Int J Clin Exp Med 2018;11(6):5492-5500
www.ijcem.com /ISSN:1940-5901/IJCEM0068260

Review Article

Comparison of central venous catheter drainage and conventional chest tube drainage for pneumothorax treatment: a meta-analysis

Min Han*, Chao Li*, Zheng Wang

*Department of Thoracic Surgery, Putuo Hospital, Shanghai University of Traditional Chinese Medicine, Shanghai 200062, China. *Equal contributors.*

Received May 4, 2017; Accepted March 28, 2018; Epub June 15, 2018; Published June 30, 2018

Abstract: This meta-analysis compared the effectiveness and side effects of central venous catheter (CVC) and conventional chest tube (CCT) drainage for pneumothorax treatment. Chinese- and English-language articles were mined from the Embase and PubMed online databases, the Chinese National Knowledge Infrastructure database, and Wanfang Data. Articles dated until November 2016 were included, and literature reviews were also included. The resulting studies were filtered according to several criteria, leaving a final number of 17 eligible studies, involving 1,323 pneumothorax patients. These articles were then subjected to data extraction, and quality assessment. R-3.12 software (R Foundation for Statistical Computing, Beijing, China) was used to perform the meta-analysis. The effectiveness of CVC and CCT drainage for pneumothorax was estimated using standardized mean differences (SMDs) or odds ratios (ORs) with 95% confidence intervals. The meta-analysis results showed that drainage tube removal time (SMD = -0.88, P < 0.0001), length of stay (SMD = -0.90, P = 0.0005), and complication incidence (OR = 0.13, P < 0.0001) were lower in the CVC-treated group than in the CCT-treated group. However, there were no significant differences between the CVC and CCT groups in the time taken for pulmonary reexpansion (P = 0.8452) and success rate (P = 0.2236). Quality assessments indicated that the 17 included studies were of low quality. Egger's test showed no publication bias (P > 0.05), and sensitivity analysis indicated stable results. Our study indicated that on average, CVC treatment for pneumothorax provided patients with better outcomes than did CCT treatment.

Keywords: Pneumothorax, central venous catheter, conventional chest tube, meta-analysis, publication bias, sensitivity analysis

Introduction

Pneumothorax is a condition that can induce diastasis of the lung from the chest wall through the abnormal accumulation of air in the pleural cavity [1]. Pneumothorax includes spontaneous, traumatic, and iatrogenic pneumothorax and is characterized by the sudden onset of sharp, one-sided chest pain and shortness of breath [2]. Spontaneous pneumothorax is classified into primary (occurs without an obvious cause) and secondary (occurs when lung disease exists) pneumothorax [3]. There are approximately 17-23 cases of pneumothorax per 100,000 people per year, and the incidence of pneumothorax is higher in men than in women [1, 4].

The treatment of pneumothorax involves various approaches, including early follow-up, needle decompression, central venous catheter (CVC) drainage, and conventional chest tube (CCT) drainage [5]. CCT drainage is the most common initial treatment for pneumothorax, in which a large-bore tube is usually inserted in the safe triangle area under the axilla [6]. Although CCT provides effective drainage, it can induce significant pain, operative trauma, and complications such as subcutaneous emphysema and incision infection [7, 8]. In patients with spontaneous pneumothorax, closed thoracic cavity drainage by CVC has been reported to be a convenient, effective, and safe alternative to CCT [9]. Ishibashi et al. have demonstrated that a flexible, small bore-based thoracostomy using a modified CVC induces less pain and is simpler and safer than traditional tube-based thoracostomy [10]. Contou et al. demonstrated CVC and CCT drainage to be similarly effective in treating pneumo-

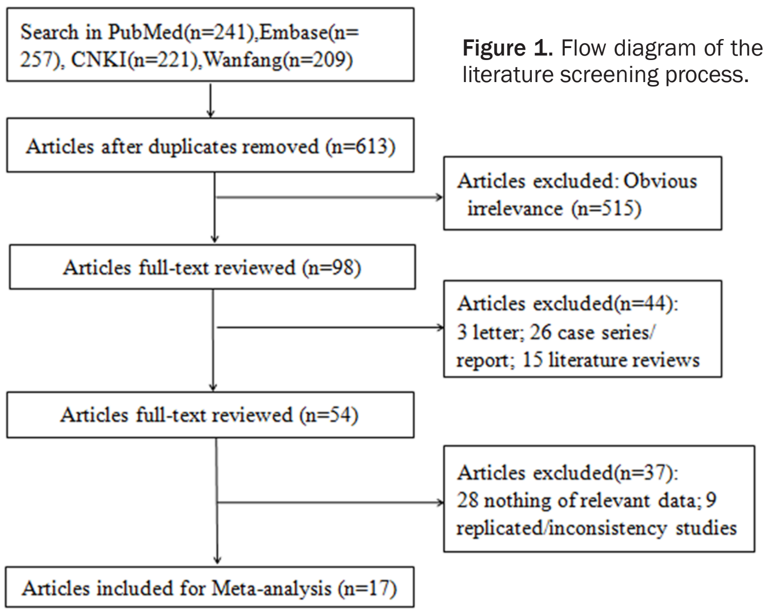


Figure 1. Flow diagram of the literature screening process.

thorax and recommended drainage via a small-bore catheter for the first-line treatment of pneumothorax [11]. However, no study to date has been rigorous enough to provide a definitive answer as to whether CVC or CCT is the superior method of treatment. To provide a theoretical basis for the improved therapy of pneumothorax, this meta-analysis was conducted to compare the curative and side effects of CVC and CCT treatments.

