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Standardized Protocol for Chest Tube Management for Trauma Patients Significantly Decreases Complications

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A B S T R A C T

THORACIC TRAUMA Causes Devastating Potential in Almost 140000 Patient Every year But Upto 75% of these Trauma can be Treated with Immediate Intervention Like Thoracostomy Tube or Chest Tube and Volume Resuscitation. Following Blunt & Penetrating Trauma.
Although Standardized protocol for Chest Tube Management for Trauma Patient Significantly Reduces Complications Chest Tube Management of blunt or penetrating Trauma A Patient with a Memothorax or Pneumothorax Resulted in Fewer Hospital Problems . Efforts to reduce complications for Trauma Patients Must Continue.

Keywords: trauma, chest injuries, chest tube management, standardized protocol.

1. INTRODUCTION

Thoracic trauma is a prevalent and important damage pattern with devastating potential implications, accounting for 25% of India's 140,000 trauma patient deaths each year [1-3]. Up to 75% of thoracic traumas can be treated with a thoracostomy tube or chest tube and volume resuscitation [2, 4]. However, because these patients are more likely to die and have long-term morbidity, multidisciplinary treatment and coordination are critical in attaining high-quality outcomes [2, 5].

Limited data exist on the standardized management for patients with hemothorax or pneumothorax (H/PTX)

Following a blunt or penetrating trauma injury. It is not uncommon for hospitals and general surgeons to approach chest tube maintenance in unique and non-uniform ways. Prior to the establishment of a new, standardized strategy to chest tube care, our institution relied on the judgment and preferences of the attending surgeon on call. This resulted in disjointed treatment strategies involving shift changes and patient hand-offs. With a greater emphasis on improving patient outcomes as the healthcare model shifts to value-based care, adopting standardized models for

treatment regimens can be an important and feasible path for hospitals to take [6]. Several studies have emerged that describe.

Standardized guidelines for chest tube placement and management were developed to improve the quality of care provided to these patients [1, 7, 8]. Martin *et al*., described an algorithmic strategy to managing thoracostomy tubes in Level 1 Trauma Center patients [8]. These algorithms result in an organized approach to managing chest tube patients, and they were used to create our institutional framework for clinical treatment of this patient group.

As a result, the goals of this study were to (1) create an institutionally standardized methodology for chest tube management at our Level 3 Trauma Center and (2) compare patient outcomes before and after implementing our protocol. Our hypothesis is that standardizing the care of trauma patients undergoing chest tube management for blunt or penetrating injuries will result in better outcomes and fewer hospital problems.

2. Aim and Objective

We wanted to examine the effectiveness of the Standardized Protocol for Chest Tube Management for Trauma Patients Significantly Reduces Complications.

3. Material and Methods

a. Study Design

After receiving institutional review board (IRB) approval, we retrospectively analyzed chart data for trauma patients who underwent chest tube placement for hemothorax or pneumothorax (H/PTX) from blunt or penetrating chest trauma between October 2023 and May 2024 at our Level 3 Trauma Centre teaching hospital. This time span was chosen to encompass the preceding and subsequent three years of protocol implementation. The patient cohort before the protocol was called "precohort," while the cohort after the protocol was labeled "post-cohort."

All patients received a >24 French chest tube for H/PTX, which necessitated wider bore catheters. Patients who underwent chest tube placement by interventional radiology (IR), received pigtail catheters, died from a nontraumatic cause, or died during the index admission were excluded from this investigation. Patient demographics included age, gender, and the mechanism of injury. Patient outcomes studied included average hospital length of stay (LOS), persistent H/PTX, recurrent H/PTX, and the requirement for additional surgical intervention during hospitalization.

b. Developed a standardized protocol for managing chest tubes.

Figure 1 shows our algorithmic approach design. The approach was based on previously described chest tube algorithms, with institutional-specific adjustments at our Level 3 Trauma Center [1, 8, 9]. The algorithm is described below. Chest tubes were inserted for eligible individuals who had experienced traumatic H/PTX, with an index chest X-ray performed at the time of insertion. If the immediate output exceeded 1,500 mL, patients were transferred to the operating room (OR). Chest tubes were inserted into a wall-mounted vacuum at −20 cm H2O for 24 hours. After the 24-hour period, the patient was re-evaluated using CXR. If a repeat CXR revealed deterioration of H/PTX, output of more than 200 mL over 24 hours, or an air leak, the patient was kept on continuous suction, and other therapies were explored [9]. If none of these symptoms existed, the patient was placed under water seal for 24 hours. After 48-hour period elapsed, if worsening of H/PTX continued, the output was over 200mL over 24 hours, or air leak was present— patient would return to the continuous suction with re-evaluation in 24hours. If none of these conditions werepresent,thechesttubewasdiscontinuedwithafollow- up CXR in 4hours and at follow-up clinic visit.

