Is chest drain insertion and fibrinolysis therapy equivalent to video-assisted thoracoscopic surgery to treat children with parapneumonic effusions?

SCENARIO

A 12-year-old boy, previously fit and well, presents to his local paediatric emergency department after 5 days of fever and a cough, and 2 days of increasing difficulty breathing. His oxygen saturation is 90% in air, and he requires 2 L of oxygen via nasal cannula. He is started on broad-spectrum antibiotics and further investigations are arranged.

A chest X-ray is performed and shows a large left-sided pleural effusion. An ultrasound demonstrates the effusion is complex and loculated, with underlying lung consolidation, in keeping with a stage II parapneumonic effusion.

The medical team wonders whether insertion of a chest drain and fibrinolysis (CDF) or video-assisted thoracoscopic surgery (VATS) would be the most appropriate next step.

STRUCTURED CLINICAL QUESTION

Is CDF therapy equivalent to VATS to treat children with parapneumonic effusions?

Population	Children under 18 years of age with parapneumonic effusions
Intervention	Chest drain with fibrinolysis
Control	Video-assisted thoracoscopic surgery
Outcomes	1. Length of hospital stay 2. Need for second intervention

SEARCH STRATEGY

Search terms including keywords such as “empyema”, “parapneumonic effusion”, “thoracostomy”, “chest drain” and “video-assisted thoracic surgery” were used in different databases to identify relevant publications (online supplemental appendix 1). This yielded 692 search results, including 346 duplicates. Abstracts were screened for relevance by two independent reviewers. Overall, 20 studies were included for review of the full manuscript.

A Cochrane review[1] of surgical versus non-surgical management of pleural empyema reviewed the length of hospital stay in patients under 18 years of age in four randomised clinical trials (RCTs) published between 2006 and 2014.[2–5] Furthermore, a systematic review published in 2019 by Pacilli and Nataraja[6] reviewed the four RCTs considered in the Cochrane review, one additional RCT published in 2006[7] and five prospective cohort studies. Primary data published since the end date of the authors’ search (June 2018) were considered to complement the evidence from their meta-analysis. This yielded one additional RCT[8] and two retrospective cohort studies[9 10]. Data were then extracted by two independent reviewers from the five studies included (table 1).

LITERATURE APPRAISAL

DISCUSSION

The most recent systematic review identified through our search was the study by Pacilli and Nataraja (table 1), including five RCTs and five prospective cohort studies. Pacilli and Nataraja found a small but statistically significant reduction in the length of stay in patients receiving primary VATS compared with CDF (standard difference of means (SDM) −0.45 (CI −0.78 to −0.12), p=0.007). A similar trend was observed by an earlier

Table 1 Summary of included studies and appraisal

Study	Study type	Patient group	Key results	Key appraisal
Pacilli and Nataraja[6]	Systematic review and meta-analysis (level 2a)	1654 procedures: 1337 (81%) VATS, 317 (19%) CDF 5 cohort studies, 2006–2018 within the UK, USA and Taiwan 5 RCTs, 2006–2014 within the USA, UK, Spain and Turkey <18 years old	Length of hospital stay shorter in VATS (SDM −0.45 (95% CI −0.78 to −0.12)) Second intervention rate lower in VATS (RR 0.55 (95% CI 0.34 to 0.88))	High heterogeneity for length of hospital stay data (I^2=88%) No subanalysis by study design Range of severity included (stage I–III) Higher proportion of VATS compared with CDF
Derderian *et al*[9]	Retrospective cohort study (level 3b)	3365 patients: 523 (16%) VATS, 2842 (84%) CDF 52 tertiary paediatric hospitals, 2010–2017 within the USA <18 years old	Length of hospital stay shorter in VATS (rate ratio 0.77 (95% CI 0.75 to 0.78))	Very narrow CI, large numbers, large effect size Retrospective study using administrative data Total length of hospital stay rather than post-intervention
Shankar *et al*[8]	Single-centre RCT (level 1b)	41 patients: 20 (49%) VATS, 21 (51%) CDF Single tertiary centre in India <18 years old	Length of hospital stay similar in VATS and CDF (7 days vs 8 days, p=0.24) Second intervention rate similar in VATS and CDF (2/20 (10%) in VATS vs 1/21 (4.7%) in CDF, p>0.05)	Only patients with stage II empyema included Patients first had chest drain without fibrinolysis for 24 hours, then randomised if not deemed to be improving Not powered for second intervention rate outcome
Ibarra Rodriguez *et al*[10]	Retrospective cohort study (level 3b)	35 patients: 25 (71%) VATS, 10 (29%) CDF Single tertiary centre in Spain <14 years old	Length of hospital stay similar in VATS and CDF (9 days vs 12 days, p=0.09) Second intervention rate similar in VATS and CDF (16% in VATS and 29% in CDF, p>0.05)	Small sample size Retrospective design Preprocedural length of stay in VATS

