Small versus large-bore thoracostomy for traumatic hemothorax: A systematic review and meta-analysis

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BACKGROUND: Traumatic hemothorax (HTX) is common, and while it is recommended to drain it with a tube thoracostomy, there is no consensus on the optimal catheter size. We performed a systematic review to test the hypothesis that small bore tube thoracostomy (SBTT) (≤14 F) is as effective as large-bore tube thoracostomy (LBTT) (≥20F) for the treatment of HTX.

METHODS: Pubmed, EMBASE, Scopus, and Cochrane review were searched from inception to November 2022 for randomized controlled trials or cohort studies that included adult trauma patients with HTX who received a tube thoracostomy. Data was extracted and Critical Appraisal Skills Program checklists were used for study appraisal. The primary outcome was failure rate, defined as incompletely drained or retained HTX requiring a second intervention. Cumulative analysis was performed with χ^2 test for dichotomous variables and an unpaired t-test for continuous variables. Meta-analysis was performed using a random effects model.

RESULTS: There were 2,008 articles screened, of which nine were included in the analysis. The studies included 1,847 patients (714 SBTT and 1,233 LBTT). The mean age of patients was 46 years, 75% were male, average ISS was 20, and 81% had blunt trauma. Failure rate was not significantly different between SBTT (17.8%) and LBTT (21.5%) (p = 0.166). Additionally, there were no significant differences between SBTT vs. LBTT in mortality (2.9% vs. 6.1%, p = 0.062) or complication rate (12.3% vs. 12.5%, p = 0.941), however SBTT had significantly higher initial drainage volumes (753 vs. 398 mL, $p < 0.001$) and fewer tube days (4.3 vs. 6.2, $p < 0.001$). There are several limitations. Some studies did not report all the outcomes of interest, and many of the studies are subject to selection bias.

CONCLUSION: SBTT may be as effective as LBTT for the treatment of traumatic HTX. (*J Trauma Acute Care Surg.* 2024;97: 631–638. Copyright © 2024 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Systematic Review/Meta-Analysis; Level IV.

KEY WORDS: Thoracostomy; hemothorax; pigtail catheter; chest tube.

There are approximately 300,000 traumatic hemothoraces (HTX) diagnosed in the United States each year.[1] Current guidelines recommend HTX be drained with tube thoracostomy, however there is no consensus on the size of catheter.[1] Traditionally, large-bore tube thoracostomy (LBTT) has routinely been used for drainage of traumatic HTX. Similarly, LBTT has been the treatment of choice for drainage of pneumothorax (PTX), however in recent years, there has been a paradigm shift toward a more routine use of small-bore tube thoracostomy (SBTT), such as pigtail catheters, for managing PTX.[2] Small-bore tube thoracostomy advantages include smaller incision, improved patient comfort, and outpatient management.[2,3] As it has become more common to place a pigtail catheter for traumatic PTX, the next logical step was for clinicians to investigate their use for hemopneumothorax (HPTX) and HTX as well.[4]

In 2021, the Eastern Association for the Surgery of Trauma conditionally recommended using smaller-caliber pigtail catheters for drainage of HTX over LBTT for hemodynamically stable patients, however this was based on very low-quality evidence.[1] Their review only included four studies, two of which had overlapping patients. In the meantime, newer high-quality data have been published.[5,6] Other reviews have attempted to answer the question of whether pigtail catheters or chest tubes should be placed for HTX. However, a true systematic review using PRISMA guidelines exclusively evaluating this question has yet to be performed.[7–9]

To fill this gap, we performed a systematic review to test the hypothesis that SBTT (≤14 F) are as effective as LBTT (≥20F) for the treatment of HTX.

