

Office of Evidence Based Practice (EBP) – Critically Appraised Topic: Chest Tube Clearance

Specific Care Question In pediatric patients with chest tubes (mediastinal tube and pleural tube), should nursing staff regularly clear (stripping, milking) chest tubes.

Question Originator Tiffany Mullen, MSN, RN, ACCNS-P, CCRN

Literature Summary

Background. Chest tubes are placed to evacuate air, blood or exudate from the thoracic cavities. Drainage tubes must remain clear and open to allow the flow of collected fluid (Wallen et al., 2004). Children’s Mercy has adopted Elsevier Clinical Skills on Chest Tube Care which states “Stripping or milking pleural chest tubes can cause large fluctuations in intrathoracic pressure, resulting in negative pressure as low as -450 cm H₂O and should be used with caution” (Chest Tube Care, 2018). Traditionally, manipulation methods have been used to keep these tubes clear. Milking, stripping, and fanfolding are the historic manipulation techniques used. The American Association of Critical-Care Nurses reports that stripping chest tubes may significantly increase negative intrathoracic pressures that could cause harm (Halm, 2007). Also, Up-To-Date reports that chest tubes can be stripped if they are no longer draining or there is suspicion that it is full of clots or debris but this should only be performed by an experienced clinician who placed or manages the tube (Huggins & Carr, 2018).

Study characteristics. The search for suitable studies was completed on July 30th, 2018. Ms. Mullen MSN, RN, ACCNS-P, CCRN reviewed the 107 titles and abstracts found in the search and identified 11 article believed to answer the question. Two systematic reviews were identified but included the same three studies (Isaacson, George, & Brewer, 1986; Lim-Levy, Babler, De Groot-Kosolcharoen, Kosolcharoen, & Kroncke, 1986; Pierce, Piazza, & Naftel, 1991). One systematic review (Day, Perring, & Gofton, 2008) included an additional case series by Duncan & Erickson (1982). After an in-depth review five primary research articles answered the question, three from the systematic reviews and two newer studies (Dango, Siemel, Passlick, and Stremmel, 2010; Oaks et al., 1993). A meta-analysis was not done due to differing comparisons and outcomes among the studies.

Key results. There are insufficient studies which compare different methods of chest drain clearance to support or refute the relative efficacy of the various methods. The need to manipulate chest drains can be neither supported nor refuted.

Summary

The summary is not organized by outcome due to the heterogeneity of outcomes reported by the different studies.

Systematic reviews by Wallen et al. (2004) and Day et al. (2008) included the same three randomized control trials that answered the question of clearing chest tubes (Isaacson et al., 1986; Lim-Levy et al., 1986; Pierce et al., 1991). The three studies in the two systematic reviews compared the efficacy of different methods of mediastinal tube clearance in adult cardiac patients. Wallen et al. (2004) reported there was insufficient evidence to recommend one type of drain manipulation practice over another, or to support or refute the need for drain manipulation. Day et al. (2008) did not recommend manipulation of mediastinal chest drains due to lack of demonstrable benefit. Wallen et al. (2004) reported Pierce et al. (1991) as having low risk bias, Lim-Levy et al. (1986) as having moderate risk of bias due to a dropout rate of 18.3%, and Isaacson et al. (1986) as having moderate risk of bias due to unclear blinding and allocation.

A synopsis of the three included trials follow:

- Isaacson et al. (1986) studied 211 adult cardiac patients, comparing fanfolding to stripping with the outcomes of measured drainage volume and mortality. There was no significant difference in drainage between the two techniques studied. Isaacson et al. (1986) did not report the results of the tests for significance for drainage difference and the mortality rate ($n = 3$) by group.
- Lim-Levy et al. (1986) randomized adult male cardiac patients to received milking ($n = 16$), stripping ($n = 18$), or no manipulation ($n = 15$). There was no incidence of mediastinal tube blockage in either of the three groups and mean total drainage volume was not significantly different, $p = .4597$.



If you have questions regarding this Specific Care Question – please contact jmichael@cmh.edu or tamullen@cmh.edu

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- Pierce et al. (1991) studied 200 adult cardiac patients, comparing milking to stripping with the outcomes of total volume drainage, manipulation events, incidence of tamponade, and surgical re-entry. The found no significant differences between the two methods, $p > 0.5$.

