

Supplemental Material for 2026 Clinical Practice Guideline Update by the Infectious Diseases Society of America and the Pediatric Infectious Diseases Society on the Management of Community-Acquired Pneumonia in Infants and Children Older than 3 Months of Age: The Use of Pleural Fluid Drainage compared to Surgical Debridement

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CLINICAL PRACTICE GUIDELINE DEVELOPMENT PROCESS

Guideline Panel Composition

The chairs of the guideline panel were selected by the leadership of IDSA. Twelve additional panelists comprised of the full panel. The panel included clinicians with expertise in infectious diseases, pediatric infectious diseases, and emergency medicine. Panelists were diverse in gender, geographic distribution, and years of clinical experience. Guideline methodologists oversaw all methodological aspects of the guideline development and identified and summarized scientific evidence for each clinical question. IDSA staff oversaw all administrative and logistic issues related to the guideline panel.

Conflicts of Interest

All members of the expert panel complied with the IDSA policy on conflict of interest (COI), which requires disclosure of any financial, intellectual, or other interest that might be construed as constituting an actual, potential, or apparent conflict. Evaluation of such relationships as potential conflicts of interest was determined by a review process which included assessment by the Standards and Practice Guideline Subcommittee (SPGS) Chair, the SPGS liaison to the Guideline panel and the Board of Directors liaison to the SPGS, and if necessary, the Conflict of Interests Task Force of the Board. This assessment of disclosed relationships for possible COI was based on the relative weight of the financial relationship (i.e., monetary amount) and the relevance of the relationship (i.e., the degree to which an independent observer might reasonably interpret an association as related to the topic or recommendation of consideration). The reader of these guidelines should be mindful of this when the list of disclosures is reviewed. See the Notes section at the end of this guideline for the disclosures reported to IDSA.

Practice Recommendations

Clinical Practice Guidelines are statements that include recommendations intended to optimize patient care by assisting practitioners and patients in making shared decisions about appropriate health care for specific clinical circumstances. These are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options [IOM 2011]. The “IDSA Handbook on Clinical Practice Guideline Development” provides more detailed information on the processes followed throughout the development of this guideline [IDSA CPG Handbook].

GRADE Approach for Developing Clinical Practice Guidelines

The GRADE (Grading of Recommendations Assessment, Development and Evaluation) approach for the assessment of the certainty of evidence and strength of recommendation was followed. For certainty of evidence of each critical and important outcome, risk of bias, indirectness, inconsistency, and imprecision were considered, along with publication bias and other special considerations according to GRADE (see Figure 1). (Guyatt 2008, Schunemann 2020) Risk of bias for non-randomized studies was assessed by the Newcastle Ottawa scale. This information is reported in evidence profiles developed using the GRADEpro Guideline Development Tool. Based on certainties of evidence for critical outcomes, a final judgment of confidence in the evidence was made for each recommendation.

The Evidence to Decision framework was used to translate evidence of summaries into practice recommendations. All recommendations are labeled as “strong” or “conditional” according to an evaluation of the certainty of evidence, the balance between benefits and harms, patients’ values and preferences, resources/cost, and other factors such as acceptability, feasibility, and equity. Nonsystematic literature searches were used to inform these evaluations as needed. “The panel recommends” indicates a strong recommendation, and “the panel suggests” indicates a conditional recommendation. Figure 1 provides the suggested interpretation of strong and conditional recommendations for patients, clinicians, and healthcare policymakers. Where there were knowledge gaps, the panel opted to provide limited clinical guidance for reasonable approaches, rather than no guidance at all, and these statements are specifically labeled as knowledge gaps.

Approval Process

Feedback was obtained from two IDSA reviewers, three selected external peer reviewers, and the American Academy of Pediatrics (AAP). The IDSA Standards and Practice Guidelines Subcommittee (SPGS) and Board of Directors reviewed and approved the guideline prior to publication, along with any endorsing societies with the Pediatric Infectious Diseases Society (PIDS).

Process for Updating

IDSA guidelines are regularly reviewed for currency. The need for updates to the guideline is determined by a scan of current literature and the likelihood that any new data would impact the recommendations. Any changes to the guideline will be submitted for review and approval to the appropriate Committees and Board of IDSA.

SYSTEMATIC REVIEW PROCESS

Clinical Question

The clinical question was formatted according to the PICO style: Patient/Population (P), Intervention (I), Comparator/Control (C), Outcome (O). For each PICO question, outcomes of interest were identified a priori and rated as critical, important, or not important, according to their relative importance for decision-making.