METHODS

This study was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis statement (Supplemental Digital Content 1, http://links.lww.com/TA/D956).[10] The protocol was registered online with PROSPERO (CRD42022382367) (Supplemental Digital Content, http://links.lww.com/TA/D957).[11]

Search Strategy and Selection Criteria

Pubmed, EMBASE, Scopus, and Cochrane review were searched from database inception to November 2022. A search

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strategy for each database was constructed using a combination of medical subject headings and free-text terms related to tube thoracostomy for treatment of HTX using the following keywords: hemothorax, hemopneumothorax, hemothoraces, hemopneumothoraces, drainage catheter, pigtail catheter, small bore, large bore, central venous catheter, chest tube, and thoracostomy. For example, this was the search used in Pubmed (hemothorax OR hemopneumothorax OR hemothoraces OR hemopneumothoraces) AND (drainage catheter OR pigtail catheter OR chest tube OR thoracostomy OR small bore OR large bore OR central venous catheter). The electronic database search was supplemented by a manual search of the reference lists of included articles. An information specialist or librarian was not used for the search.

Titles, abstracts, and finally full-text articles were screened for pertinent information. Two independent reviewers reviewed all articles (NBL and MM). The inclusion criteria were defined a priori as follows: (1) randomized controlled trials (RCT) or cohort studies (prospective and retrospective); (2) articles that included adult (≥18 years old) trauma patients with blunt and/or penetrating thoracic injuries diagnosed with HTX or HPTX who receive a tube thoracostomy; and (3) articles that reported outcomes after treatment. Case reports, nonclinical studies, editorials, commentaries, conference abstracts, and articles in a language other than English were excluded. Nonrandomized studies were included as there are too few randomized studies on this topic. For articles with the same or overlapping patient populations only data from the most recent article was included in the cumulative analysis. Reviews were excluded but the reference lists were examined to ensure additional appropriate studies were also included in our review.

Size Definitions of Small-Bore and Large-Bore Tube Thoracostomy

Chest tubes are available in various sizes based on external diameter and range from 6F to 40F. A SBTT was defined as ≤14F and LBTT as ≥20F.[1] This size was selected as pigtail catheters are typically less than or equal to 14F whereas the minimum chest tube size used clinically is 20F.[1] Patients from included studies were categorized in these two groups based on the size of thoracostomy they received. If a study included two different size tubes that were both either ≤14F or ≥20F, all the patients from the study were analyzed in the small-bore or large-bore group, respectively.

Data Extraction and Quality Assessment

Two reviewers (NBL and MM) independently extracted the data. Any disagreement was resolved by discussion until consensus was reached or by consulting a senior author. For each article, data including the number of patients, country of origin, patient demographics, details about their injury, outcomes, and overall tube-related complications (empyema, retained hemothorax, tube obstruction, etc., as defined by each study) were extracted.

The Critical Appraisal Skills Program (CASP) checklists for RCTs and cohort studies were used to assess the methodologic quality and risk of bias on the included RCTs and cohort studies respectively.[12] The checklist for RCTs includes 11 questions. Each question was eligible to receive up to two points for a total of 22 possible points. The checklist for cohort studies includes 14 questions for a possible 28 points.

Two reviewers (NBL and MM) independently evaluated the quality of the included studies by using the appraisal tools and a CASP score was calculated for each trial. The studies were categorized as high, medium, or low-quality based on their score: ≥15, 14 to 10, ≤9 for RCTs and ≥18, 17 to 10, ≤9 for cohort studies, respectively. These categories were devised a priori by the authors. If there was a discrepancy in scores between the two authors, both scores were averaged.

