

# Management of Chest Drains: A National Survey on Surgeons-in-training Experience and Practice

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## ABSTRACT

**Background:** Chest tube insertion is a simple and sometimes life-saving procedure performed mainly by surgical residents. However with inadequate knowledge and poor expertise, complications may be life threatening. **Objective:** We aimed to determine the level of experience and expertise of resident surgeons in performing tube thoracostomy. **Methodology:** Four tertiary institutions were selected by simple random sampling. A structured questionnaire was administered to 90 residents after obtaining consent. **Results:** The majority of respondents were between 31 and 35 years. About 10% of respondents have not observed or performed tube thoracostomy while 77.8% of respondents performed tube thoracostomy for the first time during residency training. The mean score was  $6.2 \pm 2.2$  and 59.3% of respondents exhibited good experience and practice. Rotation through cardiothoracic surgery had an effect on the score ( $P = 0.034$ ). About 80.2% always obtained consent while 50.6% always used the blunt technique of insertion. About 61.7% of respondents routinely inserted a chest drain in the Triangle of safety. Only 27.2% of respondents utilized different sizes of chest tubes for different pathologies. Most respondents removed chest drains when the output is <50 mL. Twenty-six respondents (32.1%) always monitored air leak before removal of tubes in cases of pneumothorax. Superficial surgical site infection, tube dislodgement, and tube blockage were the most common complications. **Conclusion:** Many of the surgical resident lack adequate expertise in this lifesaving procedure and they lose the opportunity to learn it as interns. There is a need to stress the need to acquire this skill early, to further educate and evaluate them to avoid complications.

**KEYWORDS:** Chest drains, experience, practice, surgical residents

## INTRODUCTION

Thoracic trauma and many pleural diseases are commonly treated with tube thoracostomy. On account of its vast clinical utility, the procedure has become a mandatory skill not only for surgeons, but also for intensivists and emergency physicians.<sup>[1]</sup>

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However, tube thoracostomy is not without its own complications.<sup>[2]</sup> Early and late complications have been shown to be as low as 3% and 8% respectively in trained hands.<sup>[3]</sup>

Hence, we undertook this study to ascertain the level of experience and expertise of surgeons-in-training in Nigeria in performing tube thoracostomy safely.

## MATERIALS AND METHODS

Accredited Departments of Surgery in four university hospitals in Nigeria were selected for the study by simple random sampling. They included those of Aminu Kano University Teaching Hospital Kano, University of Benin Teaching Hospital Benin, Lagos University Teaching Hospital Lagos and University of Nigeria Teaching Hospital, Enugu. These represent the northern, southern, western, and eastern parts of the country respectively.

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Data collection was through 24-item structured questionnaires, which were distributed to surgical residents in these institutions after obtaining their consent. The questionnaires were distributed at departmental surgical meetings and retrieved at the end. It essentially covered three areas: Demographic data and postgraduate year of training, experience in performing tube thoracostomy and statements that assessed their practice based on established guidelines and recommendations on insertion and management of chest drains. What they routinely do for each step in the procedure or management was answered as always, frequently, occasionally, rarely or never.

A total of 10 marks were awarded to ten statements, each step that was perfectly answered was awarded one mark. Respondents who scored 0–6 were considered as having poor expertise in performing and managing chest drains while those who scored between 7 and 10 are judged as having good expertise in performing and managing chest drain.

The data from the returned questionnaires were entered into Statistical Package for Social Science (SPSS), version 16 (Chicago, SPSS In) and analyzed. The level of statistical significance was set at  $P < 0.05$ .

## RESULTS

Out of 90 respondents who returned their questionnaire, 39 (43.3%) were senior residents while 51 (56.7%) were junior residents. The respondents were predominantly males (94.4%), in the age range of 31–35 years (52.2%) and most have stayed in training for 3 years and above [Table 1].

