

Original Article

Evaluation of Percutaneous tube Thoracostomy Performed by Trainee in both Trauma and non-Trauma Patients

Kulsum Maula*¹, Md Kamrul Alam², Md Ibrahim Khalil³, Md Nazmul Hasan⁴, Mohammad Omar Faruq⁵
DOI: <https://doi.org/10.3329/bccj.v9i1.53053>

Abstract:

Background: Percutaneous Tube Thoracostomy (PTT) is an invasive procedure that can save life now and then in different traumatic and non-traumatic conditions. But still it is an enigma; how our trainee surgeons are at home in this procedure.

Objectives: To evaluate the outcome of the percutaneous tube thoracostomy performed by trainee in both trauma and non-trauma patients.

Study design: Prospective, Observational study. Duration of study was September, 2019 to February, 2019.

Methods: All patients who need PTT in traumatic and non-traumatic conditions were selected by purposive sampling. Thereafter, they were scrutinized according to eligibility criteria and 96 patients were finalized. A pre-tested, observation based, peer-reviewed data collection sheet was prepared before study. Data regarding clinical and surgical outcome profile were recorded. Data were compiled, edited, analyzed.

Results: Among 96 patients, the highest 32.29% belonged to age group 31-40 years and lowest 9.37% belonged to age group ≤ 20 . The mean age of the respondents was 29.19 ± 9.81 . We found out of 96 patients, 70(72.91%) were indicated PTT for traumatic conditions and rest 26(27.08%) were indicated PTT for non-traumatic chest condition where 36(37.5%) had simple pneumothorax, 21(21.87%) haemothorax, 14(14.58%) massive pleural effusion, 13(13.54%) tension pneumothorax, 10(10.41%) haemopneumothorax, and 2(2.08%) had pyothorax respectively. In 53.12% patients had right sided intercostal chest tube (ICT) insertion whereas 46.87% had left sided ICT insertion. In our study, 89.55% tube was placed at normal anatomical position. Besides, 10.41% tube thoracostomy were performed deviated from anatomical site. Among 96 patients 62.5% patients had length of incision 2-3cm, 35.41% had > 3 cm and 2.08% had < 2 cm respectively. Out of 96 patients 75(78.13%) showed uneventful outcome whereas 21(21.87%) had complications including 11.15%(11) each had wound infection, 4.46%(4) subcutaneous emphysema, 4.28%(3) drain auto expulsion, 2.85%(2) hemorrhage, 1.45%(1) had non-functioning drain and empyema with ascending infection respectively ($p < 0.05$).

Conclusion: PTT is a life saving procedure that is most frequently implemented in chest trauma patients of our country. In majority cases, outcome of PTT were uneventful (78.13). Besides this more than one third of patient had length of incision more than 3 cm that needed extra stitches and 10.41% cases PTT were placed other than the normal anatomical site. Trainees of Dhaka Medical College Hospital are doing well in their performance of PTT insertion but still some anatomical orientations are necessary to avoid operative and post-operative complications.

Key Words: PTT, Trainee, Trauma & Non Chest Trauma Patients.

Introduction

Casualty department of Dhaka Medical College (DMCH) is a department which deals with all types of trauma and a small number of non chest trauma patients. A good number of trainee works under the guidance of a Resident surgeon and a Consultant. Trainees are all those who are enrolled in their respective post graduation program. Among the trauma patient chest trauma is common. It constitutes 20-25% of all trauma death in 1st four decades of life.^{1,2,3}

Chest traumas can be categorized into blunt and penetrating chest injury. Less than 10% of blunt chest trauma and 15%-30% of penetrating trauma needs definitive surgical treatment, rest of the patients are managed non-operatively except percutaneous tube thoracostomy which can be easily managed by conventional trauma team.⁴ Oesophagus, Trachea, Heart, diaphragm, great vessels, thoracic case, lungs can be injured in thoracic trauma and it may be life threatening in some cases.⁵