Eligibility Criteria

Inclusion criteria:

- *Patient population*- Children with parapneumonic effusion
- *Intervention* - Pleural fluid drainage
- *Comparator*- No fluid drainage/observation (antibiotics alone)
- *Outcomes*- Length of stay, recurrence, cost, morbidity
- *Study design*- Randomized controlled trials (RCTs) with no date limit, observational studies

Exclusion criteria:

- *Patient population*- International populations in resource limited settings
- *Comparator*- No comparator
- *Study design*- case reports

Literature Search Methods

A medical librarian (EG) designed the literature searches for Medline via PubMed, Embase, and Cochrane Library, including appropriate MeSH terms, where applicable. Searches were limited to studies published in English. The initial formal literature searches were performed August 2019, and updated literature searches were conducted in October 2022 and July 2024. To supplement the electronic searches, reference lists of related articles and guidelines were reviewed for relevance.

Study Selection

Titles and abstracts were screened in duplicate, and all potentially relevant citations were reviewed in full text by two panelists (SS and KA). Covidence was used to facilitate screening (Covidence Systematic Review Software). Predefined inclusion and exclusion criteria tailored to meet the specific population, intervention, and comparator of each question were applied during the screening process. Abstracts and conference proceedings, letters to the editor, editorials, and review articles were excluded. The steps of the literature selection process were supervised and reviewed by a guideline methodologist for the final selection of the relevant articles. Details of this selection process are reported via PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagrams.

Data Extraction

A guideline methodologist in conjunction with panelists extracted the data for each pre-determined patient-important outcome.

Assessment of Risk of Bias

We assessed risk of bias of individual studies using the Cochrane Risk of Bias Tool for RCTs (Higgins 2011) and the Risk of Bias in Non-randomized Studies of Interventions for observational studies

Data Synthesis

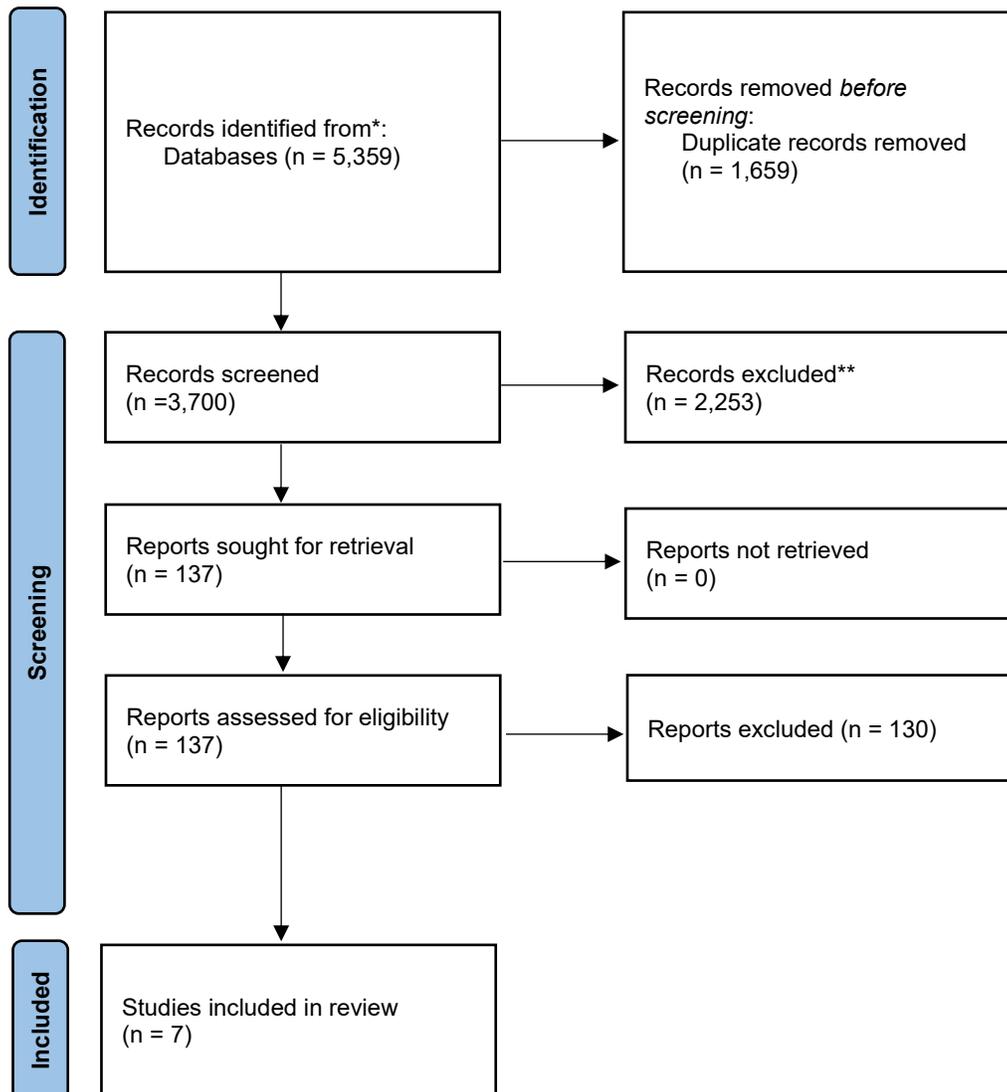
A guideline methodologist in conjunction with panelists extracted the data for each pre-determined patient-important outcome. Where applicable, data from critical and important outcomes were pooled using a random-effects model (fixed effects model for pooling rates) using RevMan [RevMan].