Dango, Sienel, Passlick, and Stremmel (2010) examined 124 adult patients with chest tubes post thoracotomy. Patients were randomized based on odd and even days to either have their chest tube milked ($n = 64$) or to have their chest tube observed ($n = 60$). There was a significant increase of postoperative pleural effusion drainage in the milking group at 48 hours after surgery ($p = .004$) but there was no difference in morbidity or mortality. The 30-day mortality rate was 1.4% in each group ($p = .99$) and 30-day morbidity was 49.3% in the milking group and 52.8% in the observation group ($p = .67$). There was overall moderate risk of bias due to the odd/even randomization and lack of allocation concealment.

Oakes et al. (1993) examined 16 pediatric oncology patients with chest tubes. Following thoracotomy, patients were assigned to have their chest tubes stripped ($n = 8$) or observed ($n = 8$). The two groups did not differ significantly in the frequency of pain, incidence of fever, breath sounds, or radiographic findings across measurement points. The author did not provide p -values for these outcomes. There was overall high risk of bias as study assignment was performed by the first author and the small sample size of the study.

Search Strategy and Results ([see PRISMA diagram](#))

(Milking OR milk OR Stripping OR strip OR manipulation OR manipulate OR clearance OR "nursing practice" OR "best practice") AND (PleuraFlow OR ClearFlow OR "Chest Tubes"[mesh] OR "chest tube" OR "chest tubes") 107 results

Studies Included in this Review (in Alphabetical Order)

Dango et al. (2010)
 Isaacson et al. (1986)
 Lim-Levy et al. (1986)
 Oakes et al. (1993)
 Pierce et al. (1991)

Studies Not Included in this Review with Exclusion Rationale (in Alphabetical Order)

Authors (YYYY)	Reason for exclusion
Arakawa et al. (2011)	Animal study
Perrault et al. (2012)	User preference study
Shalli et al. (2009)	Survey
Shiose et al. (2010)	Animal study
Sirch et al. (2016)	Retrospective propensity matched patients
St-Onge et al. (2017)	Cohort study

Method Used for Appraisal and Synthesis

The Cochrane Collaborative computer program, Review Manager (Higgins & Green, 2011)^a was used to synthesize the five included studies

^aHiggins, J. P. T., & Green, S. e. (2011). *Cochrane Handbook for Systematic Reviews of Interventions [updated March 2011]* (Version 5.1.0 ed.): The Cochrane Collaboration, 2011.

Medical Librarian Responsible for the Search Strategy

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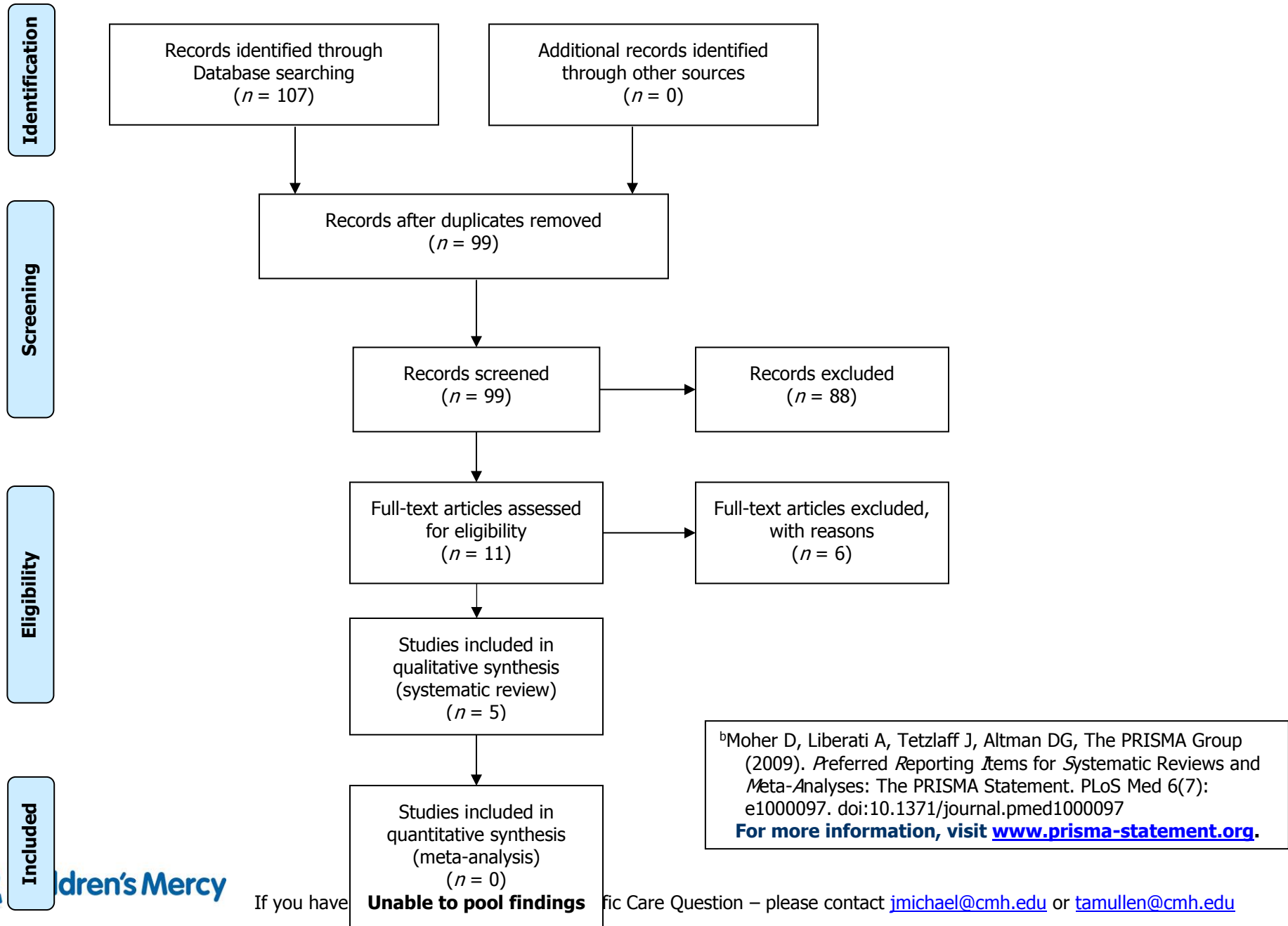
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Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)^b