Percutaneous tube thoracostomy is a lifesaving procedure in the management of chest trauma patients.⁶ It remains the most commonly performed procedure from bed side to operating room, from life threatening emergencies to post operative chest drainage in elective surgery.⁷ Placement of PTT is a simple invasive procedure that helps to monitor thoracic blood loss, evacuation of blood from pleural cavity, prevent tension pneumothorax and helps in lung re-expansion.⁷⁻⁹ It also helps to remove pathological collections of fluid or air from pleural space and to treat empyema.⁹ The 1st documented closed tube thoracostomy was given for the drainage of empyema by Hewett in 1867.¹⁰ However, during the second world war and at the time of Vietnam war, it has become the standard of care for the management of chest trauma patients.¹¹

According to British thoracic society (BTS) the accepted approach to access the plural space is triangle of safety¹², an area bordered by the anterior border of the latissimus dorsi, the lateral border of pectoralis major muscle, a line superior to

the horizontal level of nipple and an apex below the axilla. The most common site of tube insertion is 5th intercostals space in the midaxillary line.¹³ It is directed ideally towards the apicoposterior of pleural cavity for pneumothorax or towards the posterobasal for fluid.¹²⁻¹³ However any direction can be effective for both air and fluid.¹³ Unfortunately this procedure may result some complications depending on knowledge and skill of the operator in addition to general condition of the patients and the place where procedure is done.¹⁴

Tube thoracostomy has the potential to cause complications related to insertion, position and infection. These complication rates and types may differ depending on various factors including those related to the patient and the physician.¹⁵ Tube thoracostomy complications largely depend on the knowledge and skill of the operator in addition to the patients' general condition and the place in which the procedure is done.¹⁶ This procedure has traditionally been performed only by thoracic surgeons and surgery residents (SRs). However, in recent years, tube thoracostomy has been performed by other specialties such as emergency medicine residents (EMRs).¹⁷ Estimated prevalence of complications of thoracostomy to be about 13% when done by SRs and 40% when done by EMRs.¹⁷

These complication can be categorized into insertional, positional and infective.¹⁸ The risk of complications with this procedure such as bleeding, vascular and solid organ injuries is more in inexperienced hand.¹⁹ A poorly placed tube causes undrained pneumothorax, haemothorax, a post removal pneumothorax, or empyema, all of which leads to increase the length of hospital stay.²⁰ The overall complication rate associated with this procedure is 30% in all operators.⁹ Providing adequate training and improving skills during medical training are important.²⁰ The primary purpose of this study is to evaluate the outcome of percutaneous tube thoracostomy in the management of both trauma and non trauma patients exclusively placed by trainee.

Large number of patients with chest trauma and a few non trauma patients are managed mostly by trainee in casualty department of Dhaka medical college hospital. Percutaneous

tube thoracostomy plays an important role and considered as life saving procedure in the management of chest trauma as well as some chest pathology without trauma.²¹ A good recovery can be possible in patients with pneumothorax, haemothorax and tension pneumothorax.⁹ It also facilitates the symptomatic relief of patient with tubercular or malignant pleural effusion.⁹ It is safe, can be performed under local anesthesia in bed side or mini operating room. Unfortunately this procedure may result in some complications depending on knowledge and skill of the operator in addition to general condition of the patients and the place where procedure is done.¹⁴

In our country, no study was done on the evaluation of PTT performed by the trainee in casualty department. So, further research is necessary to know the outcome of PTT in the management of both trauma and non trauma patients and to reduce the complications of PTT as well.