Statistical Analysis

The primary outcome was failure rate, defined as incompletely drained or retained HTX requiring a second intervention. Retained hemothorax occurs when there is hemothorax remaining after initial drainage, but there is no clear definition of the amount of blood remaining in the chest or the timing after tube placement to be considered a retained hemothorax.[1] Second interventions could include second tube thoracostomy insertion, thrombolysis, interventional-radiology guided drainage, video-assisted thoracoscopy surgery (VATS), or open thoracotomy. Secondary outcomes included ICU length of stay (LOS), hospital LOS, initial drainage output, tube days, insertion-related complications, other complications (such as pneumonia, empyema, retained hemothorax, tube dislodgement, tube clogging, et cetera and was defined by the individual studies), and pain score. Most of the outcomes were selected *a priori* and are listed in the PROSPERO registration.[11] Several were added later after reading the studies, such as insertion-related complications. For purposes of the meta-analysis, mean and standard deviation were estimated for data reported as a median and interquartile range in order for cumulative data to be calculated.[13] Cumulative analysis was performed with χ^2 test for dichotomous variables and unpaired t-test for continuous variables. Heterogeneity among studies was quantified using Higgins I^2 statistics: $I^2 > 75\%$, >50%, and <25% were considered high, moderate, and low heterogeneity, respectively. A fixed effects model was applied for all meta-analyses. Only studies reporting outcomes for both SBTT and LBTT patients were included in the meta-analysis. Two-sided *p*-values <0.05 were considered statistically significant. Statistical analysis was performed with SPSS Statistics, version 28.0 (IBM Corp, Armonk, NY).

RESULTS

In total, 3,429 articles were identified from the initial search. After duplicates were removed, 2,008 articles remained. Of these, 1,808 manuscripts were excluded based on review of their titles, and 200 remained for abstract review. Thirteen full-text articles were reviewed, and 11 were included in the systematic review (Fig. 1).[4–6,14–21] No additional studies were identified by review of reference lists from included articles or review articles. Bauman et al[14] and Kulvatunyou et al.[4] had overlapping patients, as did Kulvatunyou et al.[6] and Bauman et al[5]. All four articles were included. However, only data from the most recent study in each pair was included in the cumulative analysis.

Quality Assessment and Description of Included Studies

All 11 studies underwent a full-text review and assessment of risk of bias. The methodology of the studies is included in Table 1 along with study and background information. All

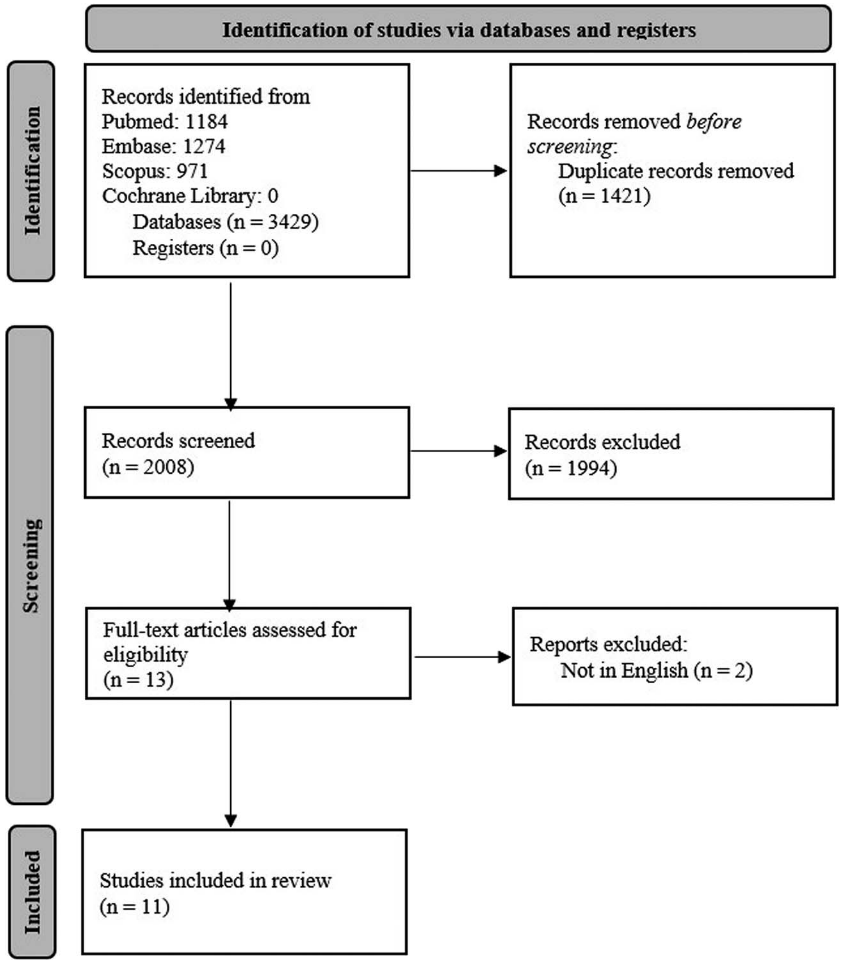

Figure 1. PRISMA 2020 Flow Diagram.