Materials and methods

Search strategy

We searched all Chinese- and English-language articles on the Embase (http://www.embase.com) and PubMed (http://www.ncbi.nlm.nih.gov/pubmed) online databases, the Chinese National Knowledge Infrastructure database (http://www.caul.edu.au/caul-programs/ceirc/publishers/cnki), and from Wanfang Data (http://www.wanfangdata.com.cn/index.html). All articles dated until November 2016 were mined using the following search query: (pneumothorax or aerothorax) AND ("central venous cannulation" OR CVC OR "central venous catheter" OR "voie veineuse centrale"). Literature review articles were also initially included to identify relevant studies that were not found by the search query.

Inclusion and exclusion criteria

All studies conforming to the following criteria were included: (1) The article was a published clinical research study involving both CVC and CCT drainage treatments; (2) The number of patients in the CVC and CCT groups were provided or could be calculated; and (3) At least one of the key treatment outcomes [i.e., drainage tube removal time (DTRT), length of stay, time of pulmonary reexpansion (TPR), complication incidence, and treatment success rate] was provided or could be calculated. All reviews, comments, reports, or letters were excluded.

Data extraction and quality assessment

Two reviewers independently extracted the following data from the included studies: published year, dates over which research data were collected, name of the first author, research area, number of patients in the experimental and control groups, demographic characteristics (including gender proportion, age composition, and the number of patients with spontaneous pneumothorax), as well as treatment outcomes such as DTRT, length of stay, TPR, complications, and treatment success. A quality assessment of the included studies was performed using the Newcastle-Ottawa Scale (NOS), which is suitable for cohort studies [12]. Any discrepancy between the two datasets was resolved by a third independent reviewer.

Statistical analysis

R-3.12 software (http://www.R-project.org; R Foundation for Statistical Computing, Beijing, China) was used to perform the meta-analysis. Standardized mean differences (SMDs) or odds ratios (ORs) and their associated 95% confidence intervals (95% CIs) were used to compare the effectiveness of CVC and CCT drainage for the treatment of pneumothorax. The Q-test [13] and I^2-statistic [14] were applied to detect any heterogeneity in the included studies. For heterogeneous datasets, the DerSimonian-Laird random-effects model was used to calculate the pooled data ($P < 0.05$, $I^2 > 50\%$). For homogeneous datasets, the Mantel-Haenszel fixed-effects model was used to pool the data ($P \geq 0.05$, $I^2 \leq 50\%$) [15]. In addition, subgroup analysis was performed according to

Table 1. Characteristics of the included studies

Author	Publication year	Study location	Study Year	NOS	Modified Jadad scores	Group	n	Age, y	M/F	SP	DTRT	Length of stay	Time of pulmonary reexpansion	Complication	Success
Contou D	2012	France	2003-2010	6	3	CVC	112	38 ± 19	NA	71	3.3 ± 1.9	4.5 ± 3.2	NA	NA	92
						CCT	100	42 ± 21	NA	46	4.6 ± 2.6	5.5 ± 3.0	NA	NA	79
Chen Y	2015	China	2010.1-2013.12	5	2	CVC	145	39.3 ± 8.7	197/69	19	3.3 ± 1.8	4.6 ± 2.6	NA	4	124
						CCT	131				4.5 ± 2.4	5.4 ± 3.4	NA	12	104
Cong JH	2015	China	2012.1-2015.6	4	2	CVC	40	16.23 ± 3.05	NA	40	2.36 ± 1.44	4.22 ± 1.23	NA	4	32
						CCT	40	15.65 ± 2.55	NA	40	4.54 ± 1.71	8.23 ± 1.71	NA	10	31
Liu JH	2009	China	2006.3-2008.12	3	2	CVC	18	18-76	13/5	18	3.65 ± 1.15	6.75 ± 1.49	2.65 ± 1.25	0	17
						CCT	16	17-69	12/4	16	5.60 ± 1.21	9.85 ± 1.24	4.90 ± 1.21	15	14
Liang CX	2009	China	2005.1-2008.3	2	1	CVC	62	15-70	58/4	48	NA	NA	4.0 ± 1.8	8*	57
						CCT	22	18-70	20/2	11	NA	NA	4.7 ± 1.0	13*	20
Jiao ZG	2007	China	2004.2-2006.5	5	2	CVC	24	4-4.87 ± 18.72	NA	24	3.45 ± 1.32	8.10 ± 4.49	NA	NA	NA
						CCT	27	43.30 ± 18.07	NA	27	5.65 ± 3.57	9.65 ± 5.43	NA	NA	NA
Xu P	2007	China	2004.10-2006.10	4	2	CVC	30	16-77	21/9	13	NA	7.65 ± 1.49	5.00 ± 1.50	2*	28
						CCT	27	20-68	19/8	15	NA	9.75 ± 1.14	4.54 ± 1.31	16*	26
Wang XZ	2012	China	2005.1-2010.12	2	1	CVC	32	17-78	28/4	25	NA	NA	5.0 ± 1.5	3*	29
						CCT	32	16-75	29/3	23	NA	NA	4.8 ± 1.1	15*	30
Wei L	2008	China	2001.3-2007.5	4	2	CVC	52	17-73	24/18	52	NA	NA	5.01 ± 1.5	NA	47
						CCT	47	18-69	31/16	47	NA	NA	4.8 ± 1.0	NA	43
Chen HD	2005	China	NA	2	1	CVC	15	M: 66.7	10/5	15	NA	10.31 ± 4.25	5.54 ± 3.43	1	NA
						CCT	16	M: 67.4	9/7	16	NA	9.62 ± 3.98	5.27 ± 3.17	3	NA
Wu SL	2012	China	2007.1-2011.12	5	2	CVC	32	17-41	29/3	32	NA	NA	NA	0	30
						CCT	32	16-42	30/2	32	NA	NA	NA	2	29
Chen QL	2009	China	2007.1-2011.12	2	1	CVC	23	17-72	19/4	13	NA	NA	NA	0	19
						CCT	23	16-70	17/6	12	NA	NA	NA	5	15
Wan QY	2007	China	2004.3-2005.5	3	2	CVC	22	50.5 ± 18.7	18/4	22	NA	7.3 ± 2.8	5.0 ± 2.5	0	20
						CCT	22	51.7 ± 18.2	16/6	22	NA	9.4 ± 3.0	4.8 ± 2.0	8	19
Jin XW	2013	China	2004.5-2013.2	5	2	CVC	42	57 ± 3.14	38/4	0	NA	7.2 ± 1.2	4.2 ± 1.7	1	38
						CCT	33	55 ± 2.14	30/3	0	NA	9.8 ± 2.3	3.8 ± 1.1	4	31
Wang XH	2009	China	2004.1-2007.6	4	2	CVC	11	23-80	8/3	NA	NA	NA	NA	0	NA
						CCT	17	21-75	13/4	NA	NA	NA	NA	2	NA
Wu HJ	2005	China	2001.4-2003.6	3	2	CVC	25	16-70	18/7	NA	NA	NA	5.0 ± 1.5	2	22
						CCT	28	18-70	20/8	NA	NA	NA	4.7 ± 1.0	10	26
Ye H	2003	China	1999-2001	2	1	CVC	11	32.9 ± 10.7	7/4	11	NA	10.31 ± 4.25	5.54 ± 3.43	NA	NA
						CCT	14	30.8 ± 12.6	11/3	14	NA	9.62 ± 3.98	5.27 ± 3.17	NA	NA

