



## Original article

# Comparison of small lumen versus large lumen inter costal catheter drainage in empyema thoracis on degree of comfort and re-expansion of lungs: An open label, quasi randomized study

Sunil Kumar<sup>\*</sup>, Shally Awasthi, Nishant Verma, Sarika Gupta

Department of Pediatrics, King George Medical University, Lucknow, India

## ARTICLE INFO

## Keywords:

Pyothorax  
Community acquired pneumonia  
Inter-coastal drainage  
FLACC scale

## ABSTRACT

**Background:** Use of intercostal drainage tube (ICDT) is an accepted treatment of empyema thoracis (ET). We compared the effectiveness of small versus large lumen ICDT on degree of pain on 4th day of ICDT insertion as well as drainage of pus in cases of ET.

**Methods:** It was an open labelled quasi randomized study, conducted in a tertiary care Hospital of Northern India. Children 2 month to 12 year old were randomized by days of the week into two groups. In group A, 12/14F and in group B, >14F ICDT was used (1,2,12). Face, Legs, Activity, Cry, Consolability (FLACC) pain scoring was used on 4th day of ICDT insertion. Ultrasound (USG) of thorax was done on day 1, between day 5-6 and 10-12 to assess the amount of fluid.

**Results:** From September 2018 to August 2019, 130 cases (66 in group A and 64 in group B) were enrolled. FLACC Pain score was higher in group B ( $7.50 \pm 1.272$ ) as compared to group A ( $2.86 \pm 0.839$ ) ( $p = 0.034$ ). There was no significant difference in amount of fluid drained between day 1 and 5 in group A versus group B ( $159.3 \text{ ml} \pm 125.9 \text{ ml}$  versus  $179.5 \text{ ml} \pm 167.6 \text{ ml}$ ,  $p = 0.2$ ) and between day 1 & 10 ( $205.6 \text{ ml} \pm 130.2 \text{ ml}$  versus  $244.5 \text{ ml} \pm 174.7 \text{ ml}$ ,  $p = 0.7$ ).

**Conclusion:** Small lumen (12F-14F) ICDT cause substantially less pain than large lumen (>14F) ICDT without significant difference in drainage of pus and duration of hospital stay in children with ET.

## 1. Introduction

Community Acquired pneumonia (CAP) is the leading cause of morbidity and mortality globally in children. In 2015, India, Nigeria, Indonesia, and China contributed to more than 54% of all global pneumonia cases, with 32% of the global burden from India alone.<sup>1</sup> Complications of CAP can be - local or distant. Local complications include pleural effusion, empyema, pneumothorax, necrotizing pneumonia, lung abscess, bronchiectasis, and pyopericardium. Distant complications of CAP are septicemia and metastatic infection like osteomyelitis, septic arthritis, meningitis, etc.<sup>2</sup>

ET complicates bacterial pneumonia in 5–10% of children.<sup>3</sup> The majority of cases can be successfully managed with antibiotics and chest tube drainage alone. Thoracotomy was needed in a small proportion of cases.<sup>4</sup> Though the incidence of ET has declined in the west due to the effective use of broad-spectrum antibiotics, it still remains a significant health problem in developing countries due to low socioeconomic

status, Malnutrition, delay in diagnosis of pneumonia, and delay in initiating treatment, misdiagnosis or inadequate/inappropriate treatment of pneumonia, non-evacuation of pus from pleural space and delayed referral to the higher centre could be the possible reasons.<sup>5</sup> For empyema, besides antibiotics, various treatment options are available ICD or decortication by video-assisted thoracoscopic surgery (VATS).<sup>6</sup>

Evacuation of pus by the placement of ICDT is the initial treatment in children with ET, VATS requires an advanced stage of ET which does not respond to ICDT (1,2&14). Wide bore (>14 F) tubes has been preferred for ICD placement because it is considered to improve drainage and reduce the risk of the blockade. However, the use of a wide bore ICD tube may be associated with greater discomfort for the child.<sup>7-9</sup> The present study was carried out to determine the effect of small lumen ICDT versus large lumen ICDT on the degree of comfort and re-expansion of lungs in patients with ET.

<sup>\*</sup> Corresponding author.

E-mail address: [sunilkumarrims09@gmail.com](mailto:sunilkumarrims09@gmail.com) (S. Kumar).

<https://doi.org/10.1016/j.cegh.2022.101142>

Received 8 July 2022; Received in revised form 16 August 2022; Accepted 5 September 2022

Available online 13 September 2022

2213-3984/© 2022 The Authors. Published by Elsevier B.V. on behalf of INDIACLEN. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## 2. Material and methods

This study was an open-label quasi-randomized trial conducted in the Pediatrics Department of King George Medical University, Lucknow from September 2018 to August 2019 involving children 2 months to 12 with a diagnosis of ET. The study protocol was approved by the institute ethics committee [Ref. code: 93rd ECM II B-Thesis/P27]. ET is characterized by accumulation of frank pus in pleural space<sup>6</sup>. The criteria for the diagnosis of ET were the presence of pleural effusion on radiological examination and USG-guided aspiration of frank pus from pleural space. Exclusion criteria were pneumothorax, shock, malignancy, bilateral empyema, and recurrent empyema.

