

Article

# Assessing the Safety and Effectiveness of Percutaneous Tube Thoracostomy Performed by Trainee Physicians: Insights from a Tertiary Academic Medical Center

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DOI:10.61561/ssbgjms.v6i03.116

## Abstract

## Article Information

Received Date: Aug 08, 2025

Revised Date: Aug 10, 2025

Accepted Date: Sep 10, 2025

Published Date: Sep 27, 2025

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**Background:** Percutaneous tube thoracostomy is an essential procedure for treating pleural space diseases such as pneumothorax, hemothorax, and pleural effusion. While life-saving, it carries risks if not performed properly. In tertiary teaching hospitals, trainee doctors often perform this procedure under supervision. Evaluating their outcomes helps improve training and ensure patient safety.

**Objectives:** To evaluate the practice and outcomes of percutaneous tube thoracostomy performed by trainee doctors at a tertiary teaching hospital.

**Materials and methods:** This cross-sectional observational study was conducted in the Casualty Department of Dhaka Medical College Hospital from September 2024 to February 2025, with ethical approval. A total of 112 trauma patients aged above 15 years were included, excluding those with prior chest surgery, diabetes, trauma-related deaths, transfers after PTT, or age below 12 years. Data on demographics, procedural details of percutaneous tube thoracostomy, and post-procedural outcomes were collected and analyzed using SPSS version 25

**Results:** The study included 112 patients aged 17–61 years, with a mean age of  $36.2 \pm 11.8$  years; the largest group was 31–40 years (35.5%), followed by 21–30 years (25%). Most percutaneous tube thoracostomies (82.1%) were performed within the recommended “safety triangle,” predominantly at the 5th intercostal space (48.2%). The commonly used tube sizes were 30Fr (46.4%), 28Fr (32.1%), and 32Fr (21.4%), with a mean incision length of  $2.71 \pm 0.54$  cm. Post-procedure recovery was uneventful in 69.6% of patients, while 30.4% experienced complications, most commonly auto-expulsion/leakage (8%), haemorrhage (7.1%), wound infection (6.3%), subcutaneous emphysema (4.5%), and non-functioning tubes (4.5%).

**Conclusion:** Percutaneous tube thoracostomy carried out by trainee doctors in a tertiary teaching hospital is largely safe and effective. Most procedures followed standard practices, including correct placement within the safety triangle, appropriate tube size, and suitable incision length. Although most patients recovered without complications, a significant number experienced minor issues, underscoring the importance of proper training, supervision, and strict adherence to procedural protocols to maintain patient safety.

**Keywords:** Percutaneous tube thoracostomy, Trainee, Trauma.

### Research in Context

**Evidence before this study:** Percutaneous tube thoracostomy (PTT) is a critical, life-saving procedure frequently performed in emergency and trauma settings. Given its increasing performance by trainee physicians, particularly in tertiary academic centers, understanding the safety and efficacy of this practice is paramount for patient care and medical education. Prior literature has reported varying complication rates for PTT performed by residents, ranging from approximately 13% for surgical residents to up to 40% for emergency medicine residents, with overall rates often cited around 30%. While guidelines emphasize anatomical landmarks like the "triangle of safety" and appropriate tube sizing, the real-world adherence to these standards and their direct impact on outcomes when performed by trainees in specific regional contexts warrants continuous evaluation. The existing evidence broadly supports supervised trainee involvement but highlights the need for rigorous training and oversight to minimize adverse events.

**What this study adds:** This study provides contemporary, real-world data from a tertiary academic medical center in Dhaka, Bangladesh, specifically evaluating PTT performed *exclusively* by trainee doctors on trauma patients. It meticulously details procedural adherence, including the high rate (82.1%) of placement within the recommended "triangle of safety" and the most common tube sizes and incision lengths utilized. Crucially, it quantifies a specific complication rate of 30.4% in this trainee-led cohort, identifying common issues such as auto-expulsion/eye leakage (8%), hemorrhage (7.1%), and wound infection (6.3%). These findings are consistent with the higher end of previously reported complication rates for trainee-performed procedures, underscoring the ongoing challenges and the persistent need for robust training. This research offers valuable insights into current practice patterns and associated outcomes in a busy trauma setting.