Materials & Methods

This prospective observational study was conducted in the emergency & casualty department, DMCH, Dhaka, a tertiary care hospital during the period of November 2018 to April 2019. The research work was carried out after obtaining ethical clearance from concerned department, Research review committee and ethical review committee, Dhaka medical college, Dhaka. All patients attended to the department of casualty for either chest trauma or chest pathology without trauma requiring PTT were included in this study. Exclusion criteria were patients who had history of previous chest surgery, Diabetes mellitus, patients who were died due to trauma related cause, patients who were transferred to another hospital after PTT, Patients who were excluded were below 12 years of age. After initial exclusion patients were interviewed face to face for the purpose of collection of data. Data collection was done with the proper consent of the patients/ patient's legal guardian. Then the patients were examined for certain signs and those were recorded in data collection sheet. Patients demographic variable (age, sex, body mass index) and main outcome variable (indication of tube thoracostomy, length of incision, size of thoracostomy tube, site of insertion, side of insertion, proper encirclement and tube fixation, incidence of replacement, incidence of complication following PTT, wound infection, ascending infection, water level, incidence of thoracotomy) were reviewed. In this study uneventful was meant by an improvement of patient conditions both clinically and radiologically after 3 to 4 days of PTT and removal of tube was done in 5 to 7 days following PTT without any significant complications. After collection of data, editing and screening were done manually. Then data were prepared for analysis by using SPSS-23. Patient's follow up was done up to 3 months following PTT.

RESULTS:

Total 96 patients with chest trauma and chest pathology without trauma were included in this study according to selection criteria. Study period was 6 months which was conducted in casualty department of DMCH. Total number of

1. Specialist, Emergency Department, United Hospital Limited, Dhaka 1212, Bangladesh.
2. Professor and Head of the department, Thoracic Surgery, Dhaka Medical College Hospital, Dhaka 1000, Bangladesh.
3. Assistant Professor, Surgery, Dhaka Medical College Hospital, Dhaka 1000, Bangladesh.
4. Resident Medical Officer (RMO), Intensive Care Unit (ICU), Labaid Specialized Hospital, Dhaka 1205, Bangladesh.
5. Professor of CCM and Chief Consultant, GICU and ED, United Hospital Ltd, Dhaka 1212, Bangladesh.

*Corresponding Author:

Dr. Kulsum Maula
MBBS, MRCS (Edinburgh)
Specialist, Emergency Department, United Hospital Limited
Dhaka 1212, Bangladesh.
Email: mili.maula@yahoo.com
Contact: +8801727729955

patients who required PTT was categorized in 2 groups. Out of study patients, 70(72.91%) were indicated for PTT for traumatic conditions and rest 26(27.08%) were indicated for non-traumatic condition.

Table-1: Distribution of patients according to age (n=96)

Age group (in years)	Frequency (%) (n=96)
≤20	9 (9.37%)
21 – 30	26 (27.08%)
31 – 40	31 (32.29%)
41 – 50	14 (14.58%)
>50	16 (16.67%)
Mean age±SD (in years)	29.19±9.81
Age range (in years)	17 – 56

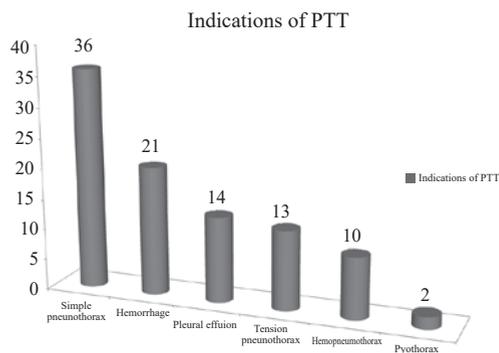


Figure-1: Distribution of patients according to Indications of PTT (n=96)

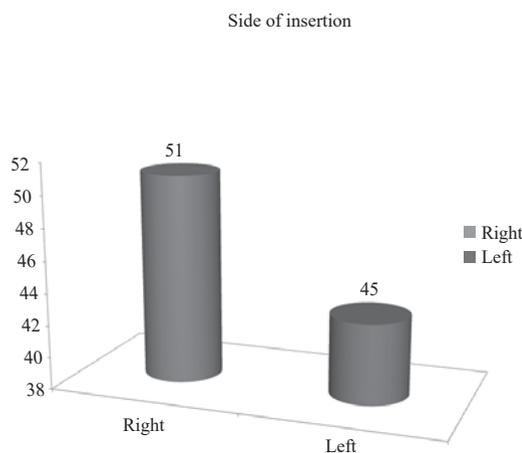


Figure-2: Distribution of patients according to side of insertion (n=96)