CVC, central venous catheter; CCT, conventional chest tube; SP, spontaneous pneumothorax; *, subcutaneous emphysema; DTRT, drainage tube removal time; NOS, Newcastle-Ottawa Scale; M/F, male/female; y, years.

Table 2. Meta-analysis results for DTRT, length of stay, TPR, complication incidence, and treatment success rate

Type	Total study individuals		Test of association			Model	Test of heterogeneity[a,b]			Egger's test[c]	
	CVC	CCT	SMD/OR (95% CI)	Z	P		Q	P	I^2 (%)	t	P
DTRT	339	314	-0.8819 [-1.2276; -0.5362]	5.00	< 0.0001	Random	14.32	0.0063	72.1	2.8717	0.06396
Length of stay	459	426	-0.8965 [-1.4012; -0.3918]	3.48	0.0005	Random	98.26	< 0.0001	90.8	1.6316	0.1414
TPR	309	257	-0.0297 [-0.3274; 0.2681]	0.20	0.8452	Random	26.09	0.0020	65.5	1.608	0.1465
Complication	497	439	0.1300 [0.0819; 0.2065]	8.64	< 0.0001	Fixed	12.64	0.3958	5.1	0.13262	0.8969
Success	617	537	1.2330 [0.8800; 1.7274]	1.22	0.2236	Fixed	4.07	0.9678	0	1.8432	0.09511

DTRT, drainage tube removal time; TPR, time of pulmonary reexpansion; CVC, central venous catheter; CCT, conventional chest tube; [a]A random-effects model was used when the *P* value for the heterogeneity test was < 0.05, otherwise the fixed-effect model was used. [b]P < 0.05 is considered statistically significant for Q statistics. [c]Egger's test was used to evaluate publication bias, P < 0.05 is considered statistically significant. SMD, standardized mean difference; OR, odds ratio; CI, confidence interval.

the study type. Publication bias was also evaluated using Egger's test [16]. Where publication bias was present, the trim and fill method was used for recalculation, followed by a comparison of the adjusted effect indicators with their previous values [17]. To perform sensitivity analysis, one study at a time was excluded from the dataset and the resulting impact on the pooled data was examined.

Results

Eligible studies

A flow diagram of the literature screening process is shown in **Figure 1**. Using the described search strategy, 928 studies were selected, of which, 315 were excluded because they represented repeat studies; thus, the remaining 613 studies were included. Browsing the article titles and abstracts filtered out a further 515 studies based on an obvious lack of relevance. The remaining 98 studies were then filtered further to remove 15 reviews, three letters, 26 case series, and 28 other studies that could not provide relevant data. A final number of 17 eligible studies were finally included in the meta-analysis [11, 18-33].