**Implications of all the available evidence:** The cumulative evidence, reinforced by this study, strongly supports the continued integration of PTT into trainee curricula, provided there is stringent supervision and adherence to standardized protocols. While PTT performed by trainees appears largely safe and effective, the persistent, non-trivial complication rates—even for relatively minor issues—underscore the critical importance of continuous skills development, simulation-based training, and real-time senior oversight. Healthcare institutions should leverage such data to refine training modules, implement checklists, and ensure that a structured learning environment minimizes risks. Future research should explore interventions to further reduce complication rates in trainee-performed procedures, potentially focusing on advanced simulation, immediate feedback mechanisms, and assessing the impact of different supervisory models on patient outcomes and trainee proficiency gain.

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### Introduction

Percutaneous tube thoracostomy (PTT) is a lifesaving intervention commonly used in the management of chest trauma as well as certain non-traumatic pleural conditions such as empyema or malignant effusions<sup>1-4</sup>. The procedure allows evacuation of air or fluid, prevents tension pneumothorax, facilitates lung re-expansion, and helps monitor thoracic bleeding<sup>1-3</sup>. The first documented closed tube thoracostomy was performed by Hewett in 1867 for empyema<sup>5,10</sup>. Its role in trauma care became more prominent during the Second World War and the Vietnam War, establishing it as a standard treatment for chest injuries<sup>6,7</sup>.

According to the British Thoracic Society (BTS), the recommended site for tube insertion is the "triangle of safety," bordered by the anterior border of the latissimus dorsi, the lateral border of the pectoralis major, a line superior to the nipple, and an apex below the axilla<sup>3</sup>. The 5th intercostal space in the midaxillary line is most commonly used, directed apicoposteriorly for pneumothorax and posterobasally for fluid<sup>3,8</sup>. However, any direction can effectively drain both air and fluid<sup>8</sup>.

Despite its simplicity, PTT carries risks including insertional, positional, and infectious complications<sup>9-13</sup>. These are influenced by operator skill, patient condition, and procedural environment<sup>11</sup>. Studies report complication rates of approximately 13% for surgical residents and up to 40% for emergency medicine residents, with an overall complication rate of 30%.<sup>2,3,12</sup> Poorly placed tubes may result in undrained pneumothorax, hemothorax, post-removal pneumothorax, or empyema, prolonging hospital stay<sup>13</sup>.

Traditionally performed by thoracic surgeons, PTT is increasingly done by trainee doctors in emergency and casualty settings<sup>2,12</sup>. At Dhaka Medical College Hospital, trainee-performed PTT is frequently used for trauma patients. When performed correctly, it is safe, effective under local anaesthesia, and can be done at the bedside or in a mini operating room<sup>3,4</sup>. Adequate training and skill development are crucial to minimize complications and ensure optimal patient outcomes<sup>3</sup>. This study aims to evaluate the outcomes, efficacy, and complication rates of percutaneous tube thoracostomy performed exclusively by trainee doctors in the management of trauma patients.

## Materials & Methods

This cross-sectional observational study was carried out in the Casualty Department of Dhaka Medical College Hospital (DMCH), a tertiary care & academic center, Dhaka, from September 2024 to February 2025. Ethical clearance for the study was obtained from the relevant department, the Research Review Committee, and the Ethical Review Committee of Dhaka Medical College, Dhaka. A total of 112 trauma patients aged over 15 years presenting to the casualty department of DMCH were considered for inclusion. Patients with a history of previous chest surgery, diabetes mellitus, trauma-related deaths, those transferred to another hospital after percutaneous tube thoracostomy (PTT), and patients under 12 years of age were excluded.

Patients were examined for specific clinical signs, which were documented in a structured data collection sheet. Demographic variables (age, sex, body mass index) and key outcome variables—including indications for tube thoracostomy, incision length, thoracostomy tube size, site and side of insertion, tube fixation, need for replacement, post-procedural complications, wound infection, ascending infection, water seal status, and incidence of thoracotomy—were recorded. After data collection, manual editing and screening were performed. The dataset was then prepared and analyzed using SPSS version 25.