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Table 1
Characteristics of Studies
Dango 2010

Methods	Prospective randomized trial, adults
Participants	<p>Setting: University hospital at Germany for a 11 month study duration</p> <p>Randomized into study: <i>N</i> = 145</p> <ul style="list-style-type: none"> • Milking: <i>n</i> = 73 • Observation: <i>n</i> = 72 <p>Completed Study: <i>N</i> = 124</p> <ul style="list-style-type: none"> • Milking: <i>n</i> = 64 • Observation: <i>n</i> = 60 <p>Gender, males:</p> <ul style="list-style-type: none"> • Milking: <i>n</i> = 51 (70%) • Observation: <i>n</i> = 45 (62.5%) <p>Age: Not reported</p> <p>Inclusion Criteria:</p> <ol style="list-style-type: none"> 1. >18 years 2. Had pulmonary resection through an open approach <p>Exclusion Criteria:</p> <ul style="list-style-type: none"> • Patients with empyemas, re-thoracotomy, or breast wall resections. <p>Power Analysis: For an estimated power of 90%, a sample size of 60 patients for each group was necessary to show a difference of 20% (1 day) for the primary end-points</p>
Interventions	<p>All subjects had two chest tubes during the first 48 h after thoracotomy. Routinely, two silicon chest tubes (anterior 21Ch and posterior 24Ch, silicon chest tubes, Redax Company, Mirandola, Italy) were placed after thoracotomy and connected to a water-sealed drainage system. The ventral chest tube was removed when there was no evidence of an air leak in the previous 24 h, and the dorsal tube was removed when less than 200 ml drainage was recorded in 24 h. The two interventions were:</p> <ul style="list-style-type: none"> • Milking/Stripping: Milking was applied to both chest tubes for 1 min every 2 h within the first 48 h postoperatively and continuous suction of –20 cm H₂O was maintained for 48 h. Stripping was carried out 2 h after admission to the ICU. • Observation: No manipulation <p>Patients were discharged and re-examined within a standardized follow-up period defined by protocol to be 40 days after discharge from the hospital within two prescheduled visits in an ambulatory setting at the outpatient unit for control.</p>
Outcomes	<p>Primary outcome(s):</p> <ul style="list-style-type: none"> • Post-operative morbidity • Duration of drainage • Air leaks <p>Secondary outcome(s)</p> <ul style="list-style-type: none"> • Length of stay <p>Safety outcome(s):</p> <ul style="list-style-type: none"> • Surgical and pulmonary complications