studies had an increased risk of bias due to the inability to blind the patient or provider to the intervention. Description of the methods for four studies were not detailed enough to accurately assess the risk of bias in their methodology.[16–18,21]

Of the 11 included studies, there were three RCTs, three prospective cohort studies, and five retrospective cohort studies. The manuscripts were from three countries: seven from the United States, three from Japan, and one from China. Excluding the two studies with overlapping patients, the nine remaining studies included 1,847 patients and 1,972 tube thoracostomies (730 SBTT and 1,242 LBTT). These patients were enrolled from 2002 to 2020. Four studies included patients with PTX, HPTX, and HTX; only one of these separated outcomes of patients with PTX from those with HPTX or HTX. Three studies included patients with HPTX or HTX, and two studies included patients with HTX only. The average age was 46 years, 75% were male, average Injury Severity Score was 20, and 81% had blunt trauma (Table 1).

Clinical Outcomes

Five studies reported on the primary outcome of failure rate. There was no significant difference in failure rate between SBTT and LBTT (17.8% vs. 21.5%, $p = 0.166$), however SBTT required less VATS than LBTT, (3.0 vs. 7.2, $p = 0.001$). There was no significant difference in mortality (SBTT, 2.9% vs. LBTT, 6.1%, $p = 0.062$) or complication rate (SBTT, 12.3% vs. LBTT, 12.5%, $p = 0.941$). However, there was a significant difference in initial drainage (SBTT, 753 vs. LBTT, 398 mL, $p < 0.001$) and tube days (SBTT, 4.3 vs. LBTT, 6.2 days, $p < 0.001$). Although there was no difference in overall complications, SBTT had a higher rate of insertion-related complications (4.4 vs. 2.2, $p = 0.036$) (Table 2). Some studies only reported insertion-related complications whereas others had a broader definition of complications they reported. Insertion-related complications for LBTT included bleeding requiring surgical control, intra-hepatic placement, malpositioned tube, dislodgement, and kinked tube. Those for SBTT included bleeding requiring surgical control, intra-hepatic placement, placement through the spleen, heart puncture, technical failure requiring conversion to LBTT, malpositioning, and dislodgement.

Only two studies reported pain scores, and each used a different scoring system, preventing cumulative analysis. Bauman et al.[5] used the IPE score, which was institutionally created and unvalidated. It is a scale from 1–5 with 5 being “the worst experience of my life!” They reported a significant difference between the two groups, with the SBTT group reporting a median score of 1 while the LBTT group reported a median score of 3 ($p = 0.001$). Inaba et al.[15] used the validated Visual Analog Scale pain score to evaluate pain intensity at the site of thoracostomy