Eighty-one respondents (90%) have passed chest tubes while 9 respondents have neither observed nor passed chest tube in their career. This group of surgeons-in-training were requested not to provide further responses. Out of the 81 respondents who have performed tube thoracostomy, 63 (77.8%) actually passed chest tubes for the first time during residency training, 9 (11.1%) did so during housemanship/internship, 6 (7.4%) as youth corporers and 3 (3.7%) as medical officers. Fifty-eight respondents (64.4%) have rotated through the cardiothoracic surgery unit while 32 (35.6%) have not.

The mean score was  $6.2 \pm 2.2$  (0–10). Forty-eight respondents scored between 7 and 10 marks, satisfying the criteria for good expertise in performing tube thoracostomy and managing chest drain while 33 respondents scored between 0 and 6. Senior residents, residents who have spent 3 years or above in training and those who have rotated through (CTS) Cardiothoracic Surgery unit had a better score. The relationship between the score and the rank and year of training was not statistically significant, however, the relationship between score and rotation through CTS was statistically significant ( $P = 0.034$ ) [Table 2].

Fifty-two respondents (64.2%) always obtained consent before tube thoracostomy. The majority of respondents (80.2%) always re-examined the chest radiograph while 72.8% always infiltrated

**Table 1: Demographic data**

Demographic data	n (%)
Sex	
Male	85 (94.4)
Female	5 (5.6)
Total	90 (100)
Age	
25–30	19 (21.1)
31–35	47 (52.2)
36–40	19 (21.1)
41–45	4 (4.5)
46–50	1 (1.1)
Total	90 (100)
Level of training	
PGY 1	10 (11.1)
PGY 2	20 (22.2)
PGY 3	23 (25.6)
>3	37 (41.1)
Total	90 (100)

PGY: Postgraduate year

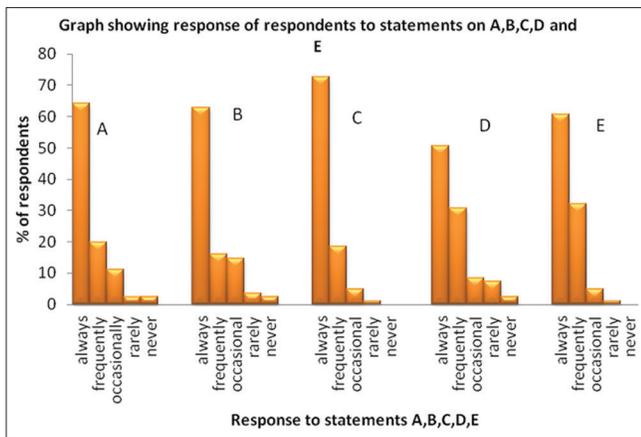
**Table 2: Variables and score**

Variable	Performance			P
	No of respondents with good performance	Percentage within variable (%)	Percentage within score (%)	
Rank				
Senior registrar	21	55.3	43.8	0.473
Registrar	27	62.8	56.2	
Year of training				
PGY 1	5	71.4	10.4	0.475
PGY 2	10	62.5	20.8	
PGY 3	15	68.2	31.2	
>3	18	50.0	37.5	
Rotated through CTS				
Yes	34	58.6	60.9	0.034
No	14	70.8	29.2	

PGY: Postgraduate year, CTS: Cardiothoracic surgery unit

generously down to the parietal pleura with local anesthetic (LA) agent. Only approximately half of the respondents (50.6%) routinely inserted a chest drain using the blunt technique and 61.7% of respondents routinely inserted the chest drain into the triangle of safety [Figure 1].