Table -2: Distribution of the patients according to Site of tube thoracostomy (n=96)

Site of tube thoracostomy	Frequency (%) (n=96)
At normal anatomical position (safety triangle)	86 (89.58%)
4 th ICS	14 (14.58%)
5 th ICS	48 (51.61%)
6 th ICS	24 (25.00%)
7 th ICS	1 (1.04%)
Infront of Anterior axillary line	5 (5.20%)
Behind the Posterior axillary line	4 (4.16%)

Table-3: Distribution of patients according to length of incision (n=96)

Length of incision (in cm)	Frequency (%) (n=96)
<2	2 (2.08%)
2 – 3 (standard)	60 (62.50%)
>3	34 (35.41%)
Mean length ± SD (in cm)	2.9±0.8
Range	1.9 – 4.5

Table 4: Distribution of patients according to size of tube (n= 96)

Size of Tube	Frequency (n=96)
28 Fr	46 (47.91 %)
30 Fr	15 (15.62%)
32 Fr	28 (29.17%)
36Fr	7 (7.29%)

Table- 5: Distribution of patient according to infection after PTT

Infection	Trauma n=70	Non trauma n=26	Total n=96
Wound infection	6 (8.57%)	5(19.23%)	11(11.45%)
Empyema with ascending infection	0(0.00%)	1(1.04%)	1(1.04%)

*Single patient may have both infections

Table-6: Distribution of patients according to tube fixation (n=96)

Tube fixation	Total
Proper encircled and tube fixation	93 (96.87%)
Replacement of tube	3 (3.13%)

Table-7: Distribution of patients according to outcome after PTT (n=96)

Outcome	Trauma (n=70)	Non-trauma (n=26)	Total (n=96)	P-value
Uneventful	57 (81.42%)	18 (69.23%)	75 (78.12%)	0.19 ^{NS}
Complications	13 (18.57%)	8 (30.76%)	21 (21.87%)	
Wound infection	6 (8.57%)	5 (19.23%)	11 (11.45%)	
Hemorrhage	2 (2.85%)	0 (0%)	2 (2.08%)	<0.05 ^S
Drain autoexpulsion/ eye leakage	2 (2.85%)	1 (3.84%)	3 (3.13%)	
Subcutaneous emphysema	3 (4.28%)	1 (3.84%)	4 (4.16%)	
Non-functioning drain	0 (0%)	1 (3.84%)	1 (1.04%)	
Empyema with ascending infection Thoracotomy	0 (0%)	0(0%)	0(0%)	

*Single patient may have multiple complications

Discussion

Percutaneous tube thoracostomy is often a life saving intervention; however, it carries significant morbidity related to iatrogenic injury. In our study tube thoracostomy was performed exclusively by trainee who found that pneumothorax, haemothorax, haemopneumothorax, tension pneumothorax, pleural effusion and pyothorax were good indications of using percutaneous tube thoracostomy. In this study overall complication rate was 21.87% that it was close to previous studies where it never exceeded 30%.^{20,22,23,24}

In our 96 study patients, the highest 32.29% number of PTT belonged to age group 31-40 years and lowest 9.37% number of PTT belonged to age group ≤20 years. The mean age of the respondents was 29.19±9.81. Massaga et al had highest number of patient belonged to the age group 30-49 years.²⁵ The highest incidence in this age group can be attributed to the active lifestyle with highest exposure to use of automobile, machinery, assault and sports.

In our study, out of 96 patients 89.55 % tubes were placed within triangle of safety. Besides, 10.41% tube thoracostomy were performed outside the triangle of safety such as in front of anterior axillary line, behind the posterior axillary line and 7th intercostal space. Out of 96 patients, 53.12% had right sided intercostal chest tube (ICT) insertion whereas 46.87% had left sided ICT insertion.

Among 96 patients 62.5% patients had length of incision 2-3cm, 35.41% had >3cm and 2.08% had <2cm respectively. Standard length of incision in case of tube thoracostomy should be 2 to 3 cm.^{26, 27} Our study revealed, more than one third of patients had length of incision >3cm. It was mostly because PTT was performed by trainee surgeon. Sometime extra stitches were needed to close the incision.