Statistical Analysis

Mann-Whitney U-tests and Fisher's exact tests were used to compare the results of patients who received therapy before to and after the implementation of the standardized protocol. Patient outcomes were also analysed using odds ratios. All statistical analyses were carried out using SAS v9.4 (SAS Institute, Cary, NC). Statistical significance was determined as $p < 0.05$.

4. RESULTS

This study included 143 patients, with 43 in the precohort and 100 in the postcohort (see Table 1). The patient demographics are reported in Table 1. The age, gender, and trauma mechanism were similar amongst groups (Table 1).

The postcohort had a substantial decrease in hospital LOS compared to the precohort ($p < 0.02$), with an average 2-day reduction (Table 2). Persistent H/PTX rates were 15% lower in the postcohort ($p < 0.05$). The probability of persistent H/PTX was predicted to be.

The use of the approach resulted in a 0.40 times (or 60%) reduction (OR = 0.40, 95% CI = 0.17-0.95). Recurrent H/PTX rates were the same (7%). Only 14% of the post-cohort required additional surgical intervention, compared to

37% in the pre-cohort ($p < 0.003$; see Figure 2). Implementing the regimen reduced the likelihood of requiring additional surgical intervention by 73% (OR = 0.27; 95% CI = 0.12–0.63).

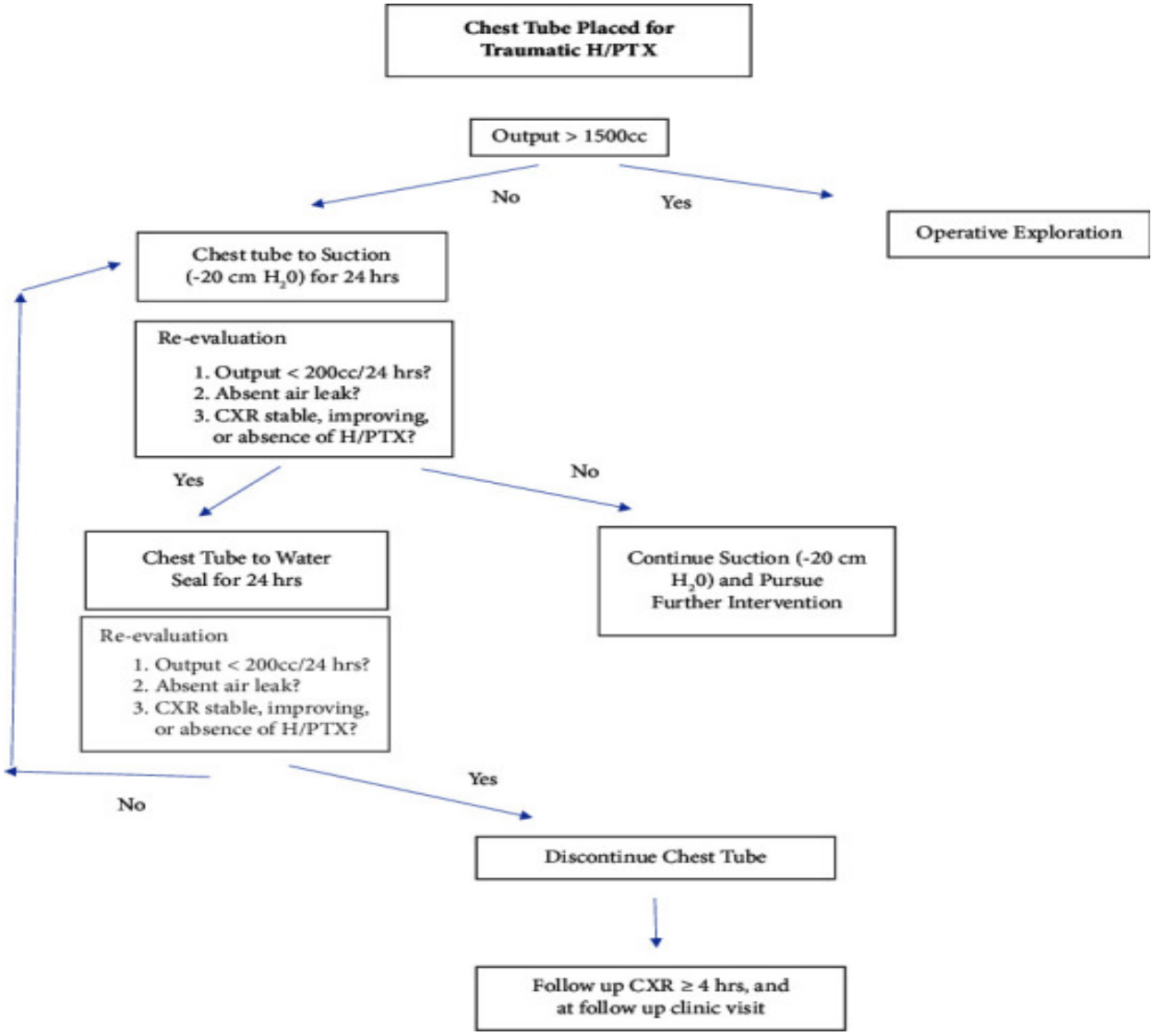

Figure 1: Chest tube management algorithm

Table 1: Patient demographics