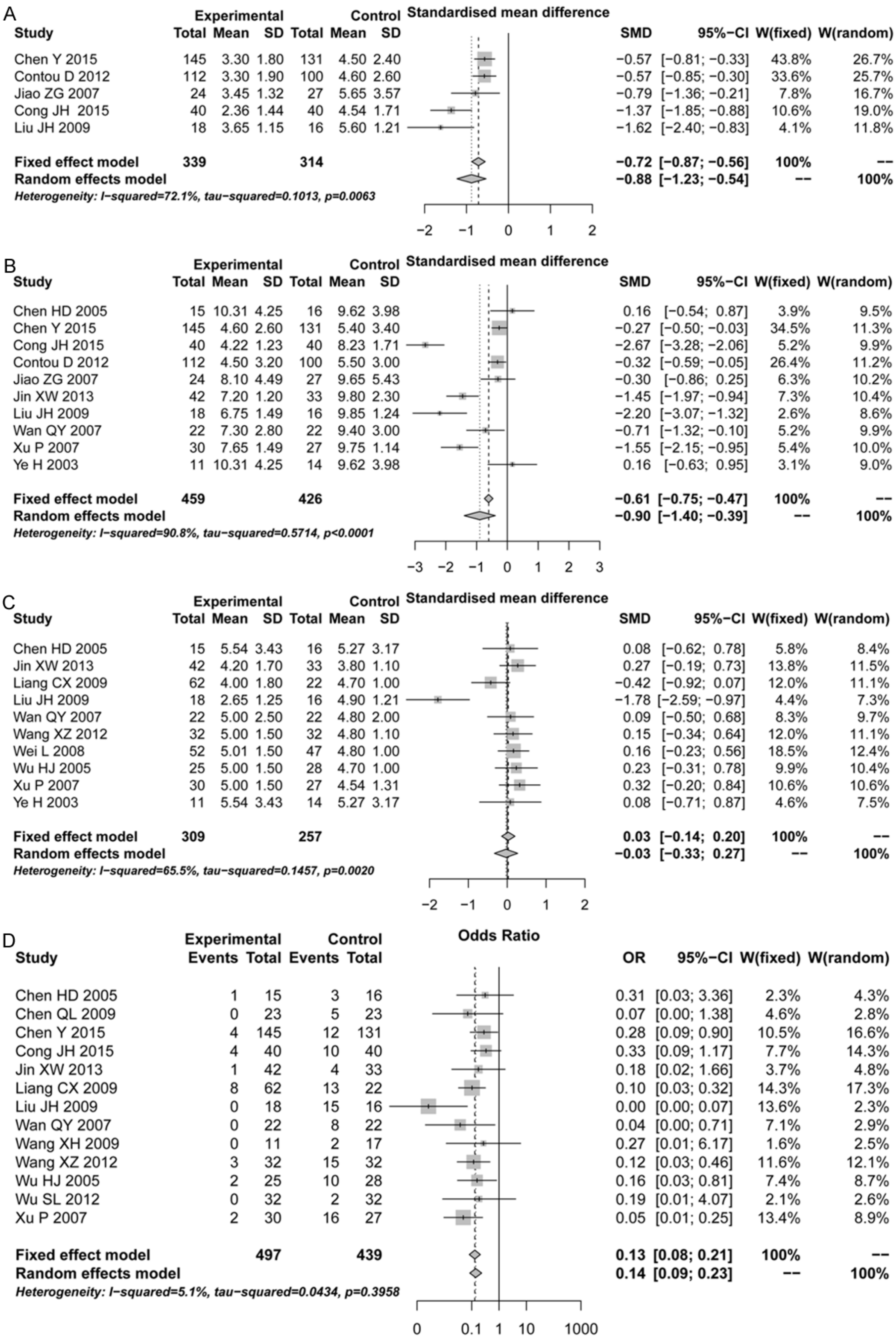
The characteristics of the 17 included studies are listed in **Table 1**. These studies involved a total of 1,323 pneumothorax patients, including 696 patients in the CVC treatment group and 627 in the CCT treatment group. All studies were cohort studies (including retrospective and prospective cohort studies), with a publication year between 2003 and 2015 and the year of data collection between 1999 and 2015. Geographical areas covered by these studies were France and China. The gender proportion overall was unbalanced, and there were more men than women. The age composition of patients greatly varied between the studies, but there was no significant age difference between the two groups overall. Spontaneous pneumothorax accounted for the largest proportion of cases, with some studies only reporting on spontaneous pneumothorax. Meta-analysis was also performed for the following treatment outcomes: DTRT, length of stay, TPR, complication incidence, and treatment success rate. The quality assessment scores for studies ranged from 2 to 6, indicating a low quality overall (scores < 6 represent low quality).

Meta-analysis

Significant heterogeneity ($P < 0.05$, $I^2 > 50\%$) was present; thus, the random-effects model was used to calculate the pooled data for DTRT [SMD = -0.88, 95% CI: (-1.23; -0.54)], length of stay [SMD = -0.90, 95% CI: (-1.40; -0.39)], and TPR [SMD = -0.03, 95% CI: (-0.33; 0.27)]. Homogeneous results were also obtained ($P \geq 0.05$, $I^2 \leq 50\%$); thus, the fixed-effects model was used to pool these data for complication incidence [OR = 0.13, 95% CI: (0.08; 0.21)] and success rate [OR = 1.23, 95% CI: (0.88; 1.73)]. Meta-analysis showed significant differences between the CVC and CCT treatment groups for DTRT (P < 0.0001), length of stay (P = 0.0005), and complication incidence (P < 0.0001) indexes, will all three parameters being lower for the CVC group than for the CCT group. However, no significant differences were observed for TPR (P = 0.8452) and treatment success rates (P = 0.2236) (**Table 2**; **Figure 2**).

Publication bias and sensitivity analysis

Egger's test showed no publication bias among the included studies (P > 0.05), suggest-