TABLE 1. Study and Patient Characteristics

Study ID	1[14]	2*[4]	3[15]	4[6]	5*[5]	6**[16]	7[17]	8**[18]	9[19]	10**[20]	11[21]	Total
Year	2018	2012	2012	2021	2021	2020	2020	2009	2017	2020	2012	2009–2020
Years of enrollment	2008–2014	2009–2011	2007–2010	2015–2020	2015–2018	2013–2018	2010–2017	2002–2006	2010–2016	2012–2015	2003–2009	2002–2020
Country	USA	USA	USA	USA	USA	Japan	USA	USA	Japan	Japan	China	-
Study Design	PC	PC	PC	RCT	RCT	RC	RC	RC	RC	RC	RCT	-
Patients, n	496	227	233	119	43	102	220	90	116	64	407	1847
SBTT, n	189	36	-	56	20	9	191	71	-	-	214	730
LBTT, n	307	191	275	63	23	98	72	44	124	66	193	1242
Diagnosis (n patients)	HTX HPTX	HTX HPTX	HTX HPTX PTX	HTX HPTX	HTX HPTX	HTX (9) HPTX (50) PTX (43)	HTX		HTX HPTX	HTX (7) HPTX (36) PTX (24)	HTX	
Tube sizes (F)	14 32–40	14 32–40	28–32 36–40	14 28–32	14 28–32	8 20	12–14 28–32	10–14 32–36	20–22 28	20–24 28	7 2 cm	
Age (years)			36			60	-			65	36	46
SBTT	52	53		56	62			50	61			
LBTT	42	41		54	55			41	59			
Male, %			87			77				76	64	75
SBTT	76	75		84	85		70	69	73			
LBTT	77	73		81	96		85	77	78			
ISS, mean			19			18	-			29	23	20
SBTT	16	18		18	18			19	24			
LBTT	17	21		17	16			24	28			
Chest AIS, mean			-			3.6	-	-		3.9	-	
SBTT	3	3.1		4	3.5				3.9			
LBTT	3	3.3		4	4.0				4.0			
Blunt, %			47			-		-		95	100	81
SBTT	86	83		87	95		99		96			
LBTT	55	62		75	74		95		92			
Who Placed the Tubes	SR or EM	SR	SR or EM	SR	SR	EM or TS	-	SBTT IR LBTT SR	EM	EM	-	
Emergent Placement, %	46		-	0	0				100	-	-	
SBTT	15							-				
LBTT	64							0				
Hospital Day of Placement, mean			-			-	>1.5		<2 h	<1	-	
SBTT	1	1		2	2.5			5.5				
LBTT	0	0		1	1			2.3				
CASP score (category)	25 (high)	20 (high)	25 (high)	19 (high)	18 (high)	16 (moderate)	20 (high)	15 (moderate)	26 (high)	21 (high)	16 (high)	

*Studies with overlapping data are listed to the right of the more recent study.
**Does not separate outcomes for hemothorax and pneumothorax.
AIS, abbreviated injury scale; EM, emergency medicine; F, French; IR, interventional radiology; ISS, injury severity scale; LBTT, large bore tube thoracostomy; PC, prospective cohort; RC, retrospective cohort; RCT, randomized controlled trial; SBTT, small bore tube thoracostomy; SR, surgery resident; TS, thoracic surgeon.