Assessment of Certainty of Evidence

We assessed the certainty of evidence at the outcome level using the GRADE approach (Schünemann 2013). We followed the guidance developed by the GRADE working group to communicate the findings of the systematic review (Santesso 2020).

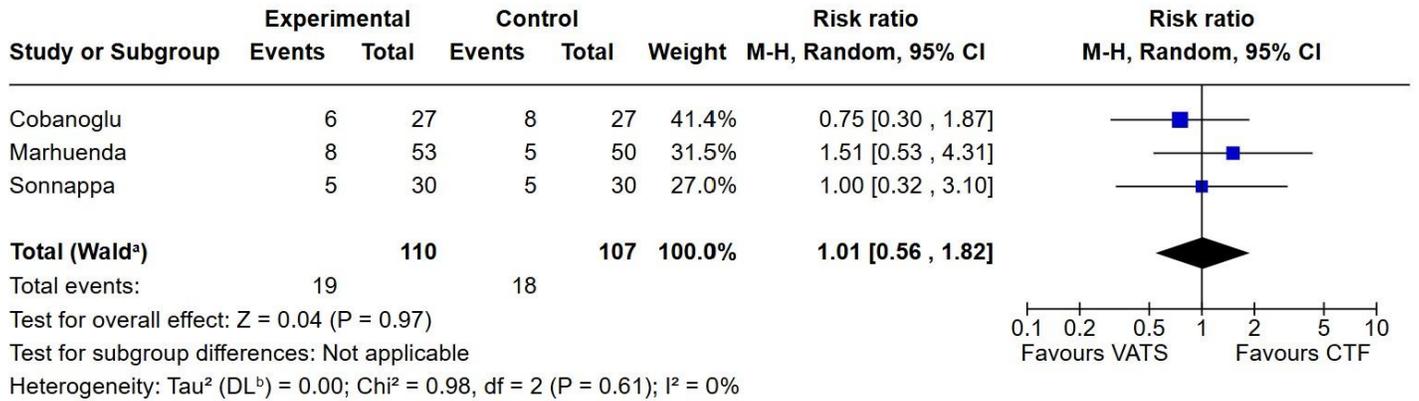
SYSTEMATIC REVIEW RESULTS

Results of the Search



Analyses

Figure 2. Need for Further Intervention (RCT)

