

# Indications for Tube Thoracostomies and Factors Associated with Complications among Patients Admitted to Bugando Medical Centre, Mwanza, Tanzania

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## Abstract:-

### ➤ Introduction:

Tube thoracostomy is the procedure used in management of traumatic and atraumatic chest conditions. Despite its relative safety, it can still lead to potentially severe complications during or post its insertion.

### ➤ Objective:

To determine the common indications and complications for tube thoracostomies with their associated factors.

### ➤ Patients and methods:

This was a prospective longitudinal study for a total duration of 6 months involving patients who underwent tube thoracostomy during the study period. Recruitment of the patients was done under Convenience sampling technique from all hospital wards and units. A standardized structured questionnaire with TT Complication Reporting Tool incorporated into it was used and all data were entered into an Excel sheet then transferred to STATA version 15.0 software for analysis.

### ➤ Results:

Tuberculous and malignant effusion were the commonest indication by 36.9% followed by thoracic empyema (10.81%) in atraumatic category. In trauma; 16.22% had hemo-pneumothorax followed by pneumothorax (13.5%), 15.3% underwent tube thoracostomy as a post thoracotomy requirement. The observed 33.3% complications rate was significantly associated with age and tube duration where by tube size and urgency showed significant association with the depicted individual complications.

### ➤ Conclusions:

The usefulness of tube thoracostomy cuts across both atraumatic and traumatic indications. Despite its usefulness, it is not without complications as factors like age and tube duration are highly associated with its occurrence. We therefore emphasize on the utilization of proper measures towards complication rates reduction whilst accommodating its desired management outcome.

**Keywords:** Tube Thoracostomy, Indications, Complications, Factors Associated.

## I. INTRODUCTION

### ➤ Background

Tube thoracostomy has been performed as a lifesaving procedure as it can be used to evacuate blood in the pleural cavity, prevent tension pneumothorax and increase lung re-expansion, thereby reducing tamponade effects on low-pressure pulmonary vessels and henceforth alleviating respiratory compromise [1]. The indications for tube thoracostomy can be classified based on the causes being traumatic or atraumatic etiologies [1], in Tanzania tube thoracostomy remains one of the common procedures in emergency and most of cardiothoracic departments [2, 3]. Previous studies done at Bugando Medical Centre and Muhimbili National hospital by Monafisha *et al* [2] and Massaga *et al* [3] depicted that chest trauma was the commonest indication for tube thoracostomy placement.

Tube thoracostomy though commonly performed procedure in thoracic surgeries, but it is not without complications [4]. The AAST has classified complications related to tube thoracostomy as insertional (e.g. pneumothorax, structural injuries and subcutaneous emphysema), positional (e.g. kinking/obstruction and diaphragmatic injury), infective (e.g. surgical sites infection) and post removal complications (e.g. post removal bleeding and pneumothorax, retained foreign body). These complications are associated with increased length of hospital stay contributing to other morbidities and even mortalities.

Despite being the commonest life serving procedure in cardiothoracic surgery, there is a paucity of data regarding this subject in our local setting. Previous studies at BMC focused on traumatic indications [2] and no study was performed to evaluate the atraumatic indications for tube thoracostomy. This existing knowledge gap has prompted the author to conduct this study so as to analyze this problem in our local environment. The aim of this study is to determine the common indications for tube thoracostomy and factors associated with complications among patients admitted to BMC, a tertiary care and zonal hospital in northwestern Tanzania.

## II. MATERIALS AND METHODS

### ➤ Study Design and Setting

This was a prospective longitudinal study of patients who underwent tube thoracostomy over a period of 6 months from February 2023 to July 2023 at Bugando Medical Centre (BMC) which is a referral, consultant tertiary and zonal hospital for the Lake and western zones of united republic of Tanzania. It is also a teaching hospital for the Catholic University of Health and Allied Sciences (CUHAS) with a capacity of over 1000 beds. Data collection was done on patients at the Emergency department (who were to be admitted), and already admitted patients who met enrolment criteria from all surgical and medical wards.