In our study, most frequently used tube size was 28 Fr (47.91%). 28(29.17%), 15(15.62%) and 7(7.29%) respondents used 32 Fr, 30Fr and 36 Fr respectively and these findings were supported by previous study⁹

Out of 96 patients enrolled in our study 70(72.91%) were trauma patients and 26(27.08%) were non-trauma or pathological chest conditions. Simple pneumothorax, Haemothorax, tension pneumothorax, haemo pneumothorax, pyothorax and pleural effusion are the common indications of insertion of PTT which are also supported by previous studies.^{13, 28}

In non-trauma related situations, tuberculosis play a major role.²⁹ Our study showed, majority patients with non trauma conditions presented with tuberculosis. Additionally, some patients were suffering from lung malignancy. Valdés et al. found that tuberculous and cancerous pleural effusions were the most frequent.³⁰ According to Fartoukh et al., more than 50% of effusions are related to transudates and non-infectious exudates.³¹ The situation of empyema thoracis and para-pneumonic infections seem to represent a special challenge nowadays, especially in children.³⁰

PTT procedure is also associated with significant morbidity and occasional mortality.²⁰ Published complications in adult patients include lacerations of the lung, intercostal artery, esophagus, stomach, liver, spleen, diaphragm, pulmonary artery and atrium as well as right ventricular compression.²⁵ In our study, the overall complication rate was 21.87% where each tube was placed exclusively by a resident physician, this value still fit well within the previously published literature range of up to 30%.^{20,22-24}

The operator skill seems to be a clear predictor of outcome. Khanzada et al described a complication rate as low as 5% when the procedure was performed by general surgeons.³² It is necessary to improve the skill of surgical trainees on the procedure of PTT as in low-income settings, they are the first line health care providers.³³

We observed wound infection in 11.45% which is supported by previous study 11.1%.¹⁴ Besides, subcutaneous emphysema 4.46%, drain auto expulsion 3.13%, hemorrhage from injury to intercostal artery 2.08% and non-functioning drain 1.04% were the frequent complications in our study which are similar to a previous study.^{14, 15} The incidence of empyema thoracic with ascending infection is 1.04% after tube thoracostomy which is also close to previous study 1 to 25%.^{32, 34} However, in our study the rate of wound infection was greater in non trauma category than trauma category.

In our study no patients required thoracotomy.

There is little doubt about relationship between iatrogenic

complications and insufficient training of the operator.²⁰ There are at least two potential explanations for these findings. One, the need of urgent PTT by individuals other than thoracic surgeon may be prone to complications in most severely injured patients. Second, the operator performing PTT might have been less skilled.²⁰

The management of these complications still relies on conservative measures such as replacement of the tube, preferably under guidance.³⁵ One of the exceptions is the situation of residual haemothorax after chest injury where the risk of empyema thoracis seems to be high.³⁶ The wise use of procedures such as open window thoracotomy and myoplasty which are feasible even in low-income settings, are likely to reduce the thoracotomy and thoracoscopy rate especially in critically ill patients.³⁷

In addition, co-operative efforts should be made between all individuals dealing with trauma care and thoracic surgeons should be involved earlier in the management of most severe chest trauma as well as pathological chest condition without trauma.

Conclusion

The common indications of using PTT are simple pneumothorax, hemothorax, tension pneumothorax and pleural effusion. In majority cases, outcome of PTT were uneventful except some cases showed complications including wound infection, hemorrhage, subcutaneous emphysema, drain auto expulsion and non-functioning drain. Besides, few cases PTT were placed other than the normal anatomical site. Therefore, it can be concluded that trainees of Dhaka Medical College Hospitals are doing well in their performance of PTT insertion; however, still some anatomical orientations are necessary to avoid complications. It was an observational single centered study. Study Duration is short and it does not proclaim the scenario of whole country.

Multi-disciplinary approach of research work together with long study period can make a study more precise and authentic in this regard.