TABLE 2. Outcomes

Study ID	1[14]	2*[4]	3[15]	4[6]	5*[5]	6**[16]	7[17]	8**[18]	9[19]	10**[20]	11[21]	Total	p
Patients, n	496	227	233	119	43	102	220	90	116	64	407	1847	-
SBTT	189	36	—	56	20	9	191	71	—	—	214	714	
LBTT	307	191	275	63	23	98	72	44	124	66	193	1233	
Failure Rate, n (%)													
SBTT (n = 316)	39 (21)	3 (8)	—	7 (11)	2 (10)	—	—	10 (14)	—	—	—	56 (18)	0.166
LBTT (n = 755)	73 (24)	45 (24)	53 (19)	8 (13)	4 (17)			9 (20)		19 (29)		162 (21)	
Second TT	—			—	—	—	—	—		—	—	—	—
SBTT		2 (6)	—						—				
LBTT		24 (13)	14 (5)						6 (5)				
Thrombolysis	—	—		—	—	—	—	—		—	—	—	—
SBTT			—						—				
LBTT			17 (6)						0 (0)				
IR Drainage	—	—		—	—	—	—	—	—	—	—	—	—
SBTT			-										
LBTT			11 (4)										
Open Thoracotomy	—	—		—	—	1 (1)	—	—		—	—	—	—
SBTT			—						—				
LBTT			3 (1)						3 (2)				
VATS, n (%)						6 (6)							**0.001**
SBTT (n = 507)	7 (4)	2 (6)	-	4 (7)	1 (5)		0 (0)	4 (6)	—	—	—	15 (3.0)	
LBTT (n = 761)	39 (13)	29 (15)	8 (3)	3 (5)	2 (9)		4 (6)	1 (1)				55 (7.2)	
Insertion-Related Complications, n (%)			—			—	—	—	—	—			**0.036**
SBTT (n = 459)	17 (9)	3 (8)		1 (2)	0 (0)				0 (0)		2 (1)	20 (4.4)	
LBTT (n = 687)	14 (5)	7 (4)		1 (2)	0 (0)						0 (0)	15 (2.2)	
Other Complications, n (%)	—	—		—	—	8 (8)		—		—			0.941
SBTT (n = 405)			—				35 (18)		—		15 (7)	50 (12)	
LBTT (n = 664)			43 (16)				10 (14)		16 (13)		14 (7)	83 (13)	
Pneumonia	—	—		—	—	—		—	—	—			0.685
SBTT (n = 191)			-				14 (7)					14 (7)	
LBTT (n = 347)			13 (5)				0 (0)					13 (4)	
Empyema	—	—		—	—	—				—			0.163
SBTT (n = 476)			—				2 (1)	5 (4)	—		0 (0)	7 (1)	
LBTT (n = 708)			12 (4)				1 (1)	1 (1)	2 (2)		3 (2)	19 (3)	
Retained HTX	—	—		—	-	4 (4)		—		—			**0.009**
SBTT (n = 405)			—				5 (3)		—		7 (3)	12 (3)	
LBTT (n = 664)			31 (11)				3 (4)		4 (3)		6 (3)	44 (7)	
Initial Drainage (mL)						—		—		—	Total:		**<0.001**
SBTT	425†	560	—	600†	650†		811		—		890	753	
LBTT	300†	426	354	400†	400†		738		324		840	398	
Tube Days (d)						3.9							**<0.001**
SBTT	4†	5†	—	4†	4†		3.6	5.5	—	—	4.6	4.3	
LBTT	5†	6†	6.3	5†	4†		6.0	7	7.7	6.3	5.0	6.0	
ICU LOS (d)			—			—	—			—	—		0.193
SBTT	1†	2†		2.5†	0†			8.2	—			5.5	
LBTT	3†	2†		2†	0†			11	2.6			4.7	
Hospital LOS (d)			—			—					—		**<0.001**
SBTT	8†	10†		8.5†	6.5†		15.1	10.5	—	—		12.3	
LBTT	9†	8†		8†	7†		15.0	16.5	31.1	19.3		16.6	
Ventilator Days (d)			—			—	—		—	—	—	—	—
SBTT	0†	0		0†	0			12					
LBTT	0†	0		0†	0			13					

Continued next page

TABLE 2. *(Continued)*

Study ID	1[14]	2*[4]	3[15]	4[6]	5*[5]	6**[16]	7[17]	8**[18]	9[19]	10**[20]	11[21]	Total	*p*
Mortality, n (%)			—		-	3	—	—		—	—		0.062
SBTT (n = 245)	6 (3)	1 (3)		1 (2)					—			7 (2.9)	
LBTT (n = 494)	25 (8)	13 (7)		1 (2)					4 (3)			30 (6.1)	
Pain score			VAS	IPE	IPE							—	—
SBTT			6	1†	1†								
LBTT			6.7	3†	3†								

*Studies with overlapping data are listed to the right of the more recent study.
**Does not separate outcomes for hemothorax and pneumothorax.
†Median; all other numbers are the mean.
IR, interventional radiology; TT, tube thoracostomy.

insertion (Delgado). It ranges from 0 "no pain" to 10 "worst pain". They did not find a difference between groups (6.0 vs. 6.7, $p = 0.237$).