### ➤ Study Participants, Study Sample and Data Collection

The study population included all traumatic and atraumatic patients who underwent tube thoracostomy at Bugando medical Centre during the study period, admitted and consented/assented for the study. The sample size was calculated using Taro Yamane formula and the minimum number was 109 patients of which we were able to enroll 111 patients in our study. Patients were recruited from all the surgical and medical wards within the first 24 hours of the procedure. Those who met the inclusion criteria were allowed to read / contemplate on the information depicted on the consent form before signing, and for those who were not able to read; the research assistant or the medical by-proxy present at a time offered assistance. In all patients' detailed history, thorough physical examination with relevant investigation were done respectively.

The first 24 hours were essential for detecting the insertional complications whilst the other complications were evaluated daily towards tube removal. The draining system also was regularly examined for any signs of blockage, thorough pulmonary system examination done on the same bases to evaluate the progress. The follow-up was done until 2 weeks after the removal of the tube.

A standardized coded structured checklist with a standard tube thoracostomy complication reporting tool [11] giving all the required data from the demographics, diagnostic modalities, indications and all tube thoracostomy related complications was used for data collection.

### ➤ Data Analysis

All checklists were assigned with serial numbers, data entered into an Excel sheet and then transferred to the STATA version 15.0 software for analysis according to the objectives of the study. Categorical variables are presented in percentages /proportions, whereas continuous variables are described as mean ( $\pm$  standard deviation) or median (interquartile range) depending on the distribution of data. Categorical variables are summarized using absolute frequency and proportions (percent). We used a univariate followed by multivariate logistic regression analysis model to measure the associations between variables, the level of significance was considered to be p-value < 0.05.

### ➤ Ethics

Ethical clearance was sought from the Joint CUHAS/ BMC research, ethic and review committee (CREC) before the commencement of the study. Permission to conduct the study was then obtained from the relevant BMC authority. Enrolled participants were required to sign a written informed consent/assent for the study. Patient's privacy was assured, their information and data were then collected under strict confidentiality. The study did not in either way interfere with the decision of the attending doctor, and the patient's refusal to consent or withdraw from the study did not jeopardize their access to medical care.

### III. RESULTS

#### ➤ Demographics Characteristics of the Study Participants

A total of 111 patients who underwent tube thoracostomy at BMC were recruited. 18.0% of patients aged  $\leq 20$  years, 71.1% were in their second to sixth decades and about 10.8% aged more than 60 years. The mean age was 36.3 with 17SD and the males were 1.6 times the number of the females.

#### ➤ Operative characteristics

About 30.6% of patients were subjected to the tube size of  $\leq 28$  Fr caliber, and tube size of more than 28Fr was placed to the majority of the patients which corresponded to 69.4%. Most of the tubes (83.8%) were placed via the safe triangle with the few through other sites. The few (16.2%) were placed via the 6<sup>th</sup> or 7<sup>th</sup> intercostal space and all of them were placed during thoracotomy with gross visualization of internal organs. Elective procedures constituted the majority by 67.6% with 32.4% done under emergency bases.

57.7% of patients stayed with the tube in place for more than a day to a week, 30.6% had 8 to 13 days to tube extubation whilst nearly 12 % spent more than 14 days. The mean duration for tube stay was observed to be 7.7 days (4SD). Nearly all procedures were done by registrars (medical officers) with a negligible 2.7% done by the consultant.

#### ➤ Common Indications for Tube Thoracostomy

Out of all 111 patients, 53(47.7%) underwent tube thoracostomy as per the traumatic indications predominated by Hemopneumothorax 18(16.2%) followed by pneumothorax and hemothorax. In 17(15.3%) of patients, the procedure was done as a thoracotomy routine to facilitate drainage and in about 53(47.7%) of patients; atraumatic indications were observed with 12(10.8%) cases primarily due to thoracic empyema.

Table 1 Indications for Tube Thoracostomies

Indication(s)	Number (n)	Percentage (%)
Pneumothorax	15	13.5
Haemothorax	8	7.2
Hemopneumothorax	18	16.2
Empyema	12	10.8
Post thoracotomy	17	15.3
Other Pleural effusion (Tuberculous & Malignant effusion)	41	36.9

#### ➤ Complications for Tube Thoracostomy

Amongst the 111 studied participants, 33.3% of them were observed to have 56 complications as brought by the tube thoracostomy. Individually, Insertional and infective complications were leading with the least being removal complications.