Patients were quasi-randomized by days of the week to undergo intercostal drainage using either a small-bore ICD catheter (Group A/12-14 F) or a wide bore ICD catheter (Group B/>14 F). After taking proper consent from parents (for children <8 years) and consent from parents with assent from children (for children >8 years), in group A (12 F-14 F), we enrolled all the eligible patients admitted on Monday and Friday and in group B (>14 F), we enrolled all the eligible patients admitted on Tuesday, Wednesday, Thursday and Saturday.

There are various techniques for ICDT insertion but in our study, the blunt dissection technique was used for ICDT insertion. Intravenous midazolam and ketamine were used to sedate all the patients and lidocaine were used for the preparation of the puncture site (usually the fifth intercostal space). After insertion of ICDT, a combination of ibuprofen & paracetamol syrup was given to all the patients for the relief of pain for 3 days. ICDT was flushed with 10 ml of sterile normal saline daily (in the morning and evening). All the patients received broad-spectrum empirical antibiotics till the culture report was awaited. When cultures were positive, the antibiotic scheme was modified accordingly.

Pain score was noted on day 4 of ICDT insertion by using the FLACC pain score.<sup>10</sup> This is a simple scale that is independent of reporting by parents or children and has a maximum score of 10 and a minimum score of zero. USG of thorax was done on day 1 (between 24 and 36 h), between day 5-6, and between day 10-12 to assess the amount of fluid. The difference in the volume of fluid in these consecutive imaging studies was used to assess the volume of fluid drained. USG was done by a trained specialist radiologist who was blinded to the type of intervention. The catheter dwell time and duration of hospital stay were also recorded.

Sample size was calculated by assuming 2 tailed distribution of alpha-0.05 and FLACC pain score of  $\geq 3$  in 40% in children with ICDT of >14 F & in 15% in children with  $\leq 14$  F ICDT on day 3rd-4th of tube insertion and power of 80%. Minimum sample size required was 100. Taking into account 10% attrition due to patients leaving against medical advice (LAMA) and absconding sample size was 108.

Results were expressed as mean  $\pm$  SD. The Mann-Whitney *U* test was used for intergroup comparisons. Chi-square test was used for comparisons of group proportions with qualitative data. A value of  $p < 0.05$  was considered significant.

## 3. Results

Over the one-year study period, 162 cases of pleural effusion were screened and among them, 130 fulfilled the inclusion criteria and were enrolled in the study (66 in Group A and 64 in Group B) (Fig. 1). On completion of day 5, one patient died in Group A and 5 patients died in Group B, thus there were 65 patients in Group A and 59 patients in Group B after day 5 (Fig. 1). As Monday and Friday are the days of consultants which are our co-guides and also days for respiratory system specialists so most of the respiratory cases come on these two days that's