Just above a quarter of respondents (27.2%) always utilized different sizes of tubes for different pathologies and the same proportion of respondents always positioned the tip of the tube apically to drain pneumothorax and basally to drain pleural effusion. In contrast, 9.9% and 6.2% of respondents rarely or never positioned tubes based on what was being drained. The majority of respondents (70.4%) always monitored chest drain for respiratory swings and kinking. Twenty-six respondents (32.1%) always monitored air leak before removal of the tube in patients treated for pneumothorax. Some of the respondents (16.7%) do not routinely use underwater seal



**Figure 1:** Graph showing response to statements on consent, performing thoracocentesis, infiltration with local anesthetic down to pleura, using blunt technique and triangle of safety, (a) obtaining consent as a routine, (b) performing thoracocentesis before tube thoracostomy as a routine, (c) Infiltration of local anesthetic down to the parietal pleura as a routine, (d) passing chest tube using the blunt dissection technique as a routine, (e) using the triangle of safety as a routine

drainage system. Almost one-fifth of respondents never have on any occasion applied suction to the drainage system while 59.5% have either occasionally or rarely applied suction to the drainage system.

Most of the respondents removed chest drain when the effluent is <100 mL. The majority (70.4%) removed the drain when the effluent is <50 mL, and 24.7% removed the drain when the effluent is between 50 and 100 mL.

Fifty-five respondents (67.9%) always removed chest drain at the height of inspiration and 76.5% always requested for chest radiograph after removal of chest drains. The three most common complications reported by the respondents include superficial surgical site infection, tube blockage, and tube dislodgement.

## DISCUSSION

It is not surprising that residents who have rotated through CTS had better experience and expertise because tube thoracostomy is one of the most common procedures performed in thoracic units. In a study by Elsayed *et al.*, the level of experience, seniority and specialty all had an effect on knowledge about chest drains.<sup>[4]</sup> In addition to rotating through CTS unit, senior residents and residents who have spent 3 years and above had a better score but the relationship was not statistically significant. This may be due to the fact that some of the senior residents were not opportune to do a rotation in CTS early in their career and hence the knowledge gap.

Taking consent for any surgical procedure is a standard practice. This is usually neglected in developing and underdeveloped world.<sup>[5]</sup> Interestingly, our study has revealed that most of our residents did not neglect taking consent for this procedure.

Tube thoracostomy is a painful procedure. Luketich *et al.* revealed that 50% of patients undergoing this procedure experienced pain levels of 9–10 on a scale of 10.<sup>[6]</sup> It is, therefore, understandable why 72.8% of our resident surgeons had always generously infiltrated down to the parietal pleura using LA agent.

In addition to clinical examination, it is absolutely necessary to re-examine the chest radiograph before tube thoracostomy. 30.2% of our respondents always did this. It is also necessary to do thoracocentesis which may or may not be image-guided. Even the entire procedure may be image-guided. This has been shown to have a high success rate of 71–86% and useful in the presence of loculations, localized effusion and empyema.<sup>[7,8]</sup>

Blunt dissection technique is the preferred method for tube thoracostomy. Unfortunately, only half of our respondents always used this technique. Trocar technique has been shown to increase the risk of tube malposition and thoracic organ injury.<sup>[2,9,10]</sup> Seldinger technique has also been employed. With the blunt technique, it is also possible to do a finger sweep within the thoracic cavity to ensure there is no adhesion between the lung and the pleural surface. This will prevent inadvertent passage of the tube into the pulmonary parenchyma.

The triangle of safety has been recommended as the preferred site for the intercostal drain.<sup>[11]</sup> It is an area bordered by the anterior border of latissimus dorsi, the lateral edge of pectoralis major, a line just superior to the horizontal level of the nipple (or horizontal line corresponding to the 5<sup>th</sup> intercostal space) and an apex below the axilla. A significant proportion of our residents (61.7%) routinely inserted the chest drain in the triangle of safety. In contrast, in a previous study, only 44% of surgeons indicated that they will insert a chest drain within the safe triangle. However, this position may not be strictly adhered to in cases of the loculated pleural collection, empyema, previous chest tube placements, an anamnesis relevant to pulmonary disease and previous surgeries.<sup>[12]</sup> For patients undergoing secondary intervention, the location of chest drain may not matter.<sup>[13]</sup>