## Results

The age distribution of the 112 patients shows a wide age range from 17 to 61 years, with a mean age of  $36.2 \pm 11.8$  years. The largest proportion of patients (35.5%) was aged 31–40 years, followed by 21–30 years (25%). Regarding the site of tube thoracostomy, the majority of procedures (82.1%) were performed within the safety triangle. Within this group, the 5th intercostal space was most frequently used (48.2%), followed by 6th ICS or below (23.2%) and 4th ICS (10.7%). A smaller proportion of tubes were placed outside the safety triangle, either in front of the anterior axillary line (7.1%) or behind the posterior axillary line (10.7%). The most commonly used tube size was 30Fr (46.4%), followed by 28Fr (32.1%) and 32Fr (21.4%). Regarding incision length, most patients (58.9%) had an incision of 2–3 cm, while 28.6% had an incision >3 cm and 12.5% <2 cm. The mean incision length was  $2.71 \pm 0.54$  cm. Post-procedure outcomes showed that 69.6% of patients had uneventful recovery following tube thoracostomy. Complications occurred in 30.4% of patients, with auto expulsion/eye leakage being the most common (8%), followed by haemorrhage (7.1%), wound infection (6.3%), subcutaneous emphysema (4.5%), and non-functioning tubes (4.5%).

**Table 1: Demographic, Procedural, and Post-procedure Characteristics of Patients Undergoing Tube Thoracostomy (n = 112)**

| Variable                  | Category                               | Frequency (n)                     | Percentage (%) |
|---------------------------|----------------------------------------|-----------------------------------|----------------|
| Age (years)               | < 20                                   | 9                                 | 8              |
|                           | 21–30                                  | 28                                | 25             |
|                           | 31–40                                  | 39                                | 35.5           |
|                           | 41–50                                  | 17                                | 15.2           |
|                           | > 50                                   | 19                                | 16.9           |
|                           | <b>Mean <math>\pm</math> SD</b>        | <b>36.2 <math>\pm</math> 11.8</b> |                |
|                           | <b>Range</b>                           | <b>17 – 61</b>                    |                |
| Site of Tube Thoracostomy | Safety Triangle (overall)              | 92                                | 82.1           |
|                           | • 4th Intercostal Space                | 12                                | 10.7           |
|                           | • 5th Intercostal Space                | 54                                | 48.2           |
|                           | • 6th Intercostal Space or below       | 26                                | 23.2           |
|                           | In front of the Anterior Axillary Line | 8                                 | 7.1            |
|                           | Behind the Posterior Axillary Line     | 12                                | 10.7           |
| Tube Size                 | 28 Fr                                  | 36                                | 32.1           |
|                           | 30 Fr                                  | 52                                | 46.4           |
|                           | 32 Fr                                  | 24                                | 21.4           |
| Length of Incision (cm)   | < 2                                    | 14                                | 12.5           |
|                           | 2–3                                    | 66                                | 58.9           |
|                           | > 3                                    | 32                                | 28.6           |
|                           | <b>Mean <math>\pm</math> SD</b>        | <b>2.71 <math>\pm</math> 0.54</b> |                |
|                           | <b>Range</b>                           | <b>1.9 – 4.5</b>                  |                |
| Post-procedure Outcome    | Uneventful                             | 78                                | 69.6           |
|                           | Any Complication                       | 34                                | 30.4           |
|                           | • Hemorrhage                           | 8                                 | 7.1            |
|                           | • Subcutaneous Emphysema               | 5                                 | 4.5            |
|                           | • Wound Infection                      | 7                                 | 6.3            |
|                           | • Auto-expulsion/Eye leakage           | 9                                 | 8              |
|                           | • Non-functioning                      | 5                                 | 4.5            |

## Discussion

Percutaneous tube thoracostomy (PTT) is a widely used, lifesaving intervention for both traumatic and non-traumatic chest conditions<sup>3,7</sup>. In our study, the mean age of patients was 36.2  $\pm$  11.8 years, with the highest proportion (35.5%) in the 31–40-year age group. This aligns with previous studies reporting that middle-aged adults, often due to higher exposure to road traffic accidents, occupational hazards, and trauma-related activities, constitute the majority of chest trauma cases<sup>14</sup>. Patients at the extremes of age were less frequently affected, reflecting the lower incidence of traumatic chest injuries in these groups.