A
Experimental Control Standardised mean difference
Study Total Mean SD Total Mean SD SMD 95%−CI W(fixed) W(random)
Chen Y 2015 145 3.30 1.80 131 4.50 2.40 −0.57 [−0.81; −0.33] 43.8% 26.7%
Contou D 2012 112 3.30 1.90 100 4.60 2.60 −0.57 [−0.85; −0.30] 33.6% 25.7%
Jiao ZG 2007 24 3.45 1.32 27 5.65 3.57 −0.79 [−1.36; −0.21] 7.8% 16.7%
Cong JH 2015 40 2.36 1.44 40 4.54 1.71 −1.37 [−1.85; −0.88] 10.6% 19.0%
Liu JH 2009 18 3.65 1.15 16 5.60 1.21 −1.62 [−2.40; −0.83] 4.1% 11.8%
Fixed effect model 339 314 −0.72 [−0.87; −0.56] 100% --
Random effects model −0.88 [−1.23; −0.54] -- 100%
Heterogeneity: I−squared=72.1%, tau−squared=0.1013, p=0.0063
−2 −1 0 1 2
B
Experimental Control Standardised mean difference
Study Total Mean SD Total Mean SD SMD 95%−CI W(fixed) W(random)
Chen HD 2005 15 10.31 4.25 16 9.62 3.98 0.16 [−0.54; 0.87] 3.9% 9.5%
Chen Y 2015 145 4.60 2.60 131 5.40 3.40 −0.27 [−0.50; −0.03] 34.5% 11.3%
Cong JH 2015 40 4.22 1.23 40 8.23 1.71 −2.67 [−3.28; −2.06] 5.2% 9.9%
Contou D 2012 112 4.50 3.20 100 5.50 3.00 −0.32 [−0.59; −0.05] 26.4% 11.2%
Jiao ZG 2007 24 8.10 4.49 27 9.65 5.43 −0.30 [−0.86; 0.25] 6.3% 10.2%
Jin XW 2013 42 7.20 1.20 33 9.80 2.30 −1.45 [−1.97; −0.94] 7.3% 10.4%
Liu JH 2009 18 6.75 1.49 16 9.85 1.24 −2.20 [−3.07; −1.32] 2.6% 8.6%
Wan QY 2007 22 7.30 2.80 22 9.40 3.00 −0.71 [−1.32; −0.10] 5.2% 9.9%
Xu P 2007 30 7.65 1.49 27 9.75 1.14 −1.55 [−2.15; −0.95] 5.4% 10.0%
Ye H 2003 11 10.31 4.25 14 9.62 3.98 0.16 [−0.63; 0.95] 3.1% 9.0%
Fixed effect model 459 426 −0.61 [−0.75; −0.47] 100% --
Random effects model −0.90 [−1.40; −0.39] -- 100%
Heterogeneity: I−squared=90.8%, tau−squared=0.5714, p<0.0001
−3 −2 −1 0 1 2 3
C
Experimental Control Standardised mean difference
Study Total Mean SD Total Mean SD SMD 95%−CI W(fixed) W(random)
Chen HD 2005 15 5.54 3.43 16 5.27 3.17 0.08 [−0.62; 0.78] 5.8% 8.4%
Jin XW 2013 42 4.20 1.70 33 3.80 1.10 0.27 [−0.19; 0.73] 13.8% 11.5%
Liang CX 2009 62 4.00 1.80 22 4.70 1.00 −0.42 [−0.92; 0.07] 12.0% 11.1%
Liu JH 2009 18 2.65 1.25 16 4.90 1.21 −1.78 [−2.59; −0.97] 4.4% 7.3%
Wan QY 2007 22 5.00 2.50 22 4.80 2.00 0.09 [−0.50; 0.68] 8.3% 9.7%
Wang XZ 2012 32 5.00 1.50 32 4.80 1.10 0.15 [−0.34; 0.64] 12.0% 11.1%
Wei L 2008 52 5.01 1.50 47 4.80 1.00 0.16 [−0.23; 0.56] 18.5% 12.4%
Wu HJ 2005 25 5.00 1.50 28 4.70 1.00 0.23 [−0.31; 0.78] 9.9% 10.4%
Xu P 2007 30 5.00 1.50 27 4.54 1.31 0.32 [−0.20; 0.84] 10.6% 10.6%
Ye H 2003 11 5.54 3.43 14 5.27 3.17 0.08 [−0.71; 0.87] 4.6% 7.5%
Fixed effect model 309 257 0.03 [−0.14; 0.20] 100% --
Random effects model −0.03 [−0.33; 0.27] -- 100%
Heterogeneity: I−squared=65.5%, tau−squared=0.1457, p=0.0020
−2 −1 0 1 2
D
Experimental Control Odds Ratio
Study Events Total Events Total OR 95%−CI W(fixed) W(random)
Chen HD 2005 1 15 3 16 0.31 [0.03; 3.36] 2.3% 4.3%
Chen QL 2009 0 23 5 23 0.07 [0.00; 1.38] 4.6% 2.8%
Chen Y 2015 4 145 12 131 0.28 [0.09; 0.90] 10.5% 16.6%
Cong JH 2015 4 40 10 40 0.33 [0.09; 1.17] 7.7% 14.3%
Jin XW 2013 1 42 4 33 0.18 [0.02; 1.66] 3.7% 4.8%
Liang CX 2009 8 62 13 22 0.10 [0.03; 0.32] 14.3% 17.3%
Liu JH 2009 0 18 15 16 0.00 [0.00; 0.07] 13.6% 2.3%
Wan QY 2007 0 22 8 22 0.04 [0.00; 0.71] 7.1% 2.9%
Wang XH 2009 0 11 2 17 0.27 [0.01; 6.17] 1.6% 2.5%
Wang XZ 2012 3 32 15 32 0.12 [0.03; 0.46] 11.6% 12.1%
Wu HJ 2005 2 25 10 28 0.16 [0.03; 0.81] 7.4% 8.7%
Wu SL 2012 0 32 2 32 0.19 [0.01; 4.07] 2.1% 2.6%
Xu P 2007 2 30 16 27 0.05 [0.01; 0.25] 13.4% 8.9%
Fixed effect model 497 439 0.13 [0.08; 0.21] 100% --
Random effects model 0.14 [0.09; 0.23] -- 100%
Heterogeneity: I−squared=5.1%, tau−squared=0.0434, p=0.3958
0 0.1 1 10 1000