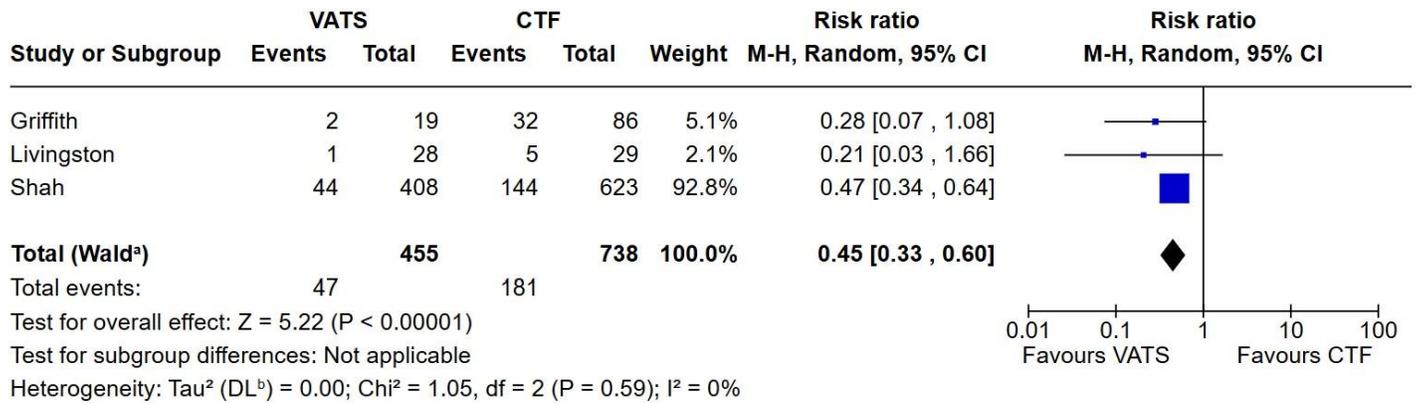


Footnotes

^aCI calculated by Wald-type method.

^b Tau^2 calculated by DerSimonian and Laird method.

Figure 3. Need for Further Intervention (Observational)

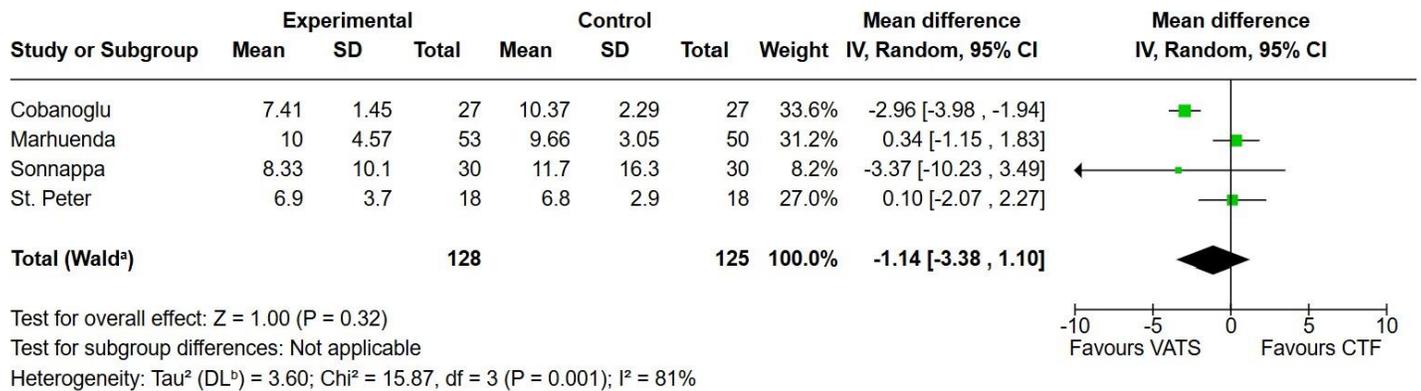


Footnotes

^aCI calculated by Wald-type method.

^b Tau^2 calculated by DerSimonian and Laird method.

Figure 4. Post Treatment Length of Stay (RCT)

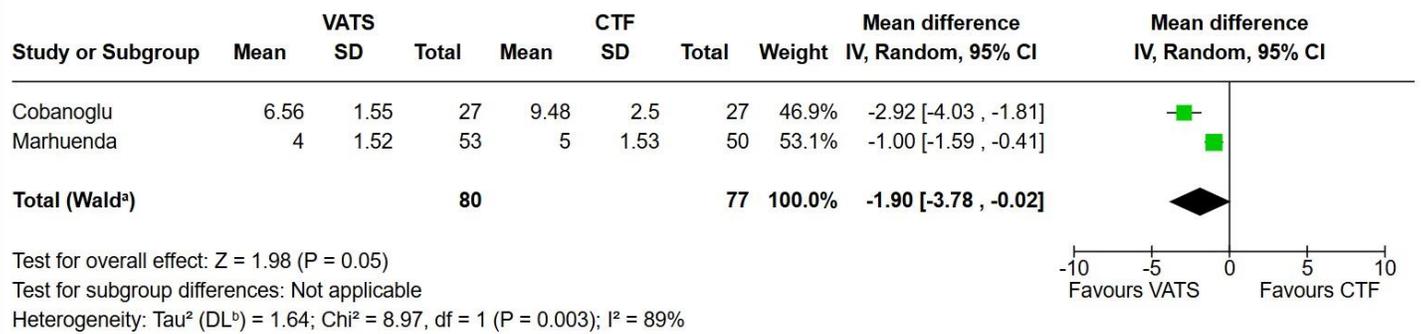


Footnotes

^aCI calculated by Wald-type method.

^bTau² calculated by DerSimonian and Laird method.

