that the distal end is inserted into the bottle and the tip placed below the water seal level. At the distal end of the tubing is connected the second needle cap (with the sealed end excised) to ensure the tip is kept straight and always under water. The water seal level is indicated by a length or piece of plaster placed at the waist of the bottle (about midway). The amount drained over time is determined by measuring the fluid volume (using a calibrated jug) above the water seal level. These bottles are not transferrable from one patient to another in other words they are disposed. Patients were followed up with serial chest X-rays until certified cured before removal of the chest tube. Data collected were analyzed with Statistical Package for Social Sciences (SPSS) version 15.0 software program (SPSS 2006, Inc., Chicago, IL, USA).

Results

A total of 167 patients were managed. There were 106 (63.5%) males and 61 (36.5%) females. The mean age was 34.85 ± 16.72 with a range of 1-80 years. The most frequent indication was for malignant/paramalignant effusion, 46 (27.5%) [Table 1]. Others were trauma 44 (26.3%), parapneumonic effusion 20 (12%), post-thoracotomy 14 (8.4%), empyema thoracis 12 (7.2%), heart disease and tuberculous effusion 11 (6.6%) each, pneumothorax 8 (4.8%), and misdiagnosis 1 (0.6%). A 101 (60.5%) of the procedures were performed by registrars, 41 (24.6%) by consultants, house officers 15 (9%), and senior registrars 10 (6%). The overall complication rate was 16.8% with more frequent complications been empyema (5.6%) and pneumothorax (3.6%) [Table 2]. The average duration of tube placement was 13.02 ± 12.362 days and range of 1-110 days.

Discussion

TT is the most frequently performed surgical procedure in thoracic practice. As a life-saving procedure, general surgeons, intensivists, emergency, and respiratory physicians may at one time or the other be required to perform it.[1] The indications for TT is the same for all institutions. The pattern of distribution of these indications or the frequency of insertion with respect to specific disease entity may however differ. While Khanzanda and Samad found tuberculous related effusion to be their commonest indication (36.1%) this constituted only 6.6% in our findings.[2] This may appear curious given the endemicity of tuberculosis in sub-Saharan Africa. This may however be due to institutional factors like referral bias and diagnostic acumen. For instance the lack of more sensitive and specific kits like the use of adenosine deaminase, polymerase chain reaction and IgA-enzyme-linked immunosorbent assay may partly be responsible for the low yield in this high endemic region.[3,4] Also while malignancy related effusion constituted the most common indication in our finding (27.5%) Khanzanda and Samad found 10.4%. The first documented description of a closed tube drainage for empyema was by Hewett in 1867.[1,5] Since then, the practice has advanced to the present day practice, which allows the use of suction device and or the use of a double or triple bottle system[6] [Figure 3]. The use of improvised drainage system in our institution is occasioned by several factors. First is the fact that many patients can't afford the ideal drainage bottle [Figure 4], which costs an average of 70 USD. Thus, low patronage discourages marketers from making the device available within a reasonable time and distance. Therefore, in an emergency situation and were patient is indigent, improvisation not only saves life, but also saves time and cuts cost. Comparatively, the average cost of our set up is 3 USD. This cost advantage in a country with an average gross domestic product of 6.56% and poverty ratio of over 70% is challenged by the drawbacks of the materials used for the improvisation.[7,8] These disadvantages include: (i) The capacity of the container above the water seal level, which is less than a liter necessitating frequent emptying; (ii) frequent emptying predisposes to