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Notes	<p>No information on subject's age. Unable to analyze drainage removal and LOS as a range was reported instead of a SD</p> <ul style="list-style-type: none"> • Anterior drainage removal (days): $p = 0.33$ <ul style="list-style-type: none"> ○ Milking: 2.8 (1-7) ○ Observation: 3.1 (1-9) • Posterior drainage removal (days): $p = 0.38$ <ul style="list-style-type: none"> ○ Milking: 5.1 (3-13) ○ Observation: 5.6(3-17) • LOS $p = 0.74$ <ul style="list-style-type: none"> ○ Milking: 13.4 (7-32) ○ Observation: 13.2 (8-29)
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Risk of bias table

Bias	Scholars judgment	Support for judgment
Random sequence generation (selection bias)	High risk	Randomization was carried out on the basis of the operation date; on even-numbered days the chest tubes were milked, on odd-numbered days the chest tubes were observed
Allocation concealment (selection bias)	High risk	Allocation did not occur
Blinding of participants and personnel (performance bias)	Low risk	The study could not be designated as 'blind' as the ward physician had to be aware of which group the patient was randomized in order to follow the protocol; the review authors judge that the outcome measurement is not likely to be influence by lack of blinding.
Blinding of outcome assessment (detection bias)	Low risk	Study was not blinded. Physician was aware of the group. All records were kept in patient's room. The review authors judge that the outcome measurement is not likely to be influence by lack of blinding.
Incomplete outcome data (attrition bias)	Low risk	Even though 21 participants dropped out of the study and were not included in the analysis, the remaining group sizes (Milking $n = 64$ and Control $n = 60$) attained the needed sample sizes to meet study power.
Selective reporting (reporting bias)	Unclear risk	It is unclear if the participant's age had any effect on the study results.
Other bias	Unclear risk	

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Day 2008

Design	Qualitative Systematic Review
Objective	In patients who have undergone cardiothoracic surgery does manipulation of drainage tubes affect drainage volumes or post-surgical outcome?
Methods	<p>Protocol and registration. Not reported</p> <p>Eligibility Criteria. Patients who have undergone cardiothoracic surgery does manipulation of drainage tubes affect drainage volumes or post-surgical outcome.</p> <p>Information. Medline 1950 to September 2007 using OVID interface</p> <p>Search. Thoracic Surgery OR Cardiac Surgical Procedures OR heart surgery AND Chest Tubes OR Drainage OR mediastinal drain OR chest drain AND Hemorrhage OR Postoperative Complications OR Postoperative Hemorrhage OR bleeding OR Cardiac tamponade OR Drainage</p> <p>Study Selection. Not reported</p> <p>Data collection process. Not reported</p> <p>Risk of Bias across studies. Not reported</p> <p>Summary measures. Qualitatively reported</p> <p>Synthesis of results. Outcome listed in table qualitatively</p>
Results	<p>Study Selection.</p> <ul style="list-style-type: none"> • Number of studies resulted from search: $N = 681$ • Number of studies provided the best evidence to answer the research question: $n = 4$ • Table also included Cochrane database of systematic reviews by Wallen et al. (2002) <p>Synthesis of results.</p> <ul style="list-style-type: none"> • Study 1: Prospective case series by Duncan and Erickson, (1982) <ul style="list-style-type: none"> ▪ Pressure of up to 408 cm H₂O were recorded during manual tube stripping ▪ May have potential to cause tissue damage as adverse event • Study 2: Prospective randomized controlled by Isaacson et al. (1986) <ul style="list-style-type: none"> ▪ Milking 467ml vs stripping 433 ml in post-operative 0-8 hours ▪ Milking 96ml vs stripping 93ml in post-operative 8-12 hours ▪ No significant differences in drainage outputs • Study 3: Prospective randomized controlled by Lim-Levy et a.,(1986) <ul style="list-style-type: none"> ○ Mean total drainage volume <ul style="list-style-type: none"> ▪ milking 756.38ml ▪ stripping 869.84ml