Figure 5. Duration of Chest Tube Placement Forest Plot (RCT)

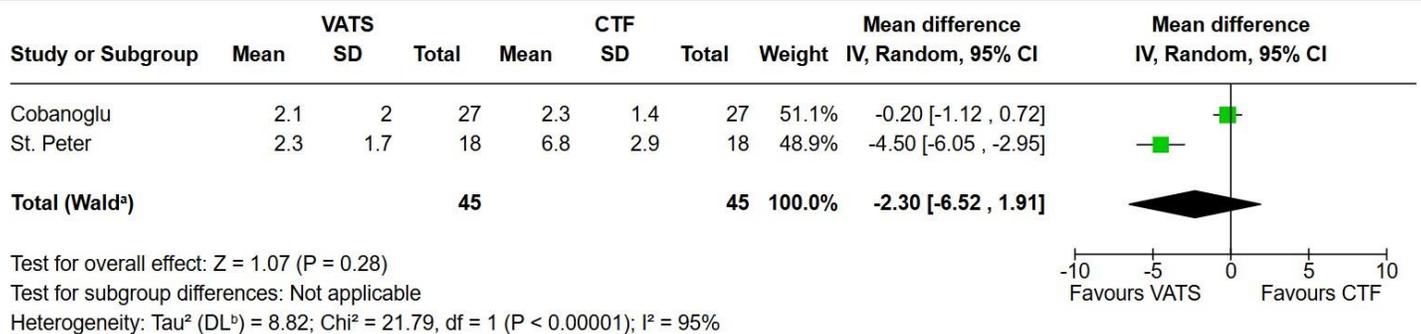


Footnotes

^aCI calculated by Wald-type method.

^bTau² calculated by DerSimonian and Laird method.

Figure 6. Supplemental Oxygen Days (RCT)



Footnotes

^aCI calculated by Wald-type method.

^bTau² calculated by DerSimonian and Laird method.

Characteristics of Included Studies

Author	Location	Study Design	Study Population	Number of Patients, age,	Intervention Description	Comparator Description
Marhuenda 2014	Spain	RCT	Patients <15yrs with community-acquire pneumonia w/ diagnosis of parapneumonic effusion requiring chest tube drainage; sonographic features of complicated effusion	N=103; mean age VATS: 4.14 (1.1-13.7); Urokinase: 4.63 (1.0-12.2)	VATS debridement	Chest tube with Urokinase
Sonnappa 2006	United Kingdom	RCT	Patients <16yrs with radiographic evidence of empyema and indication for drainage	N=60; median age VATS: 3.57 (2.28-7); Urokinase 3.07 (2.28-5.38)	VATS debridement	Chest tube with Urokinase
St. Peter 2009	USA	RCT	Patients <18yrs with diagnosis of empyema	N=36; mean age VATS: 4.8 ±4.3; Fibrinolysis: 5.2±4.2	VATS debridement	Fibrinolytic therapy
Cobangolu 2011	Turkey	RCT	Children with stage II and III empyema	N=54; mean age VATS: 8.74±2.6;	VATS debridement	Fibrinolytic therapy
Griffith 2018	United Kingdom	Retrospective cohort	Patients ≤16yrs with parapneumonic effusion, pleural effusion, or pleural empyema	N=115; mean age 4.95 (range 61 days to 14.66 years)	VATS debridement	Urokinase fibrinolysis
Livingston 2016	Canada	Retrospective cohort	Pediatric patients <18yr with a diagnosis of pleural empyema	N=67; mean age VATS: 5.2yrs (6m-16yr); Fibrinolysis: 6.1yrs (6m-17yr)	VATS debridement	Chest tube with fibrinolytics
Shah 2011	USA	Retrospective cohort	Children ≤18yrs receiving pleural drainage for complicated pneumonia	N=3,500	VATS debridement	Chest tube with fibrinolytics

Evidence Tables

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	VATS	CTF	Relative (95% CI)	Absolute (95% CI)		

Need for further intervention

3 (Cobanoglu 2011, Marhuenda 2014, Sonnappa 2006)	randomised trials	serious ^a	not serious	not serious	serious ^b	none	19/110 (17.3%)	18/107 (16.8%)	RR 1.01 (0.56 to 1.82)	2 more per 1,000 (from 74 fewer to 138 more)	⊕⊕○○ Low ^{a,b}	CRITICAL
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Need for further intervention (NRSI)

3 (Griffith 2018, Livingston 2016, Shah 2011)	non-randomised studies	serious ^c	not serious	not serious	not serious	none	47/455 (10.3%)	181/738 (24.5%)	RR 0.45 (0.33 to 0.60)	135 fewer per 1,000 (from 164 fewer to 98 fewer)	⊕○○○ Very low ^c	CRITICAL
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Post-treatment LOS