breaches in asepsis; (iii) inability to apply suction to the drainage bottle; (iv) the urine bag tubing easily gets occluded by thick pus or fibrinous exudates; and (v) the distal end of the tube is often pulled above the water-seal level if not properly secured with a tape of plaster when the patient moves and this leads to pneumothorax. The insertion of a chest tube (TT) though life-saving and apparently simple to perform is fraught with a lot of complications.[1,2,5] The complication rates vary but may be as low as 2-10% and as high as 25-30%.[2,5] The complications have been classified as insertional, positional or infective. The anxiety over these complications is further heightened when the set-up is not the ideal or the conventional type as in our case. Though, the procedures were done by doctors with different levels of expertise and experience, the observed overall complication rate of 16.8% is tolerable considering the reports by other researchers.[2,5] Complication rates from previous studies in our sub region were as high as 24.3% and 41.5% as reported by Iribhogbe and Uwuigbe and Nwofor and Ekwunife respectively. These studies however did not state if they used improvised or conventional drainage kits.[9,10] The relatively high incidence of empyema and pneumothorax may be related to technical factors as enumerated above with respect to the limitations of the drainage bottle (improvisation). It is possible that these complications may have been higher and particularly pneumothorax may have gone unnoticed since the recorded cases were only picked up during routine clinical evaluation supported by chest X-ray. The case of misdiagnosis is related to the passage by a junior resident who placed a tube for a patient with huge intrathoracic mass appearing on chest X-ray as massive homogenous radio-opacity mistaken for fluid. This complication can be avoided if more elaborate investigations like computer tomography scan are done as similar misdiagnoses have been reported previously.[11] The two cases of wrong placement involved the extrapleural placement by a consultant which required an exploratory thoracotomy to detect and intraperitoneal placement by a junior resident. It is however noteworthy that no mortality occurred related to the procedure as this is not uncommon.[12] The relatively long duration of tube placement (13.02 ± 12.362, with a range of 1-110 days) compared to that observed by Khanzanda and Samad (6 ± 2.06, with a range of 2-14 days) may be rated to the caliber of the improvised urine bag tubing (not the chest tube) with an internal diameter of approximately 0.5 cm compared with the conventional of about a centimeter. This factor coupled with the inability to apply suction to the receptacle, no doubt, decreases the velocity of fluid drainage. Therefore, the relative stasis of slow drainage allows for clogging of the narrow tube by fibrinous exudates or thick pus (especially where drainage is not facilitated with

Table 1: The relative indications for tube thoracostomy

Indications	Frequency	Percentage
Parapneumonic effusion	20	12.0
Empyema	12	7.2
Trauma	44	26.3
Post-operative	14	8.4
Pneumothorax	8	4.8
Malignant pleural effusion	46	27.5
Heart disease	11	6.6
TB	11	6.6
Misdiagnosis	1	0.6
Total	167	100.0

TB: Tuberculosis

Table 2: The various complications of tube thoracostomy using the improvised chest drain

Complications	Frequency	Percentage
Without complications	139	83.2
Empyema	9	5.4
Pneumothorax	6	3.6
Accidental dislodgement	3	1.8
Wrong placement	2	1.2
Tube blockage	1	0.6
Subcutaneous emphysema	3	1.8
Recurrence	2	1.2
Tube site sepsis	2	1.2
Total	167	100.0

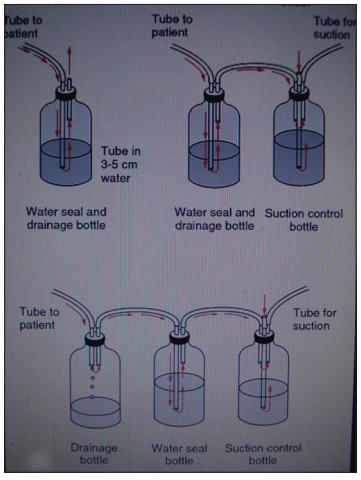

Figure 3: Single, double and triple bottle systems indicating ports for connection to patient and to suction machine

Figure 4: More recent modification of the double or triple bottle systems (e.g., Atrium®, Pleurvac®), been used on a patient and connected to a suction device

Table 3: Duration of tube placement

Duration in days	Frequency	Percentage
1-15	122	73.1
16-30	37	22.2
31-45	5	3.0
46-60	2	1.2
61-75		0.6
76-90		
106-120	1	0.6
Total	167	100.0

the use of fibrinolytics to reduce viscosity or consistency).[13,14] Though one case of tube blockage was documented in our finding, there were other cases of blockage, which were easily dislodged (milked) and were thus considered inconsequential. The former however required tube removal and re-insertion. To prevent significant complication, this setup requires frequent trouble shooting and tackling of observed problems. Concerning the range of tube placement one patient died on the day of tube placement from her index problem not related to the procedure, while the patient whose duration extended to 110 days was a patient who had decortication for chronic empyema thoracis of 3 years duration. The wide range notwithstanding, the median duration of tube placement was 10 days as can be seen from Table 3 which shows that 73.1% of the patients had their tubes removed within 15 days. This is approximates more closely to the finding of Khanzanda and Samad. Most of those who fell outside this range were patients with recalcitrant malignant effusions or those with chronic empyema thoracis in which conservative management was adopted either for the reason of their unfitness for surgery or could because they could not afford early surgery due to financial constraint.

Conclusion

TT can be a relatively safe procedure with acceptable complication rate even with improvised underwater seal drainage bottles when compared with conventional kits. Therefore, in resource challenged settings or in case of emergencies, improvisations can be undertaken to save lives.

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