	Precohort ($n = 43$)	**Postcohort ($n = 100$)**	***p* value**
Age in years (SD) Min-Max*†	48 (17) 18–91	51 (21) 17–97	0.45
Male gender‡	58% (25)	70% (70)	0.18
Blunt mechanism‡	91% (39)	95% (95)	0.45
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SD = standard deviation. †Mann–Whitney *U*-tests were used to compare quantitative variables, and ‡Fisher's exact tests were used to compare the categorized variables across all groups. *These values are given as the mean and standard deviation, with a range of minimum to maximum values. The remaining values are given as a percentage of the specific category. Gender options included male or female. Mechanisms included blunt or penetrating.

Hospital LOS significantly decreased in the postcohort as compared to the precohort ($p = 0.02$), with the postcohort LOS shorter by an average of 2 days (Table 2). Persistent H/PTX rates were 15% lower in the postcohort ($p = 0.04$). The odds of persistent H/PTX were estimated to be 0.40 times lower (or 60% lower) after the protocol was implemented (OR = 0.40, 95% CI = 0.17–0.95). Recurrent H/PTX rates were identical (7%). Only 14% of the postcohort needed further surgical intervention vs 37% in the precohort ($p = 0.003$; Figure 2). The odds of needing further surgical

intervention are estimated to be 0.27 times lower (or 73% lower) after the protocol was implemented (OR = 0.27; 95% CI = 0.12–0.63).

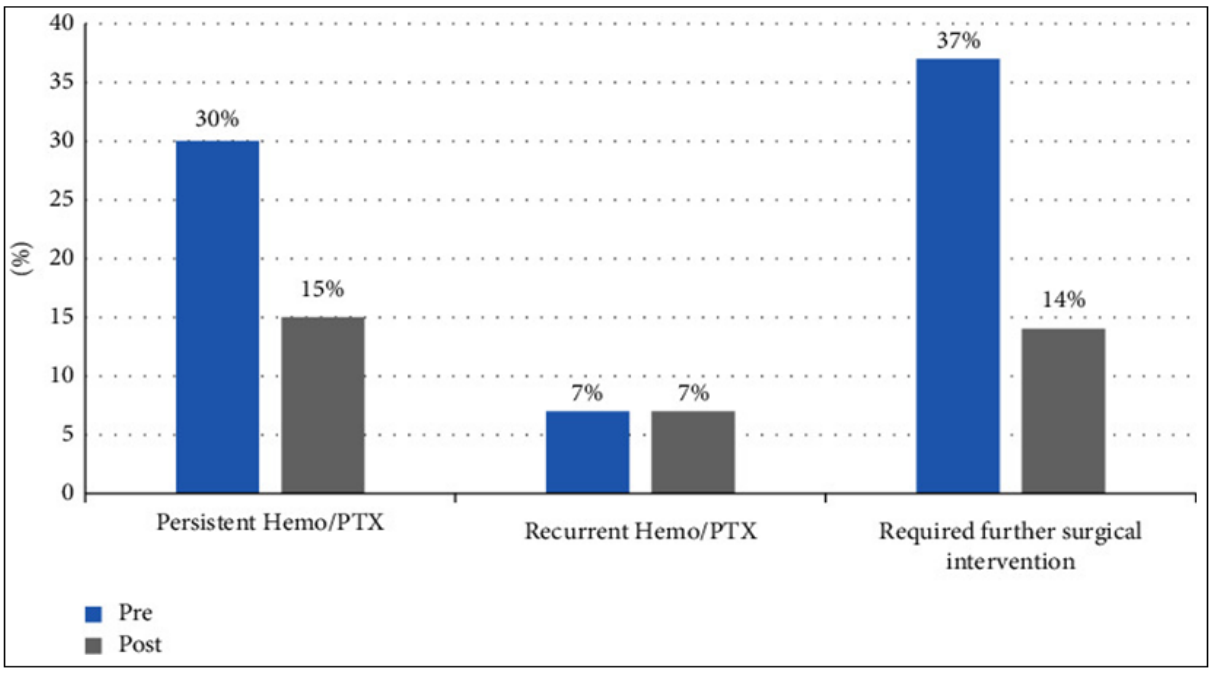

Figure 2:

Table 2: Patient outcomes comparing precohort and postcohort of the chest tube management protocol

	Precohort (*n* = 43)	**Postcohort (*n* = 100)**	***p* value**
Hospital LOS (SD) Min-Max†*	11.6 (9.9) 2–45	9.7 (10.5) 1–50	0.02
Persistent H/PTX‡	30% (13)	15% (15)	0.04
Recurrent H/PTX‡	7% (3)	7% (7)	0.99
Required further surgical intervention‡	37% (16)	14% (14)	0.003
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LOS = length of stay; SD = standard deviation; H/PTX = hemothorax or pneumothorax. †Mann–Whitney *U*-tests were used to compare quantitative variables, and ‡Fisher's exact tests were used to compare the categorized variables across all groups. *These values are given as the mean and standard deviation, with a range of minimum to maximum values. The remaining values are given as a percentage of the specific category.

5. DISCUSSION

Our study found that after the implementation of a standardized, algorithmic approach to chest tube management for patients sustaining a traumatic H/PTX resulted in a significant improvement in patient outcomes and hospital complications. Hospital LOS decreased by an average of 2 days, persistent H/PTX rates halved, and surgical intervention rates decreased by 23%. In our precohort, there was a complication rate of 37% (16/43), and our postcohort had a complication rate of 22% (22/100). Our improved complication rate seen was comparable to a previous study by Menger*et al*., that reported a thoracostomy tube complication rate of 22.1% following thoracic trauma [10].

Recently, the Western Trauma Association developed a critical decisions algorithm for the evaluation and management of traumatic pneumothorax [11]. Their recommendations were based on the available published studies and expert panel opinion. They found considerable research gaps in the published literature including differentiation in the management of blunt vs penetrating mechanism and physiological impact of size of the PTX. They concluded that pneumothoraces require an objective view to management and demand ongoing investigations [11]. Our study adds to the limited body of literature to guide practitioners with a systematic, algorithmic approach.

Our hospital LOS improved to an average of 9.7 days. This remains a higher LOS when compared to the previous reports of 4.1 days in similar cohorts [9]. This difference may be attributed to a higher level of injury severity and is comparable to a Level 1 Trauma Center study by Martin *et al*., with an average LOS of 10.4 days [8]. The high

standard deviation we saw in our cohort, with outliers in the higher range, may have positively skewed our data. Hospital duration may also be affected by concomitant injuries sustained by the studied patient population.

Our study found no differences in the recurrent H/PTX, but found a significant improvement in persistent H/PTX. This can theoretically be attributed to strict algorithmic protocol guidelines in which patients are immediately placed on water seal at a standardized pressure. Patients requiring surgical intervention at any time point also decreased, which we believe was due to vigilant re-evaluation check points with limited indications for OR management. As these injuries are generally recommended to be treated expectantly, a decrease in OR utilization is an important outcome in this patient population.

The strengths of the current study include description of a single-institution experience with the implementation of a new, standardized chest tube management protocol. While there is a general consensus on chest tube management, there is limited evidence on algorithms and management postinsertion. The present study contains several limitations. All cases were from a single, Level II Trauma Center teaching hospital, which could limit generalizability. This was a retrospective study which inherently creates concerns for the selection bias and confounding. It also cannot determine the causation and only imply that the improvement in outcomes was associated with implementing practice guidelines. Furthermore, our sample sizes are relatively small and are not in equal proportions. In line with this, we were unable to delineate between the differences in our hemothorax and pneumothorax patients due to our sample size and type 2 error probability. The difference in the management of hemothorax and pneumothorax (e.g., chest tube size) could represent a potential bias of our study. However, standardized protocols for chest tube management are limited [1, 8]—so we believe our study represents an important model. Lastly, variability exists among institutions; resource constraints and patient-specific factors may require alternative approaches on a case-by-case manner. Despite these limitations, our data did show decreased LOS and less surgical intervention in patients with traumatic H/PTX when their chest tube was managed using uniform practice guidelines.

6. CONCLUSION

In conclusion, our unified algorithmic procedure for chest tube management of blunt or penetrating trauma patients with a hemothorax or pneumothorax resulted in fewer hospital problems. Efforts to improve patient outcomes and reduce complications for trauma patients must continue.

Surgery Research and Practice 5.Health care delivery. The systematic approach described here can be modeled at similar institutions for enhanced patient care.

Data Availability: The data used to support the findings of this study are available from the corresponding author upon request.

Disclosure: The level of evidence is retrospective analysis (Level 3).

Conflicts of Interest: The authors declare that they have no conflicts of interest.

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