Meta-Analysis

When comparing SBTT to LBTT on meta-analysis, there was no difference in failure rate (relative risk [RR], 1.1; 95% confidence interval [CI], 0.9–1.3; $I^2 = 0$, $p = 0.28$), complication rate (RR, 0.99; 95% CI, 0.95–1.04; $I^2 = 0$, $p = 0.77$), mortality (RR, 1.03; 95% CI, 1.00–1.06; $I^2 = 0.65$; $p = 0.08$), ICU LOS (effect size = −0.29; 95% CI, −0.19 to 0.13; $I^2 = 0$; $p = 0.73$), or hospital LOS (effect size = 0.02; 95% CI, −0.12 to 0.16; $I^2 = 0.83$; $p = 0.74$) (Supplemental Digital Content 2, http://links.lww.com/TA/D958, 3, http://links.lww.com/TA/D959, 4, http://links.lww.com/TA/D960, 5, http://links.lww.com/TA/D961, and 6, http://links.lww.com/TA/D962).

As on cumulative analysis, on meta-analysis SBTT had significantly higher initial drainage (effect size = 0.41; 95% CI, 0.27 to 0.55; $I^2 = 0.73$; $p < 0.001$) and less tube days (effect size = −0.55; 95% CI, −0.67 to −0.43; $I^2 = 0.95$; $p < 0.001$) compared to LBTT (Supplemental Digital Content 7, http://links.lww.com/TA/D963 and 8, http://links.lww.com/TA/D964).

DISCUSSION

The major new findings in this systematic review are that SBTT may provide better initial drainage and resultant fewer days of total drainage with similar rates of failure, complications, and mortality as compared with LBTT.

Contrary to conventional wisdom, SBTT had a significantly higher initial output than LBTT. Based on Poiseuille's law, one would expect LBTT to have a higher initial output due to the larger radius of the tube, which is the major determinant for flow rate. In fact, increasing the tube size from 14F to 28F should increase the flow to the fourth power, however this was not the case suggesting that other factors are affecting flow rates and drainage volume.[4,5] One possibility for this difference is that the pigtail catheters tend to be placed in less emergent situations and in a delayed fashion, allowing more time for fluid to accumulate. Most of the included studies placed a LBTT either emergently or within the first day, whereas most SBTT were not placed emergently and in a delayed fashion of at least a day or more. The SBTT placed in the days following admission may be placed into an already coagulated HTX which could alter the drainage time and the amount of drainage. The only RCT that reported the initial output found pigtail catheters had a significantly higher initial output than chest tubes (600 vs. 400 mL, $p = 0.005$), however the pigtail catheters were placed a median of one day later than chest tubes.[6] Another explanation is that ultrasound guidance is used for SBTT placement, allowing the tube to be placed directly in the HTX, whereas LBTT is blindly performed. Although the initial output was higher for SBTT, the one study that reported the total output showed no significant difference between the two.[21] Future studies should report the total drainage in addition to the initial drainage, as there may not be a difference. Thoracic irrigation following tube thoracostomy placement is gaining favor in the prevention of retained HTX, so future studies should include whether that was performed as it decreases tube failure rate by significantly reducing secondary intervention rate.[22–24]

We defined our primary outcome of failure rate as incompletely drained or retained HTX requiring a second intervention, however there is no clear definition of a retained HTX. Previous studies have used different modalities to diagnose them: some require a chest CT whereas others utilized a chest radiograph, ultrasound, or chest CT.[1] There is also no clear cut-off of when it can be diagnosed, but some studies use over 48 hours after thoracostomy tube placement.[1] Few of the studies included in this review included how they defined retained HTX or how they decided which secondary intervention to perform. There are several debates in the literature on management of retained HTX, including early (≤4 days) versus late (>4 days) VATS or intrapleural thrombolytic therapy vs. immediate VATS.[1] The majority of the studies in this review included the number of VATS performed, but few listed the number of other interventions performed, such as how many patients received thrombolytic therapy or when they were done. The choice of secondary intervention and when to perform it can impact outcomes, such as hospital LOS and tube days, so this may have contributed to differences between the SBTT and LBTT groups in this study.[1]

Small bore tube thoracostomy also had significantly less tube days, however this did not translate into a shorter ICU or hospital LOS for those patients. The tubes were removed on Days 4 and 6, however the patients were discharged, on average, on Days 12 and 17 for SBTT and LBTT, respectively. This is most likely secondary to other concomitant injuries that prolonged hospitalization, particularly given that the mean Injury Severity Score was 23.