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	<ul style="list-style-type: none"> ▪ control 883.33ml ○ Frequency of tube occlusion - no occlusion detected in any patient ○ Incidence of arrhythmias - No significant difference between among the 3 groups while 16 subjects had arrhythmias not stated in which group ○ Average heart rate - no significant difference between among the 3 groups • Study 4: Prospective randomized controlled by Pierce et al. (1991) <ul style="list-style-type: none"> ○ Mean total drainage volume - no significant difference between the 2 groups <ul style="list-style-type: none"> ▪ Milking 841.6ml ▪ Stripping 515.8ml ○ Mean number of manipulation episodes - no significant difference between the 2 groups ○ Chest x-ray for tamponade - no significant difference between the 2 groups ○ Surgery re-entry - no significant difference between the 2 groups <p>Risk of bias across studies. not mentioned</p>
Discussion	<p>Summary of evidence. No particular method of manipulation can be recommended, nor can the use of manipulation at all be supported or refuted. Subsequently cannot rule out possibility of causing tissue damage.</p> <p>Limitations. Not mentioned</p>
Funding	Not reported

Oakes 1993

Methods	Randomized Control Trial
Participants	<p>Setting: Pediatric cancer center, ICU</p> <p>Randomized into Study: $N = 16$</p> <ul style="list-style-type: none"> • Group 1: No chest tube stripping (Experimental group) $n = 8$ • Group 2: Chest tube stripping according to established practice (Control group) $n = 8$ <p>Completed Study: $N = 16$</p> <ul style="list-style-type: none"> • Group 1: Experimental group $n = 8$ • Group 2: Control group $n = 8$ <p>Gender, Males:</p> <ul style="list-style-type: none"> • Group 1: Experimental group $n = 5$ • Group 2: Control group $n = 3$ <p>Age, years (mean):</p> <ul style="list-style-type: none"> • Group 2: Experimental group $n = 14.94$ • Group 1: Control group $n = 11.3$ <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Age 3 to 21 years • Comprehension of the English language • Motor coordination sufficient to point to a pain assessment scale

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	<ul style="list-style-type: none"> Presence of a single pleural chest tube connected to an Arglye Sentinel Seal™ drainage unit connected, in turn, to a wall source of suction at -20cm water pressure. <p>Exclusion criteria:</p> <ul style="list-style-type: none"> Unclear <p>Power analysis: With a sample size of 20 participants (10 per group), there would be an 80% chance of detecting effect-size differences of 1.2 standard deviations between the two groups.</p>
Interventions	<p>Group 1: Experimental group- Pain measurements were done at the same time intervals used for the control group. If large clots in the chest tube were not being drained by gravity alone, the tube was to be stripped and the patient removed from the study.</p> <p>Group 2: Control group- Chest tube stripping begin within the first postoperative hour and was repeated every 2 hours for the first 48 hours after the thoracotomy. Pain measurements with both instruments were done immediately before and after stripping at intervals of 3 to 5 minutes.</p>
Outcomes	<p>Primary outcomes:</p> <ul style="list-style-type: none"> Self-reported pain Incidence of fever Frequency of pulmonary complications
Notes	<p>Results:</p> <ul style="list-style-type: none"> The two groups did not differ significantly in the frequency of pain, incidence of fever, breath sounds, or radiographic findings across measurement points. A strong correlation was found between the pain scores using the two instruments. Patients who did not undergo chest tube stripping reported higher pain scores on the Faces Pain Scale (FPS) than the control group at two of the six 8-hour intervals. No significant difference in the Visual Analog Scale (VAS) scores was seen at any of the intervals. Patients in the experimental group received more pain medication. Results showed an expected increase in body temperature from the day of surgery to the following day in both groups, but there was no significant difference between the groups. Incidence of fever in the control group at the 4-hour postoperative measurement was higher.

Risk of bias table

Bias	Scholars judgment	Support for judgment
Random sequence generation (selection bias)	High risk	Patients were assigned to the 2 groups by fixed randomization. The first participant was randomly assigned to the appropriate stratified group by a coin toss.
Allocation concealment (selection bias)	High risk	Subsequent participants were assigned to alternate groups by the first author.
Blinding of participants and personnel (performance bias)	Low risk	The first author was aware of groups that participants were placed in. The primary investigator randomly checked the nurses techniques in chest tube stripping to ensure consistency during the study. The review authors judge that the outcome is not likely to be influenced by lack of blinding.