Table 2 Complications of Tube Thoracostomy

Complication(s)	Number (n)	Percentage n/56(%)
Insertional	19	33.9
Positional	9	16.1
Infective	16	28.6
Instructional	7	12.5
Removal	5	8.9

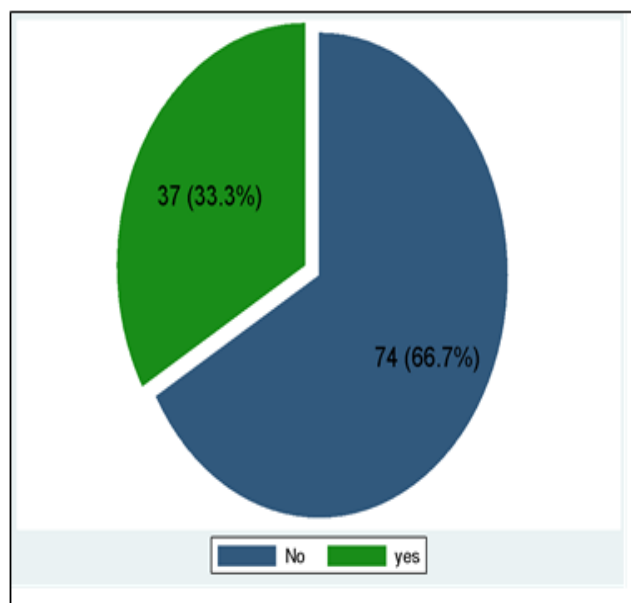


Fig 1 General Complications

#### ➤ Factors Associated with General Complications

Age was significantly associated with the complications, as patients with advanced age were 2.3 times more prone to complications as compared to those below [OR 2.30 CI: 1.40 – 3.80] P value of 0.004. Tube duration was also significantly associated with the complications occurrence of which the rate of complications was increasing 1 time more as the patient stays with the tube for a week and above [OR 1.00 CI:0.80 – 1.30], P value of 0.001.

Table 3 Overall Rate of Complications with their Associative Factors

Patient's characteristics	Complications N (%)		Univariate OR [95% CI] P- value	Multivariate OR [95% CI] P-value
	NO	YES		
<b>Age (year)</b>				
≤ 20	18(90.0)	2 (0.1)	2.30 [1.40 – 3.80] P= 0.001	2.40 [ 1.30 – 4.40] P=0.004
21 - 40	31(67.4)	15 (32.6)		
41 - 60	23(70.0)	10 (30.0)		
> 60	2(17.0)	10 (83.0)		
<b>Sex</b>				
Male	48(70.0)	21 (30.0)	1.40 [0.60 – 3.10] P=0.400	
Female	26(62.0)	16 (38.0)		
<b>Tube size (Fr)</b>				
≤ 28	27(78.0)	7 (2.0)	1.00 [0.90 – 1.00] P=0.053	
>28	47(61.0)	30 (39.0)		
<b>Tube duration (days)</b>				
≤ 7	51(80.0)	13 (20.0)	2.70 [1.50 – 4.00] P=0.001	2.30 [1.00 – 4.90] P=0.001
8 - 13	18(53.0)	16 (47.0)		
≥ 14	5(38.0)	8 (62.0)		
<b>Comorbid conditions</b>				
No	45(68.0)	21 (32.0)	1.00 [0.80 – 1.30] P=0.590	
Yes	29(64.0)	16 (36.0)		
<b>Site of placement</b>				
Safe triangle	57(62.0)	36 (38.0)	0.09 [0.01 – 0.7] P=0.024	1.50 [ 0.00 -0.001] P=0.990
Other sites	17(94.4)	1 (5.6)		
<b>Urgency</b>				
Emergency	22(61.0)	14 (39.0)	0.69 [0.30 – 1.50] P=0.390	
Elective	52(69.0)	23 (31.0)		