One consideration for using SBTT over LBTT is that there may be less pain with insertion of SBTT. Insertion of a pigtail catheter using the Seldinger technique traumatizes less tissue during insertion compared with the cut-down technique used with chest tube insertion. Kulvatunyou et al.[6] found a significant difference in pain score, but Inaba et al.[15] did not. However, previous literature comparing pigtail catheters to chest tubes for treatment of PTX has shown patients subjectively experience less pain with insertion of pigtail catheters.[2,3] Future studies should report a pain score at insertion and while the tube is in place.

We detected no difference in overall complication rates, but SBTT had a higher rate of insertion-related complications. Small bore tube thoracostomy, such as pigtails and central venous catheters, are placed using the Seldinger technique, and there is a chance of organ injury by needle puncture, as reported in several studies.[21] Use of an ultrasound-guided technique performed by a skillful operator is necessary for lowering the rate of these complications. Both tubes have the potential to be dislodged or malpositioned into the subcutaneous tissue or an organ like the liver or lung.[4]

There were some between-group differences between patients who received SBTT versus LBTT in the majority of the studies. Patients in the SBTT group in each study were generally older and more likely to have suffered blunt trauma. In addition, two studies explicitly stated they included patients who needed emergent tube placement, but only one of them included SBTT.[14,19] In the Bauman et al[14] cohort study, only 15% of the SBTT were placed emergently compared with 64% of the LBTT. Further evidence is required to determine the appropriateness of using SBTT for drainage of HTX in the emergent setting. In addition, studies are needed to delineate the indications for the use of SBTT for patients with more severe injuries (e.g., tracheobronchial injury, tension PTX, and flail chest). Based on the outcomes of this study, it may be appropriate to use SBTT, such as a pigtail, in a select group of patients who have a HTX instead of a LBTT, with the caveat that further data are required in hemodynamically unstable patients and in those with complex thoracic injuries. Consequently, for most patients requiring emergent chest drainage for HTX, LBTT remains the standard.

There are several limitations to this study and the studies included in this systematic review. Only three of the 11 included studies are RCTs, making the other studies more susceptible to selection bias. More RCTs are needed to compare these two techniques. Several studies also included patients with PTX in addition to patients with HTX or HTPX. The outcomes from these studies could have been different if patients with a PTX were excluded. Several studies reported median and interquartile range rather than mean and SD for some of their outcomes, resulting in the need to estimate the mean and standard deviation for the meta-analysis, making this a limitation of the study. In addition, several studies only had patients in the control group, i.e., all patients in their study were classified as receiving a LBTT in our study, so only including these outcomes could have skewed the cumulative analysis. Some studies did not report all the outcomes of interest. We also excluded several studies that were written in another language due to the lack of resources to interpret them. Finally, there is a possibility we did not identify all relevant studies.

Small bore tube thoracostomy may be as effective as LBTT for the management of patients with HTX. However, more RCTs and multicenter studies are required to improve the quality of evidence necessary to create high-quality clinical practice guidelines. Future work should focus on establishing which patients with traumatic HTX can be safely managed with SBTT and which patients will continue to require LBTT. For now, we recommend considering placing a SBTT in patients who do not need it placed emergently.

AURHORSHIP

N.B.L., B.L.C., K.G.P., N.N., J.P.M. participated in the conception and study design. N.B.L., M.O.A. participated in the literature review. N.B.L., M.O.A. participated in the data acquisition. N.B.L., M.O.A., C.F.ON., W.A.R., J.M.D., M.D.C.-L., L.S., J.P.M. participated in the data analysis and interpretation. N.B.L., K.G.P., J.P.M. participated in the drafting of the article. All authors contributed to the critical revision of the article and provided final approval of the version to be published.

DISCLOSURE

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