Similar study Maula et al.<sup>3</sup> reported 96 study patients; the highest 32.29% number of PTT belonged to the age group 31-40 years and lowest 9.37% number of PTT belonged to the age group  $\leq 20$  years. The mean age of the respondents was  $29.19 \pm 9.81$ .

Regarding procedural technique, the majority of tubes (82.1%) were placed within the “triangle of safety,” with the 5th intercostal space being the most common site (48.2%). A small proportion of tubes were inserted outside this area, either in front of the anterior axillary line (7.1%) or behind the posterior axillary line (10.7%). These findings suggest that trainee doctors largely adhered to recommended anatomical guidelines, though occasional deviations may have been influenced by urgency or patient anatomy<sup>9,15</sup>. Similar study Maula et al. reported out of 96 patients 89.55% tubes were placed within the triangle of safety. Besides, 10.41% tube thoracostomies were performed outside the triangle of safety such as in front of the anterior axillary line, behind the posterior axillary line and the 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.

The most commonly used tube size in our study was 30Fr (46.4%), followed by 28Fr (32.1%) and 32Fr (21.4%). The majority of incisions (58.9%) were 2–3 cm, with a mean length of  $2.71 \pm 0.54$  cm (range 1.9–4.5 cm). These results are comparable to previous studies, which recommend moderate incision lengths to ensure proper tube placement while minimizing tissue trauma<sup>16,17</sup>. A smaller proportion of patients had incisions longer than 3 cm, likely reflecting procedures performed by trainees where additional exposure or closure adjustments were needed.

Post-procedure outcomes in our study showed that 69.6% of patients had uneventful recovery, while 30.4% experienced minor complications. Auto-expulsion/eye leakage (8%) was the most common, followed by hemorrhage (7.1%), wound infection (6.3%), subcutaneous emphysema (4.5%), and non-functioning tubes (4.5%). These complication rates are consistent with previously published data, which report overall complication rates ranging from 20–30% when PTT is performed by trainees or junior operators<sup>18-22</sup>. Another study Maula et al. reported wound infection was 11.45%. This underscores the critical role of operator skill and careful technique in minimizing procedure-related morbidity.

Overall, our study confirms that PTT performed by trained trainees is generally safe and effective for managing chest trauma and select non-trauma conditions. The findings highlight the importance of adherence to standard anatomical landmarks, appropriate tube size selection, and proper incision length to optimize outcomes and reduce complications.

## Conclusion

This study highlights the outcomes of percutaneous tube thoracostomy performed by trainee doctors at a tertiary teaching hospital. Most procedures were appropriately performed within the safety triangle, particularly at the 5th intercostal space, reflecting adherence to recommended anatomical landmarks. Complications were observed, including hemorrhage, subcutaneous emphysema, wound infection, auto-expulsion with leakage, and non-functioning tubes, though most patients had an uneventful recovery. These findings suggest that with supervision and structured training, trainee doctors can perform tube thoracostomy effectively and safely. Ongoing skills development, strict adherence to standardized techniques, and close monitoring remain essential to minimize complications and improve patient outcomes.

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**To cite:** Rusama Nuzhat, SMG Saklayen, Wahidul Azad Polash, Lulu Marzan Hashi. Assessing the Safety and Effectiveness of Percutaneous Tube Thoracostomy Performed by Trainee Physicians: Insights from a Tertiary Academic Medical Center. *SSB Global Journal of Medical Science* [Internet]. 2025 Oct. 15 [cited 2025 Oct. 16];6(03):3-8. Available from: <https://ssbjournals.org/index.php/ssbgjms/article/view/116>

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