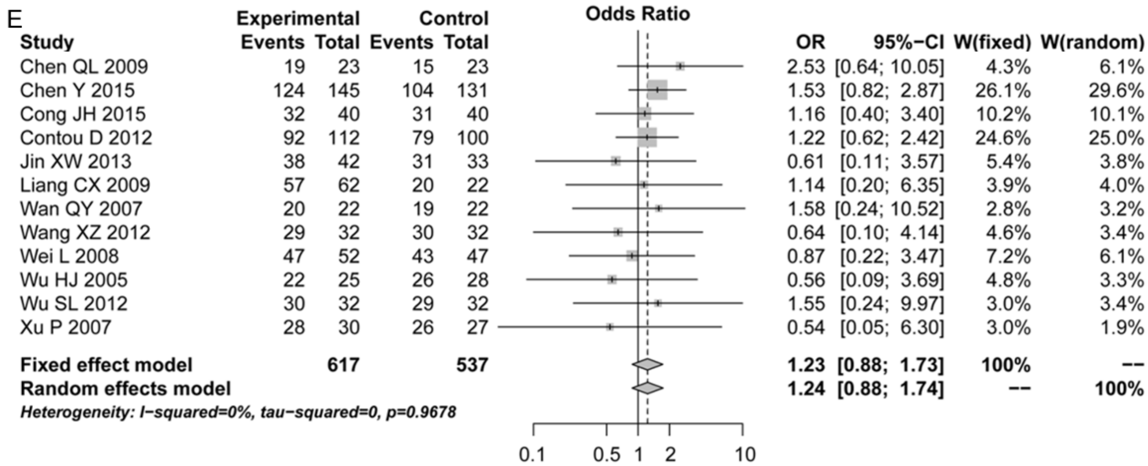
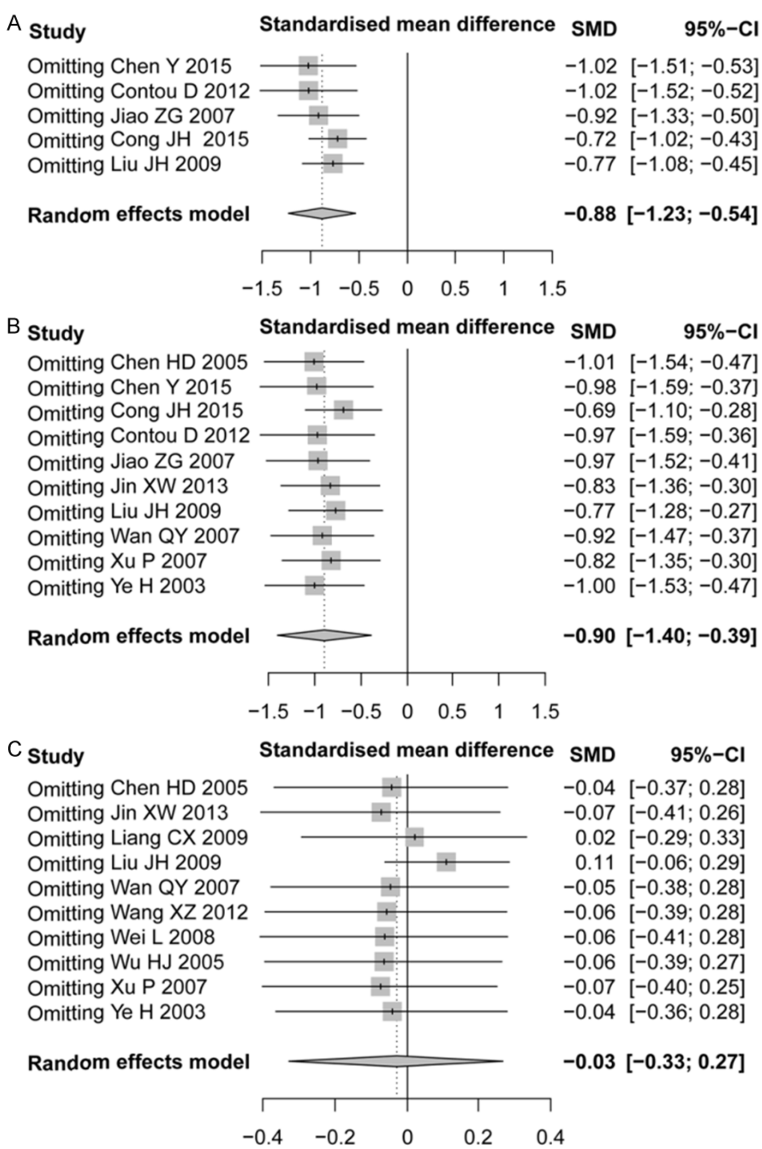


Figure 2. Forest plots of the meta-analysis of various treatment outcomes. DTRT (A), length of stay (B), TPR (C), complication incidence (D), and treatment success rate (E). DTRT, drainage tube removal time; TPR, time of pulmonary reexpansion; SD, standard deviation; SMD, standardized mean difference; OR, odds ratio; CI, confidence interval.



ing that the results were reliable (**Table 2**). Sensitivity analysis demonstrated that pooled ORs or SMDs for DTRT, length of stay, TPR, complication incidence, and success rates did not reverse following the exclusion of any study from the dataset, indicating that our results were stable (**Figure 3**).

Discussion

In the present meta-analysis, 17 eligible studies, involving 1,323 pneumothorax patients, were included. Meta-analysis showed that DTRT, length of stay, and complication incidence were lower for the CVC treatment group than for the CCT treatment group. However, no significant differences were observed for TPR and treatment success rates. Egger's test showed no publication bias among the included studies. Sensitivity analysis showed that pooled data for all indexes did not reverse, indicating that our results were stable.