➤ *Factors Associated with Insertional & Positional Complications*

About 19(17%) of the study population has shown to have complications that occurred within the first 24 hours due to tube insertion which constitute about 33.9% of the 56 complications. Tube size was significantly associated with insertional complications [OR 1.00, CI;1.00 – 1.10] P=0.040 especially to those with >28fr sized tube. Patients who had procedures on emergency setting also had significant insertional complications [OR 1.00 CI: 0.10-1.90] P=0.044. 8.1% of patients sustained positional complications, subcutaneous injuries as manifested by the presence of

ecchymosis, redness or petechial was the leading one by 6.3% where by only 1 patient in this group had kinked/obstructed tube. The complications were further observed among those patients who had a tube size of >28fr by 10.4% as compared to ≤ 28 fr size with minimal rate of 2%. Increased number of days with the tube in situ also increased the chance for this complication and the raised incidence was after one week and above and its association was significant on univariate analysis with the OR of 3.00, CI: 1.00 – 7 .00 and the P value =0. 017 which wasn't significant after controlling for other variables.

Table 4 Factors Associated with Insertional Complications

Factor	Insertional complications N (%)		Univariate OR [95% CI] P value	Multivariate OR [95% CI] P-value
	NO	YES		
<b>Age (year)</b>				
≤ 20	19(95.0)	1 (5.0)	1.70 [0.90 – 2.90] P=0.065	
21 - 40	38(82.6)	8 (17.4)		
41 - 60	27(81.8)	6 (18.2)		
> 60	8 (66.7)	4 (33.3)		
<b>Tube size (Fr)</b>				
≤ 28	32(94.1)	2 (5.9)	1.00 [1.00 – 1.10] P=0.040	1.03 [0.90 – 1.00] P=0.040
>28	60(77.9)	17 (22.0)		

<b>Tube duration (days)</b> ≤ 7 8 - 13 ≥ 14	55(85.9) 25(73.5) 12(92.3)	9 (14.1) 9 (26.5) 1 (7.7)	1.00 [0.50 – 2.00] P=0.700	
<b>Comorbid conditions</b> No Yes	53(80.3) 39(86.7)	13 (19.7) 6 (23.3)	0.90 [0.60 – 1.00] P=0.490	
<b>Practitioner level</b> Registrar Specialist	90(83.3) 2 (66.7)	18 (16.7) 1 (33.3)	2.50 [0.20 – 29.00] P=0.460	-
<b>Site of placement</b> Safe triangle Other sites	75(80.6) 17(94.4)	18 (19.4) 1 (5.5)	0.20 [0.03 – 1.00] P=0.180	-
<b>Urgency</b> Emergency Elective	26(72.2) 66(88.0)	10 (27.8) 9 (12.0)	1.00 [0.10-1.90] P=0.044	1.30 [0.10 – 10] P=0.047

➤ *Factors Associated with Instructional/Educational and Removal Complications*

Under this category of complications, no measurable significance was seen, however the instructional and equipment based complications contributed about 6.3% of all complications whereby 5.4% of them were due to lack of patient-instrumental care education. The commonest observation was the underdrainage of the underwater seal drainage as patients positioned themselves to the extent the apparatus was not in support of gravity. Only 1 patient had an improperly secured tube which led to dislodgement that required tube reinsertion. Despite having a comorbid condition being a significant predictor for this predicament OR 1.6, [ C+I 11 -2.6 P=0.045]. There was a significant drop of its association after controlling other factors in a multivariate analysis.

Only 5(4.5%) among the studied patients sustained removal complication (8.9% of the 56 complications), notably 1(0.9%) patient with post removal pneumothorax that warranted the replacement of another tube. 3(2.7%) patients had subcutaneous emphysema and 1(0.9%) patient with spontaneous tube dislodgement that also warranted replacement. On all the regressions, there was no factor studied that was denoted to explain this occurrence.

➤ *Factors Associated with Infectious Complications.*

Age and tube duration highly influenced the occurrence of the overall complications. From our observation, advanced age above 60yrs preceded infection occurrence. Also being with the tube for more than 14 days’ keeps the patient at 7 times more chances of acquiring surgical site infection. Even after controlling for other factors, age and tube duration were both significant by OR 3.00, [CI: 1.00 – 8.00, p=0.010] and OR 7.00, [CI: 2.00-22.00, p=0.001] respectively.