CDF, chest drain with fibrinolysis; RCT, randomised clinical trial; RR, relative risk ratio; SDM, standard difference of means; VATS, video-assisted thoracoscopic surgery.

systematic review by Redden *et al*,[1] but their findings did not reach statistical significance (SDM −1.99 days (CI −4.36 to 0.39)).

In the study by Pacilli and Nataraja, a higher number of patients with VATS were included compared with CDF (81% vs 19%) because of a predominance of VATS patients compared with CDF patients in the cohort studies reviewed. This is surprising as a recent retrospective study in the USA highlighted that 95% of paediatric empyemas were treated with CDF in 2017.[9] This may be evidence of reporting bias due to the specialist centres conducting cohort studies opting for VATS over CDF more frequently than other hospitals. This could mean that these centres have greater than average familiarity with VATS, which may in turn lead to the benefits of VATS in other settings being overstated.

Heterogeneity was high in both systematic reviews for data on lengths of hospital stay (I^2=88% in Pacilli and Nataraja). As Marhuenda *et al* observed,[4] this could be due to differences in clinical practice across the different countries from which the studies originate. It could also be from the varied reporting of length of stay—while most studies reported length of stay as the number of days of hospitalisation post-intervention, some studies such as St Peter *et al* reported on total length of stay.[5]

Two of the studies published since the systematic reviews did not find a statistically significant difference in length of stay between VATS and CDF groups, although in both there was a trend towards shorter admissions (7 days vs 8 days, p=0.24 in Shankar *et al* and 9 days vs 12 days, p=0.09 in Ibarra Rodriguez *et al*).[8 10]

The last study considered in this review which reported on length of stay is Derderian *et al*,[9] a large retrospective cohort study of data from the Pediatric Health Information System capturing admissions at 52 tertiary care paediatric hospitals in the USA over 2010–2017. Patients receiving VATS had an overall shorter hospital length of stay rate ratio (17.9 days±13.2 vs 14.0 days±9.77, p<0.001). Although the authors did adjust for the need for supplemental oxygen, length of hospital stay preprocedure and mechanical ventilation in an attempt to account for disease severity when analysing length of paediatric intensive care unit stay, they did not apply this adjustment to length of hospital stay data. This means that one cannot discount the possibility that baseline differences between the VATS and CDF groups, especially in terms of disease severity prior to intervention, explain the difference in lengths of stay between the two groups.

Table 2 Three stages of parapneumonic effusions[15]

Stages of parapneumonic effusions	Clinical characteristics
I	Uncomplicated effusion
II	Septated effusion
III	Organising empyema

Clinical bottom line

⇒ Video-assisted thoracoscopic surgery (VATS) and chest drain with fibrinolysis (CDF) appear equivalent for primary treatment in children with parapneumonic effusions requiring drainage in terms of length of hospital stay. (Grade B)

⇒ VATS may be associated with less frequent second interventions than CDF. (Grade B)

In terms of second intervention rates, Pacilli and Nataraja found a statistically significant difference in favour of VATS (relative risk ratio 0.55 (CI 0.34 to 0.88), p=0.01).[6] Shankar *et al*[8] and Ibarra Rodriguez *et al*[10] also reported on this outcome but did not show a statistically significant difference, although numbers of second interventions were small in both groups, and Shankar *et al* noted their study was underpowered for intervention failure rate.

Another area of heterogeneity among the studies included in the systematic review by Pacilli and Nataraja is the severity of the parapneumonic effusions considered.[6] While certain trials specifically included only patients with stage II and III effusions[4] (table 2), others included patients with all gradients of severity, which makes it challenging to compare their outcomes.

One cost-effectiveness study showed that CDF is less expensive than VATS, except if the projected length of stay associated with CDF exceeds 10.3 days, in which case the model prefers VATS[11]; another study however found that VATS was not associated with higher overall costs.[12]

A survey of paediatric surgeons in New Zealand and Australia showed 61% of them preferred CDF,[13] and the British Thoracic Society UK guideline advises VATS only after CDF failure.[14] This inclination towards CDF seems to be supported by the best available evidence on the topic.

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