Small size tubes have been found to be as effective as large bore tubes, however for drainage of hemothorax, a large bore tube is usually recommended.<sup>[11,14]</sup>

Generally speaking, any tube position can drain pleural contents though the classical teaching is aiming apically for pneumothorax and basally for pleural effusion.<sup>[11]</sup>

Chest tube clamping is discouraged especially when the tube is bubbling or if the patient is being managed for pneumothorax.<sup>[11]</sup> Interestingly, the majority of our respondents clamped chest drain, especially while transporting a patient. In a study by Baumann *et al.*, 41% of members of American College of Chest Physicians would not clamp a chest tube under any circumstances, the remaining 59% would consider a clamping trial and radiograph prior to removing a chest tube.<sup>[15]</sup> However, recent evidence have proven that a clamped chest tube may allow

for more definitive assessment of persistent occult air leaks and may avoid premature removal of tubes.<sup>[16]</sup> Clamping of the tube may not have any adverse effects on patient safety.<sup>[16]</sup>

The British Thoracic Society recommended removal of chest drain either during expiration or via Valsalva maneuver. However, 67.9% of our respondents removed chest drain at end-inspiration. Studies have shown that chest tubes may be removed successfully at end-expiration or end-inspiration,<sup>[17,18]</sup> but recent evidence has proven that removal of chest tubes at the end of expiration leads to a lower incidence of nonclinically significant pneumothorax than at the end of inspiration.<sup>[19]</sup>

Underwater seal drainage was not used routinely by our respondents. The underwater seal can be improvised with bottled water plastic with good results in poor resource settings.<sup>[20]</sup> This has been done in emergency setting, especially when the ideal drainage receptacle is not available.

Removal of chest drain may be done as soon as  $\leq 200$  mL./fluid output per day is achieved<sup>[17]</sup> especially when pleural fluid is not infected and when there is no evidence of air leaks.<sup>[21]</sup> Recent studies have suggested that removal of the tube may even be tolerated even with a secretion of  $>450$  mL./day.<sup>[22]</sup>

In some cases, suction is desirable. In these cases, a high volume and low-pressure systems usually at the level of 10–20 cmH<sub>2</sub>O is recommended.<sup>[11]</sup> In our series, some residents have never applied suction to the drainage system.

It is a standard practice to request for routine chest radiograph following the removal of a chest drain. Most of our respondents request for this. Best evidence studies have suggested this provides no diagnostic or therapeutic advantage over simple clinical assessment.<sup>[23]</sup> Prior to the removal of a chest tube, a chest radiograph should show complete lung reexpansion. No air leak should be observed during coughing or suction. 32.1% of surgical trainees meticulously monitored leakage of air. This is a good practice. However in a study by Cerfolio *et al.*, it has been shown that patients with air leaks can be safely discharged home with their chest tubes. These chest tubes can be safely removed even in patients with pneumothorax, if the patients have been asymptomatic, have no subcutaneous emphysema after 14 days on a portable device at home, and the pleural space deficit has not increased in size.<sup>[24]</sup>

Complication of tube thoracostomy can either be technical or infective.<sup>[2]</sup> Our respondents mostly encountered superficial surgical site infection, tube dislodgement or tube blockage.

Tube blockage can be caused by kinking, angulation, clot formation within the lumen or the presence of debris.<sup>[2]</sup> Tube dislodgement can be prevented by meticulous care and good technique of drain anchorage.<sup>[2]</sup> Surgical site infection can range from cellulitis to necrotizing soft tissue infection.<sup>[2]</sup>

## CONCLUSION

Our study has exposed the weak points of our surgeons-in-training in managing chest drains. There is a need to fill in the gaps before we encounter complications from tube thoracostomy. These gaps must be stressed and corrected by surgical trainers early in their surgical career.

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## Conflicts of interest

There are no conflicts of interest.

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