Table 5 Factors Associated with Infectious Complications

Factor	Infective complications		Univariate OR [95% CI] P value	Multivariate OR [95% CI] P-value
	NO	YES		
<b>Age (year)</b> ≤ 20 21 - 40 41 - 60 > 60	19(95.0) 41(89.1) 30(90.9) 5 (41.7)	1 (5.0) 5 (10.9) 3 (9.1) 7 (58.3)	2.00 [1.00 -5.00] P=0.002	3.00 [1.00 – 8.00] P=0.010
<b>Tube size (Fr)</b> ≤ 28 >28	28(82.3) 67(87.0)	6 (17.7) 10 (12.9)	0.90 [0.90 – 1.00] P=0.540	
<b>Tube duration (days)</b> ≤ 7 8 - 13 ≥ 14	62(96.9) 27(79.4) 6 (46.1)	2 (3.1) 7 (20.6) 7 (53.9)	5.00 [2.00 – 13.00] P=0.000	7.00 [2.00 – 22.00] P=0.001
<b>Comorbid conditions</b> No Yes	60(90.9) 35(77.8)	6 (9.1) 10 (22.2)	1.30 [0.90 – 1.70]	1.30 [0.90 – 2.00]

			P=0.060	P=0.120
<b>Practitioner level</b>				
Registrar	92(85.2)	16 (14.8)		
Specialist	3 (100)	0 (0.0)	-	-
<b>Site of placement</b>				
Safe triangle	77(82.8)	16 (17.2)		
Other sites	18 (100)	0 (0.0)	-	-
<b>Urgency</b>				
Emergency	34(94.4)	2 (5.6)	3.90	3.30
Elective	61(81.3)	14 (18.7)	[0.80 – 18.00]	[0.40 – 23.00]
			P=0.080	P=0.230

#### IV. DISCUSSION

Most of the studies have successfully described Tube thoracostomy indications being traumatic and atraumatic in nature. The most pronounced traumatic ones are pneumothorax, hemothorax, and hemothorax while the tubes placed as part of any post thoracotomy protocol were classified as an isolated entity. The atraumatic indications mostly were empyema and pleural effusions as per other causes [1, 5, 6, 7]. In the study of Talpur *et al* [8], pleural effusion was the common indication followed by pneumothorax, empyema thoracis, hemopneumothorax and hemothorax respectively. Another cross-sectional study done in Pakistan had similar observations to ours as the common indication enumerated was pleural effusion by 36.1% [9].

In our study the most common indication was pleural effusion followed by hemopneumothorax, post thoracotomy insertion, empyema, pneumothorax and hemothorax respectively. In the study of Hussain *et al* [10], empyema was the second commonest indication as preceded by hemothorax. Perhaps the reason for the discrepancy with our study is that the majority of the individuals he examined had atraumatic pathologies. Other studies had effusion as the leading indication conquering with ours as the entity might arise from the primary pleural and lung pathologies or because the lungs are the most secondary sites for metastatic tumors and most common presentation being pleural effusion. In another prospective study at BMC; the most common indication for tube thoracostomy was hemothorax [2], and the reason for the observed variation from our study is because they only looked at individuals who had chest trauma.

Over the course of our study, a total of 37(33.3%) patients were observed to have complications in any of the category groups [11], and the observed proportion of patients with complication was 33.33%. Individually, the highest rate of complication was observed in the insertional category, subcutaneous emphysema being the commonest. Infectious complication rate was 14.41% as per study population.

In most of the studies done, complications have been documented to range from 1 – 40% of which the developing part of the world tends to suffer more as compared to the developed countries as in Africa. In a meta-analysis done by Hernandez *et al* [12] catering around the western studies,

they observed the complications rate of 19% while observation by Nwofor in Nigeria was up to 40% [13].

Bailey observed the overall complication rate of 30% which tally with our results [4]. However, the study had only 2% of the infectious complications as compared to 14.41% observed in ours. This discrepancy may be the result of environmental factors because the process is likely performed in a more sophisticated aseptic controlled setting.

In their cross-sectional study of complications, Khanzada *et al* [9] found a position-related complication rate of 9.5%, which was almost similar to our results. However, an infectious complication was observed in only one out of all patients studied.