Reference:

- 1) Altunkaya A, Aktunc E, Kutluk AC, Buyukates M, Demircan N, Demir AS, et al. Analysis of 282 patients with thoracic Trauma. *Turk Thoracic Cardiovasc Surgery*. 2007; 15:127-132.
- 2) Shorr RM, Critenden M, Indeck M, Hartunian SL, a Rodriguez. Blunt Thoracic trauma: analysis of 515 patients. *Ann Surg* 1978;206:200-5
- 3) Livingston DH, Hauser CJ. Trauma to the chest wall and lung. In Moor EE, Feliciano DV, Mattox KL, editors. *Trauma*. 5th Ed. New York: McGraw-hill; 2004. p.507-37
- 4) Committee on Trauma, American College of Surgeons. *Advanced trauma life support*. Chicago: American College of Surgeons, 1997
- 5) Graeber GM, Prabakar G, Shields T. Blunt and penetrating injury of the chest wall, pleura and lungs. In: Shields TW, LoCicero J 3rd, Ponn RB, Rusch VW editors, *General thoracic surgery*. 6th ed. Philadelphia: Lippincott Williams & Wilkins; 2005:951-972.

- 6) Foroudzanfar MM, Safari S, Niazazari M, Baratloo A, Hashemi B, Hatamabadi B, et al. Clinical Decision to prevent unnecessary chest xray in patients with blunt multiple traumas. *Emergency medicine Australia*. 2014;26(6):561-6
- 7) Ball CG, Lord J, Laupland KB, Gmora S, Mulloy RH, and Ng AK, et al. Chest tube complications: How well are we training our residents? *Canadian Journal of Surgery*. 2007;50(6):450-8
- 8) Patterson GA, Copper JD, Deslauriers J, Lerut AEMR, Luketich JD and Rice TW. *Pearson's Thoracic and Esophageal Surgery*, 3rd ed. Chapter, 143 Pathophysiology and Initial management of thoracic trauma, Burack JH, Churchill Livingstone, an imprint of Elsevier Inc, 2008;1: 1723-37
- 9) Adhikary AB, Rajan R, Mandal S, Raha SK, Hasan K, Jahan H. A comprehensive review of tube thoracostomy and management. *Ban. J. Cvt. Surg.* 2016;1(1):36-44
- 10) Kesieme EB, Dongo A, Ezemba N, Irekpita E, Jebbin N, Kesieme C. Tube thoracostomy : Complications and its management. *Article in pulmonary med*. January 2012
- 11) Monagh SF and Swan KJ, "Tube thoracostomy: the struggle to the standard of care," *Annals of Thoracic Surgery*, vol.86, no.6, pp.2009-2022, 2008.
- 12) Laws D, Neville E, Duffy J. BTS guidelines for the insertion of a chest drain. *Thorax*. 2003; 58(Suppl 2):ii53-ii59.
- 13) Kumar A, Dutta R, Jindal T, Biswas B, Dewan RK. Safe insertion of chest tube. *The national medical J of India*. August 2009; 22(4):192-198.
- 14) Kashani P, Harati S, Shirafkan A, Amirbeigi A, Hatamabadi HR. Comparing the quality and complications of tube thoracostomy by emergency medicine and surgery residents; a Cohort study. *Emergency*. 2017;5(1):e33
- 15) Cho DY, Sohn DS, Cheon YJ, Hong K. Complications of a Tube Thoracostomy Performed by Emergency Medicine Residents. *Journal of the Korean Society of Traumatology*. 2012; 25(2):37-43.
- 16) Mancini MC. Blunt Chest Trauma. *Ingles Thoracic Surgery eMedicine com Consultado el*. 2012; 30.
- 17) Sirleaf M, Jefferson B, Christmas AB, Sing RF, Thomason MH, Huynh TT. Comparison of procedural complications between resident physicians and advanced clinical providers. *Journal of Trauma and Acute Care Surgery*. 2014; 77(1):143-7.
- 18) Ball CG, Lord J, Laupland KB, Gmora S, Mulloy RH, and Ng AK, et al. Chest tube complications: How well are we training our residents? *Canadian Journal of Surgery*. 2007;50(6):450-8
- 19) Tatti O, Turkmen S, Imamoglu M, Karaca Y, Cicek M, Yadigaroglu M, et al. A novel method for improving chest tube insertion skills among medical interns. *Saudi Med J*. October 2017; 38(10):1007-1012.
- 20) Deneuville M. Morbidity of percutaneous tube thoracostomy in trauma patients. *European J of Cardio-thoracic-Surgery*. November 2002; 22:673-678.
- 21) Tang AT, Velissaris TJ, Weeden DF, An evidence based approach to drainage of pleural cavity: evaluation of best practice. *J Eval Clin Prac*. 2002; 8(3):333-340.
- 22) Sanabria A, Valdivieso E, Gomez G, Echeverry G. Prophylactic antibiotics in chest trauma: a meta-analysis of high-quality studies. *World J Surg* 2006; 30:1843-7.
- 23) Olgac G, Aydogmus U, Mulazimoglu L, Kutlu CA. Antibiotics are not needed during tube thoracostomy for spontaneous pneumothorax: an observational case study. *J Cardiothorac Surg* 2006; 1:43.