Among the included studies, several concluded that CVC

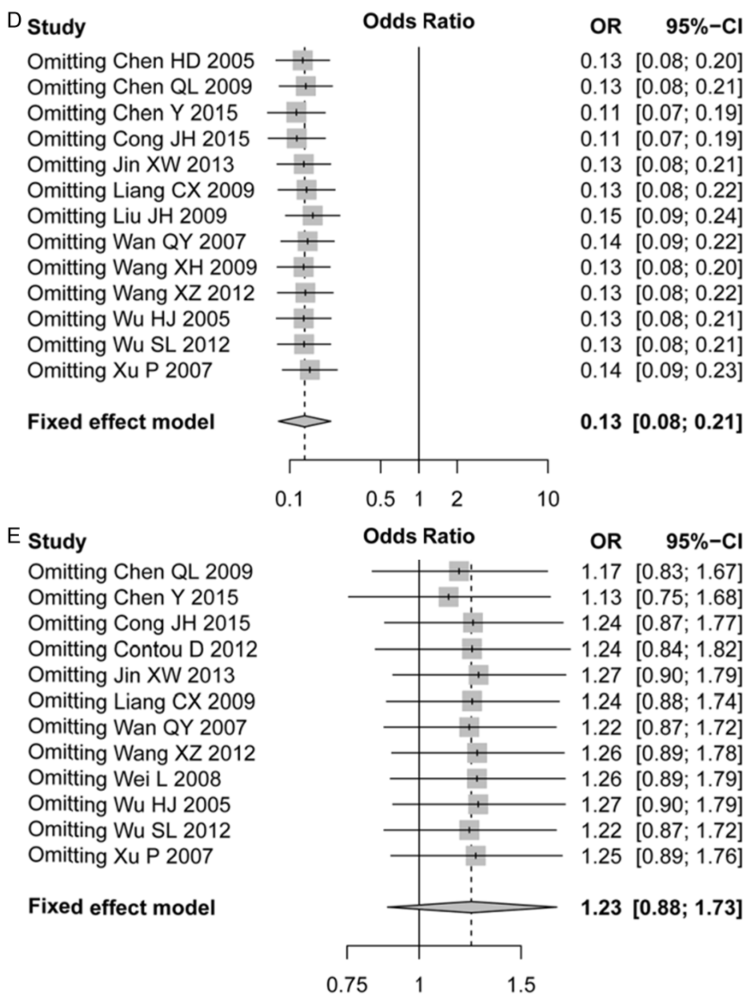


Figure 3. Forest plots of the sensitivity analysis data. Pooled results for DTRT (A), length of stay (B), TPR (C), complication incidence (D), and treatment success rate (E) did not reverse when any one study was excluded from the original dataset. DTRT, drainage tube removal time; TPR, time of pulmonary reexpansion; SMD, standardized mean difference; OR, odds ratio; CI, confidence interval.

drainage offers a higher success rate, less trauma, and lower complication incidence and medical costs than CCT drainage [22, 25, 28]. Chen et al. have demonstrated similar success rates of CVC and CCT for the treatment of pneumothorax; however, CVC shortens DTRT and length of stay and significantly decreases complication incidence [32]. Cong has found similar therapeutic effects of CVC and CCT drainage; however, CVC offers the advantages of convenient manipulation, little trauma, short indwelling time, and fewer complications [21]. Jin et al. have recommended CVC for the treatment of pneumothorax because it is safe and effective, provides quick recovery, and results in fewer complications [30]. Wang et al. have also recommended the application of CVC drainage for pneumothorax because it is simpler, can be repeatedly used, has a controllable extraction speed, results in less bleeding and trauma, and is very effective [29]. The current meta-analysis was critical for the overall quantitative assessment of various curative and side effects of CVC and CCT treatments.

Quality assessments for the included studies showed that they were of low quality. However, the purpose of this study was to analyze the effectiveness of CVC, which is a relatively new treatment approach, for the treatment of pneumothorax to provide a thorough comparison for its use in clinical practice. However, despite the utility of our results, further more statistically robust studies should be conducted. There were significant heterogeneities observed for DTRT, length of stay, and TPR; thus, the random-effects model had to be used in our analysis. These heterogeneities might derive from differences in the detection methods and units of measure used across the studies, ethnic and geographic differences in the study populations, and differing sociodemographic factors. This study focused on using meta-analysis to compare the curative and side effects of CVC and CCT drainage for pneumothorax. Several limitations of this study should be taken into consideration. First, several unknown sources of heterogeneity may have influenced the results of our meta-analysis. Second, the included studies had incomplete demographic data; therefore, subgroup analysis could not be performed. Third, the included studies were of low quality. In addition, the majority of the included studies were mined from the Chinese literature, which may have resulted in publication bias. Despite these limitations, our results appear to be stable and reliable on the basis of rigorous statistical analysis.

In conclusion, our results suggest greater curative effects of CVC than of CCT for the treatment of pneumothorax. However, more rigorous clinical studies are needed to confirm our findings.

Disclosure of conflict of interest

None.