Our results build on existing evidence of another study done at MNH in Tanzania, where the frequency of complications was similar to ours, most of which were infectious, followed by non-functioning tube [3]. The overall complication rate similarity might be explained by the resemblance of the local setting as all are tertiary facilities with specialized and super specialized services. However; the observed differences in infection rates among patients enrolled at MNH may be explained by the fact that all had traumatic indications and some had open chest wounds, so that the insertion of the tube may have acted as a secondary insult. In addition, most of their patients had a dysfunctional tube leading to stasis, which is a good breeding ground for bacterial invasion of the surgical site.

We have studied different factors that can influence complication occurrences. Age, tube size and duration, provider's level of training, comorbid conditions and the procedure urgency. Considering complication occurrence as a whole, the patient's age and tube duration influenced highly the occurrence of complications. As the age increases the complications rate were also peaking. Patients over 60 were 2.3 times more likely to develop complications compared to other age groups. The association was significant, and thus these findings add to our understanding of the effect of age on complications.

Carson *et al* [14] in America found an association between duration of tube stay and complications, with a 13.6% increase in complications when the tube was left in for more than a week. The results agree with our study because we found the same significance. This can

be explained by the fact that the longer the tube is left, the more likely it is for the formation of a film of bacteria, and as a result of long-term colonization, their number increases, making the local surgical site more susceptible to infections. However, the longer the tube is left, the greater the potential for manipulation, culminating in tissue damage and even dislodgement.

Insertional complication as the individual entity has been studied in different studies and diverse factors impelling it has been itemized. Our study has observed more rate of insertional complications with the tube size of more than 28fr commonest being subcutaneous emphysema. In a study by Peter *et al* [15] as in our study, they also observed a high rate of tube thoracostomy related complications to patients who had a large caliber tube of more than 28fr.

In one of the studies done in South Carolina, tube size also influenced complications. They observed tube blockage in small tubes of less than 28 Fr and most of the insertional complications due to a high caliber tube [16]. With this agreement, subcutaneous emphysema might be explained by a big caliber that causes damage to the tissues, making them prone for air leakage and hence its accumulation.

In our study, there was an association between the operative urgency and the insertional complications. The chances of getting insertional complication if done under a sole emergency setting agrees with the study by Jay *et al* [17]. However, in contrary to our findings, in the two studies done by Lisa Chan and Baldt *et al* [18, 19], no association was found.

Infectious complications were found to be related to age and tube duration. The incidence of surgical site infection was higher in elderly patients compared to other age groups. Immunological status may explain this association, as immunity generally declines with age, making a person more susceptible to infections, a term known as immunosenescence [20].

Duration of tube stay is another factor considered in this study. Other studies found that infections increased depending on how long the tube remained in place. Others have found the same infection rate in more than 7 days of tube stay [14, 21]. Despite the observed factors; tube thoracostomy remains to be a useful procedure since not all the factors hypothesized in other studies influence the occurrence of complications [22, 23, 24].

## V. CONCLUSION

Pleural effusion followed by hemothorax were the commonest observed indications for tube thoracostomy in our study. Advanced age, tube size and tube duration were directly proportional to the rate of general complications. The raised rate of insertional complications was significantly associated with emergency procedure setting and the increased size of the tube. Tube size and duration are all modifiable factors and can be adjusted as per the patient's indications to meet the draining goal with lowering

of adverse outcomes. Participant's sex, comorbid conditions and provider's level of training were all not statistically significant towards complication occurrence. But despite the association between urgency and complications; adequate preparations will help to improve the outcome in most of tube thoracostomies and hence maintain its usefulness in many clinical settings.

### ➤ Author's Contributions

SJA, MW and CP conceptualized the research, for the original work, SJA collected, analyzed the data and wrote the first manuscript draft. FP, WA, FK and GG participated in manuscript revision. All authors reviewed the manuscript and approved the final submission.

### ➤ Financial Support: None

### ➤ Conflicts of Interest: None

## ABBREVIATIONS

- AAST - American Association for Surgery and Trauma,
- BMC - Bugando Medical Centre
- CUHAS - Catholic University of Health and Allied Sciences
- DM - Diabetes Mellitus
- e-FAST - Extended Focused Assessment with Sonography in Trauma
- HIV - Human Immunodeficiency Virus
- ICU - Intensive Care Unit,
- TT - Tube Thoracostomy

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