- 24) Bailey R C. Complications of tube thoracostomy in trauma. *J Accid Emerg Med* 2000; 17:114-114.
- 25) Mahfood S, Hix WR, Aaron BL, Blaes P, Watson DC. Reexpansion pulmonary edema. *Ann Thorac Surg* 1988; 45:340-5
- 26) Anthony J, Jeremiah H. Chest tube placement thoracostomy procedure, EBM consult, September 2015
- 27) Nadir A, Kaptanoglu M, Gonlugur U, Cevit O, Sahin E, Akkurt I. Empyema in adults and children: difference in surgical approaches, report of 139 cases. *Acta Chir Belg.* 2007; 107(2):187-91.
- 28) Lema MK, chalya PL, Mabula JB, Mahulu W. pattern and outcome of chest injury at bhugando medical centre at Northwestern Tanzania. *J cardiothoracic surg*, 2011;6:7
- 29) Rachel Nall, RN, BCN, CCRN. Reviewed by Daniel M. Chest tube insertion: Procedure, complications, and removal. Friday 15 June 2018.
- 30) Valdés L, Alvarez D, Valle JM, Pose A, San José E. The etiology of pleural effusions in an area with high incidence of tuberculosis. *Chest.* 1996; 109(1):158-62.
- 31) Fartoukh M, Azoulay E, Galliot R et al. clinically documented pleural effusions in medical ICU patients: how useful is routine thoracentesis. *Chest.* 2002; 121(1):178-84.
- 32) Chan L, Reilly K, Henderson C. Complication rates of tube thoracostomy. *Am J Emerg Med* 1997; 15:368-70
- 33) Khanzada TW, Samad A. Indications and complications of tube thoracostomy performed by general surgeons. *J Pak Med Assoc.* 2008; 58(1):39-40.
- 34) T. S. Helling, N. R. Gyles, C. L. Eisenstein, and C. A. Soracco, "complication rates of tube thoracostomy," *The American journal of Emergency Medicine*, vol. 15 no. 4 pp.368-70, 1997.
- 35) Cicero-Sabido R, Páramo-Arroyo RF, Navarro-Reynoso FP, Pimentel-Ugarte L. Surgical procedures in 156 cases of pleural effusion: Immediate results. *Cir Cir.* 2006;74(6):409-14
- 36) Karmy-Jones R, Holevar M, Sullivan RJ, Fleisig A, Jurkovich GJ. Residual hemothorax after chest tube placement correlates with increased risk of empyema following traumatic injury. *Can Respir J.* 2008; 15(5):255-8.
- 37) Carrillo EH, Barkoe DJ, Sanchez R, Lee SK, Rosenthal A, Pepe A. Open thoracic window: a useful alternative for retained infected pleural collections in critically ill trauma patients. *Am Surg.* 2009; 75(2):152-6.