Address correspondence to: Zheng Wang, Department of Thoracic Surgery, Putuo Hospital, Shanghai University of Traditional Chinese Medicine, 164 Lanxi Road, Shanghai 200062, China. Tel: +86-21-22233222-21705; E-mail: zhehuan27heicang@163.com

References

[1] Bintcliffe O and Maskell N. Spontaneous pneumothorax. BMJ 2014; 348: g2928.
[2] Van GV and Dieu HL. Clinical and paraclinical symptoms of primary spontaneous pneumothorax. 2016.
[3] Lyra Rde M. Etiology of primary spontaneous pneumothorax. J Bras Pneumol 2016; 42: 222-226.
[4] Chen L and Zhang Z. Bedside ultrasonography for diagnosis of pneumothorax. Quant Imaging Med Surg 2015; 5: 618-623.
[5] MacDuff A, Arnold A, Harvey J; BTS Pleural Disease Guideline Group. Management of spontaneous pneumothorax: british thoracic society pleural disease guideline 2010. Thorax 2010; 65 Suppl 2: ii18-31.
[6] Keel M and Meier C. Chest injuries-what is new? Curr Opin Crit Care 2007; 13: 674-679.
[7] Ball CG, Lord J, Laupland KB, Gmora S, Mulloy RH, Ng AK, Schieman C and Kirkpatrick AW. Chest tube complications: how well are we training our residents? Can J Surg 2007; 50: 450-8.
[8] Kesieme EB, Dongo A, Ezemba N, Irekpita E, Jebbin N and Kesieme C. Tube thoracostomy: complications and its management. Pulm Med 2012; 2012: 256878.
[9] Ma TR and Shao HS. The clinical application of thoracic cavity closed drainage therapy spontaneous pneumothorax by central venous catheter (46 pou). Chinese Journal of Medicinal Guide 2012.
[10] Ishibashi H, Ohta S and Hirose M. Modified central venous catheter for pneumothorax. Gen Thorac Cardiovasc Surg 2008; 56: 309-310.
[11] Contou D, Razazi K, Katsahian S, Maitre B, Mekontso-Dessap A, Brun-Buisson C and Thille AW. Small-bore catheter versus chest tube drainage for pneumothorax. Am J Emerg Med 2012; 30: 1407-1413.
[12] Weizhi W, Xiaoyu Z, Chen S, Xiaofei Z, Baolin W and Zekuan X. Newcastle-ottawa quality assessment scale*. 2014.
[13] Lau J, Ioannidis JP and Schmid CH. Quantitative synthesis in systematic reviews. Ann Intern Med 1997; 127: 820-826.
[14] Higgins J, Thompson SG, Deeks JJ and Altman DG. Measuring inconsistency in meta-analyses. BMJ 2003; 327: 557-560.
[15] Feng RN, Zhao C, Sun CH, Li Y. Meta-analysis of TNF 308 G/A polymorphism and type 2 diabetes mellitus. PLoS One 2011; 6: e18480.
[16] Egger M, Smith GD and Phillips AN. Meta-analysis: principles and procedures. BMJ 1997; 315: 1533-1537.
[17] Duval S and Tweedie R. Trim and fill: a simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. Biometrics 2000; 56: 455-463.
[18] L C, C Z and W X. Modified central venous catheter in treatment of spontaneous pneumothorax patients. Modem Journal of Integrated Traditional Chinese and Western Medicine 2009; 18: 637-638.
[19] H Y, XD Y and GZ L. Clinical observation of treating spontaneous pneumothorax of 14 cases through thoracic drainage of the central vein catheter. Guizhou Medical Journal 2003; 27: 234-235.
[20] HJ W. Clinical analysis of treating spontaneous pneumothorax through thoracic drainage of the central vein catheter. Journal of Clinical Pulmonary Medicine 2005; 10: 594-595.
[21] JH C. Clinical observation of single cavity side hole central venous catheter in treatment of teenagers spontaneous pneumothorax of 40 patients. Journal of Nantong University (Medical Science) 2015; 35: 604-605.
[22] JH L. Modified central venous catheter by thoracic close drainage in treatment of spontaneous pneumothorax of 18 patients. Zhejiang JITCWM 2010; 20: 288-289.
[23] L W, GS W and XM P. Application of using central venous catheter in treating patients with pneumothorax(with 52 cases). J Huaihai Med 2008; 26: 35-36.
[24] P X, CY X and XJ L. Clinical analysis of treating spontaneous pneumothorax through thoracic close drainage of the central venous catheter. Prac Clin Med 2007; 8: 22-24.
[25] QL C and CW C. Clinical observation of spontaneous pneumothorax through thoracic drain-

age of the central vein catheter. Chin Comm Doc 2009; 11: 68-69.
[26] QY W and CM S. Central venous catheter by pleural closed drainage treatment of spontaneous pneumothorax. Zhejiang Clinical Medical Journal 2007; 9: 34.
[27] SL W, JM Y and XW Z. Clinical application of central venous catheter in treatment of spontaneous pneumothorax patients. Medical Frontier 2012; 2: 309-310.
[28] XD C. Cost-benefit analysis of treating spontaneous pneumothorax through thoracic drainage of the central vein catheter. Medical Economics 2005; 36: 69-70.
[29] XH W, F Z and YR H. Clinical analysis of effect of using central venous catheter indwelling by skin in treating patients with pneumothorax. Journal of Clinical Pulmonary Medicine 2009; 14: 1605-1606.
[30] XW J and TX W. Effect analysis of small joint pressure suction catheter chest drainage treatment curative of secondary pneumothorax. Modem Practical Medicine 2013; 25: 1665-1366.
[31] XZ W. Clinical observation of central venous catheter in treatment of spontaneous pneumothorax patients. Journal of Clinical Pulmonary Medicine 2012; 17: 214-215.
[32] Y C and HX D. Efficacy comparison on different thoracic drainage tube in the treatment of pneumothorax. China Modern Medicine 2015; 22: 32-34.
[33] ZG J, BY S and JX W. Two kinds of effect of chest drainage tube closed drainage for spontaneous pneumothorax. Shandong Medical Journal 2007; 47: 71.