4 (Cobanoglu 2011, Marhuenda 2014, Sonnappa 2006, St. Peter 2009)	randomised trials	serious ^a	serious ^d	not serious	serious ^e	none	128	125	-	MD 1.14 days fewer (3.38 fewer to 1.1 more)	⊕○○○ Very low ^{a,d,e}	CRITICAL
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Supplemental Oxygen days

2 (Cobanoglu 2011, Marhuenda 2014)	randomised trials	serious ^a	serious ^f	not serious	serious ^e	none	45	45	-	MD 2.3 days fewer (6.52 fewer to 1.91 more)	⊕○○○ Very low ^{a,e,f}	CRITICAL
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Duration of chest tube placement

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	VATS	CTF	Relative (95% CI)	Absolute (95% CI)		
2 (Cobanoglu 2011, St. Peter 2009)	randomised trials	serious ^a	serious ^g	not serious	not serious	none	80	77	-	MD 1.9 days lower (3.78 lower to 0.02 lower)	⊕⊕○○ Low ^{a,g}	CRITICAL

CI: confidence interval; MD: mean difference; RR: risk ratio

EXPLANATIONS

- a. Serious risk of bias related to randomization, deviations from intended intervention and missing outcome data
- b. Small number of events resulting in uncertainty. Wide confidence intervals; 95% CI crosses the null
- c. Risk of bias due to confounding, selection of participants into study and deviation from the intervention
- d. I-squared value of 81%
- e. Wide 95% CI that crosses the null
- f. I-squared value of 95%
- g. I-squared value of 89%

Risk of Bias Assessment in Included Studies

Risk of bias for included studies – Randomized Controlled Trials

Study	Risk of bias domains					Overall
	D1	D2	D3	D4	D5	
Marhuenda 2014						
Cobanoglu 2011						
St. Peter 2009						
Sonnappa 2006						

Domains:
D1: Bias arising from the randomization process.
D2: Bias due to deviations from intended intervention.
D3: Bias due to missing outcome data.
D4: Bias in measurement of the outcome.
D5: Bias in selection of the reported result.

Judgement
 High
 Low

Risk of bias for included studies – Observational Studies

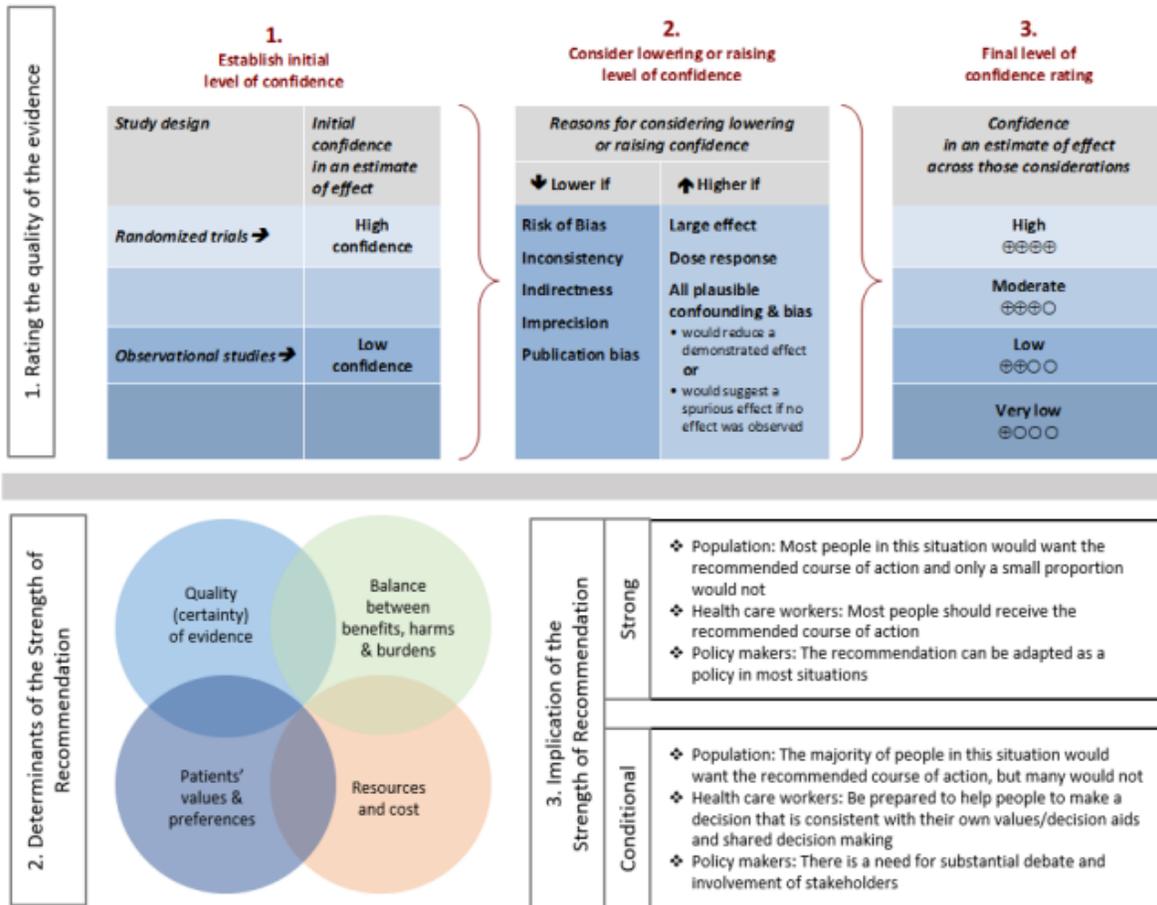
Study	Risk of bias domains							Overall
	D1	D2	D3	D4	D5	D6	D7	
Livingston 2016								
Griffith 2018								
Shah 2011								