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Blinding of outcome assessment (detection bias)	Low risk	Insufficient information provided however the review authors judge that the outcome measurement is not likely to be influenced by lack of blinding.
Incomplete outcome data (attrition bias)	High risk	Primary outcome data was addressed in results however the sample size was not obtained.
Selective reporting (reporting bias)	Low risk	Some unclear results.
Other bias	unclear	

Wallen 2004

Design	Qualitative Systematic Review
Objective	<p>To compare different methods of chest drain clearance in preventing cardiac tamponade in patients following cardiac surgery</p> <ul style="list-style-type: none"> • varying levels of suction • suction in combination with milking/stripping/fan folding/ tapping <p>Outcomes (Primary).</p> <ul style="list-style-type: none"> • Incidence of cardiac tamponade early (first 8 hours) • incidence of cardiac tamponade -late (after 8 hours) <p>Outcomes (Secondary).</p> <ul style="list-style-type: none"> • Incidence of chest tube blockage; • Incidence of successful chest tube clearance • Incidence of suspicious alteration in chest tube drainage pattern • Incidence of indicators of impending cardiac tamponade e.g. decreasing blood pressure, increased left atrial pressure, increased pulmonary capillary wedge pressure, decreased cardiac output • Mortality - all causes • Mortality - cardiovascular events • Cardiovascular events • Incidence of re-opening the chest for bleeding • Incidence of re-opening the chest for tamponade • Incidence of postoperative atrial fibrillation • Incidence of significant pericardial effusion • Absolute volume of chest tube output • Other adverse events not specified above were recorded as was duration of follow up
Methods	<p>Protocol and registration: n/a</p> <p>Eligibility Criteria. Randomized, quasi-randomized or systematically allocated clinical trials</p>

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Types of interventions.

- Various levels of low pressure suction; or
- Suction with chest tube manipulation methods (milking, tapping, fan-folding, stripping); or
- Various means of chest tube manipulation
- Any of the above with no intervention

Inclusion criteria.

- Adults and children with mediastinal chest drains following cardiac surgery
- Sub-group analysis for children was to be completed if feasible

Information sources.

Note: This review has been done multiple times, in 2002, 2004, 2007, and 2009, only the 2009 information is reflected here

- Cochrane Central Register of Controlled Trials(CENTRAL) onThe Cochrane Library Issue 3 2009,
- MEDLINE(1966 to October 2009)
- EMBASE (1980 to October 2009)
- CINAHL (1982 to October 2009)
- metaRegister of Con-trolled Trials (mRCT) including the NIH ClinialTrials.gov regis-ter at www.controlled-trials.com/mrct/(13 October 2009).

Search strategy example, 2009 CENTRAL on The Cochrane Library:

Please see study for full search strategy

Study Selection:

- References were assessed independently by two reviewers
- Full articles were obtained where a judgement was unable to be made from title/abstract
- Articles were assessed independently by two reviewers according to selection criteria to determine suitability for data extraction

Data Collection Process:

- If possible, data were extracted independently by two reviewers and results compared; differences were resolved by referral to third member of team
- each trial was independently allocated into Risk of Bias category (Low, Medium, High)
- Where data was unavailable, an attempt to contact study authors was performed.

Risk of Bias across studies:

Each trial was independently allocated into Risk of Bias category (Low, Medium, High)

Summary measures with intervention of tube manipulation (stripping, fan-folding, milking):

- Peto Odds Ratio
- Mean Difference

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	<p>Synthesis of results: Each of the two summary measures had only one study that reported that outcome.</p> <p>Additional analyses: No meta-analysis done, of the three studies included there was no data which could be included in a meta-analysis.</p>
Results	<p>Study Selection.</p> <ul style="list-style-type: none"> • Number of studies that resulted from search (2009): 636 • Number of studies after eliminating duplicates: 183 • Number of full text articles assessed for eligibility: • Number of studies included in the qualitative synthesis: 3 <p>Synthesis of results.</p> <ul style="list-style-type: none"> • Three studies with a total of 471 participants were included. • There was no data which could be included in a meta-analysis. • On the basis of single studies there was no evidence of a difference between groups on incidence of chest tube blockage, heart rate, cardiac tamponade or incidence of surgical re-entry. • Only one study reported on chest tube blockage. There was no incidence of chest tube blockage in any of the three groups (stripping, fan-folding, and control with n=16, 18, 15 respectively) • Only one study reported on incidence of surgical re-entry. This outcome (stripping versus milking; duration of follow up = eight hours). Each group had three participants who required surgical re-entry (n=100 in each group). <p>Risk of bias across studies.</p> <ul style="list-style-type: none"> • Low risk of bias: 1 study • Moderate risk of bias: 2 studies
Discussion	<p>Summary of evidence: The evidence supporting various tube manipulations to prevent chest tube blockage and/or surgical reentry is limited.</p>
Funding	Not specified

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*Studies from systematic review.

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