Domains:
D1: Bias due to confounding.
D2: Bias due to selection of participants.
D3: Bias in classification of interventions.
D4: Bias due to deviations from intended interventions.
D5: Bias due to missing data.
D6: Bias in measurement of outcomes.
D7: Bias in selection of the reported result.

Judgement
 Serious
 Moderate
 No information

Other Tables and Figures

Supplementary Figure 1. Approach and implication to rating the certainty of evidence and strength of recommendations following the GRADE approach (*unrestricted use of figure granted by the US. GRADE network*)



Search strategies

PubMed (NLM)

("Fibrinolytic Agents" [Pharmacological Action] OR "Fibrinolytic Agents"[Mesh] OR "Tissue Plasminogen Activator"[Mesh] OR "Streptokinase"[Mesh] OR "Urokinase-Type Plasminogen Activator"[Mesh] OR "Thrombolytic Therapy"[Mesh] OR "T Plasminogen Activator"[tiab] OR "Tisokinase"[tiab] OR "Tissue Activator D 44"[tiab] OR "tissue plasminogen activator"[tiab] OR "Tissue Type Plasminogen Activator"[tiab] OR "tPA"[tiab] OR "U-PA"[tiab] OR "Urokinase"[tiab] OR "Debridement"[Mesh] OR debrid*[tiab] OR "Chest Tubes"[Mesh] OR "chest tube"[tiab] OR "chest tubes"[tiab] OR "chest drain"[tiab] OR "chest drains"[tiab] OR "pleural tube"[tiab] OR "pleural tubes"[tiab] OR "pleural drain"[tiab] OR "pleural drains"[tiab] OR "small bore"[tiab] OR "large bore"[tiab] OR "Tube thoracostomy"[tiab] OR "<12Fr"[tiab] OR ">14fr" [tiab]) AND ("Empyema, Pleural"[Mesh] OR "Pleural Effusion"[Mesh] OR "pleural effusion"[tiab] OR "pleural effusions"[tiab] OR "pleura effusion"[tiab] OR "pleura effusions"[tiab] OR "parapneumonic effusion"[tiab] OR "parapneumonic effusions"[tiab] OR "pleural suppuration"[tiab] OR "lung effusion"[tiab] OR "lung effusions"[tiab] OR "empyema"[tiab])) AND (("Adolescent"[Mesh] OR "Child"[Mesh] OR "Child, Preschool"[Mesh] OR "Infant"[Mesh] OR "adolescence"[tiab] OR "adolescent"[tiab] OR "adolescents"[tiab] OR "baby"[tiab] OR "babies"[tiab] OR "child"[tiab] OR "childhood"[tiab] OR "children"[tiab] OR "infant"[tiab] OR "infants"[tiab] OR "infancy"[tiab] OR "juvenile"[tiab] OR "paediatric"[tiab] OR "paediatrics"[tiab] OR "pediatric"[tiab] OR "pediatrics"[tiab] OR "preschool child"[tiab] OR preschool children"[tiab] OR "teen"[tiab] OR "teenager"[tiab] OR "teenagers"[tiab] OR "teens"[tiab] OR "toddler"[tiab] OR "toddlers"[tiab] OR "youth"[tiab] OR "youths"[tiab])

EMBASE

('pleura effusion'/de OR 'parapneumonic effusion'/exp OR 'parapneumonic pleural effusion'/exp OR 'pleura empyema'/exp OR 'pleural effusion':ti,ab OR 'pleural effusions':ti,ab OR 'pleura effusion':ti,ab OR 'pleura effusions':ti,ab OR 'parapneumonic effusion':ti,ab OR 'parapneumonic effusions':ti,ab OR 'pleural suppuration':ti,ab OR 'lung effusion':ti,ab OR 'lung effusions':ti,ab OR 'empyema':ti,ab) AND ('chest tube'/exp OR "chest tube":ti,ab OR "chest tubes":ti,ab OR "chest drain":ti,ab OR "chest drains":ti,ab OR "pleural tube":ti,ab OR "pleural tubes":ti,ab OR "pleural drain":ti,ab OR "pleural drains":ti,ab OR "small bore":ti,ab OR "large bore":ti,ab OR "Tube thoracostomy":ti,ab OR 'fibrinolytic agent'/exp OR 'tissue plasminogen activator'/exp OR 'streptokinase'/exp OR 'urokinase'/exp OR "T Plasminogen Activator":ti,ab OR "Tisokinase":ti,ab OR "Tissue Activator D 44":ti,ab OR "tissue plasminogen activator":ti,ab OR "Tissue Type Plasminogen Activator":ti,ab OR "tPA":ti,ab OR "U-PA":ti,ab OR "Urokinase":ti,ab OR 'debridement'/exp OR debrid*:ti,ab) AND ('juvenile'/exp OR 'adolescent'/exp OR 'child'/exp OR 'infant'/exp OR 'adolescence':ti,ab OR 'adolescent':ti,ab OR 'adolescents':ti,ab OR 'baby':ti,ab OR 'babies':ti,ab OR 'boy':ti,ab OR 'boys':ti,ab OR 'child':ti,ab OR 'childhood':ti,ab OR

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teens':ti,ab OR 'preteen':ti,ab OR 'preteens':ti,ab OR 'teen':ti,ab OR 'teenager':ti,ab OR 'teenagers':ti,ab
OR
'teens':ti,ab OR 'toddler':ti,ab OR 'toddlers':ti,ab OR 'youth':ti,ab OR 'youths':ti,ab)

Cochrane (Wiley)

([mh "Empyema, Pleural"] OR [mh "Pleural Effusion"] OR "pleural effusion":ti,ab OR "pleural effusions":ti,ab OR "pleura effusion":ti,ab OR "pleura effusions":ti,ab OR "parapneumonic effusion":ti,ab OR "parapneumonic effusions":ti,ab OR "pleural suppuration":ti,ab OR "lung effusion":ti,ab OR "lung effusions":ti,ab OR "empyema":ti,ab) AND ([mh "chest tubes"] OR "chest tube":ti,ab OR "chest tubes":ti,ab OR "chest drain":ti,ab OR "chest drains":ti,ab OR "pleural tube":ti,ab OR "pleural tubes":ti,ab OR "pleural drain":ti,ab OR "pleural drains":ti,ab OR "small bore":ti,ab OR "large bore":ti,ab OR "Tube thoracostomy":ti,ab OR "<12Fr":ti,ab OR ">14fr":ti,ab OR [mh "Fibrinolytic Agents"] OR [mh "Tissue Plasminogen Activator"] OR [mh "Streptokinase"] OR [mh "Urokinase-Type Plasminogen Activator"] OR [mh "Thrombolytic Therapy"] OR "T Plasminogen Activator":ti,ab OR "Tisokinase":ti,ab OR "Tissue Activator D 44":ti,ab OR "tissue plasminogen activator":ti,ab OR "Tissue Type Plasminogen Activator":ti,ab OR "tPA":ti,ab OR "U-PA":ti,ab OR "Urokinase":ti,ab OR [mh "Debridement"] OR debrid*:ti,ab) AND ([mh "Adolescent"] OR [mh "Child"] OR [mh "Child, Preschool"] OR [mh "Infant"] OR "adolescence" OR "adolescent" OR "adolescents" OR "baby" OR "babies" OR "child" OR "childhood" OR "children" OR "infant" OR "infants" OR "infancy" OR "juvenile" OR "paediatric" OR "paediatrics" OR "pediatric" OR "pediatrics" OR "preschool child" OR "preschool children" OR "teen" OR "teenager" OR "teenagers" OR "teens" OR "toddler" OR "toddlers" OR "youth" OR "youths")

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