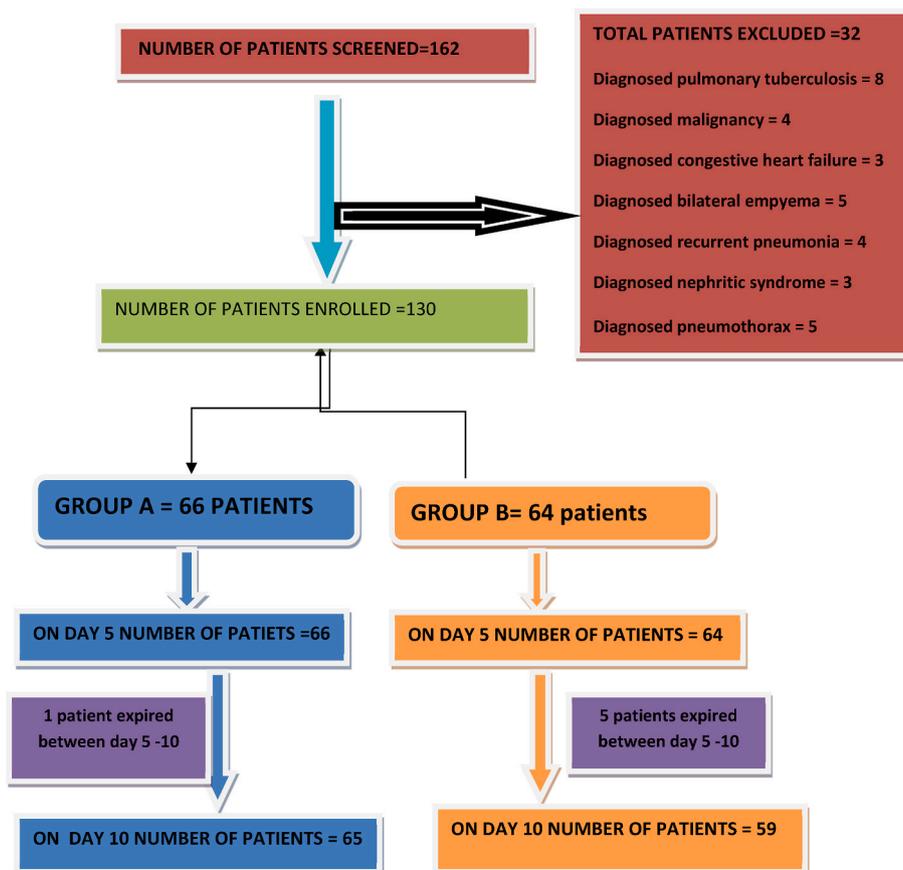


Fig. 1. Flow chart of this study

why we randomized two groups into group A (Monday, Friday) and group B (Tuesday, Wednesday, Thursday and Saturday) and enrolled almost equal cases in both groups during one year of the study period.

Table 1 shows baseline characteristics of ET cases in both groups. We have done pleural fluid culture of all the enrolled (130) cases of ET. Pleural fluid culture examination revealed that out of 130 cases of ET, pus culture was positive only in 42 (32.30%) cases (Table 1). Acinetobacter species were found in 12 (9.2%), Staphylococcus Aureus in 9 (6.92%), Klebsiella in 5 (3.8%) and Streptococcus pneumoniae in 2 (4.5%) cases.

Clinical outcome of ET in both groups is presented in Table 2. In the comparison of pain scores in both the groups on the 4th day of ICDT insertion, mean pain score was 2.86 in group A and 7.50 in group B ( $p = 0.034$ ) (Table 2).

Pus drained by small lumen ICDT and large lumen ICDT between day 1 & day 5 and between day 1 & day 10 of ICDT insertion was similar in both groups (Table 2). In comparison of duration of hospital stay and catheter dwell time, there was no significant difference in both groups. One patient expired in group A due to septic shock and 5 patients expired in group B, among 5 patients 3 expired due to septic shock, and 2 patients expired due to sepsis with multiorgan dysfunction.

#### 4. Discussion

Here, we are reporting the results of a prospective open-labeled quasi-randomized study conducted in a tertiary care hospital in Northern India to ascertain the effect of the size of an ICD tube on pain, drainage of pus, and duration of hospital stay in children with ET.

In our study, we found that there was no significant difference in drainage volume, catheter dwelling time, and duration of hospital stay between both the groups but smaller size (12–14 F) ICD tube caused substantially less pain than large lumen (>14 F) ICD tube without any impairment in the clinical outcome of the patients of ET. In coherence with our results, similar results were found by a number of authors. A prospective randomized study done by Clemensten et al.<sup>11</sup> reported FLACC pain score of 2/10 in small lumen ( $\leq 14$  F) ICD tube group and 6/10 in large lumen (>14 F) ICD tube group with  $p = 0.01$  in children with ET which was statistically significant. Rehman NM et al.,<sup>9</sup> in a prospective randomized study found FLACC pain score of 4/10 versus 6/10 with  $p = 0.013$  in small lumen ( $\leq 14$  F) ICD tube group and in large lumen (>14 F) ICD tube group respectively which was statistically significant. Another prospective randomized study done by Rehman N M et al.<sup>12</sup> by using visual analogue scale (VAS) for pain and found scores of 22/100 in small lumen ( $\leq 14$  F) ICD tube group and 26.8/100 in large lumen ICD tube group with  $p$  value of 0.04 which was statistically significant.

The available clinical data for this cohort has also allowed disquisition of the effect of size of tube on duration of hospital stay, amount of fluid drainage. In our study, on comparison of USG between day 1 & day 5 and day 1 & day 10 the difference in the drained amount of pus in both groups was not different. Similar to our results, Clemensten et al.<sup>11</sup> and

**Table 1**

Baseline demographic and laboratory data of patients.

|                                      | Group A              | Group B             | P value |
|--------------------------------------|----------------------|---------------------|---------|
| <b>Patient characteristics</b>       |                      |                     |         |
| Number (M/F)                         | 66 (44/22)           | 64 (44/20)          | 0.8     |
| Mean age, yr                         | 4.61 $\pm$ 2.37      | 4.91 $\pm$ 3.30     | 0.002   |
| <b>Blood investigations</b>          |                      |                     |         |
| Hemoglobin, gm/dl                    | 10.52 $\pm$ 1.24     | 10.08 $\pm$ 1.05    | 0.33    |
| Total leukocyte count, /cu.mm        | 16724.8 $\pm$ 7731.1 | 16,048 $\pm$ 6792.4 | 0.59    |
| <b>Pleural fluid characteristics</b> |                      |                     |         |
| pH                                   | 6.82 $\pm$ 0.07      | 6.81 $\pm$ 0.04     | 0.10    |
| Glucose, mg/dl                       | 25.43 $\pm$ 14.88    | 29.41 $\pm$ 22.75   | 0.01    |
| WBC count                            | 577.86 $\pm$ 907.72  | 567.85 $\pm$ 774.90 | 0.36    |
| Bacterial culture positive           | 22                   | 20                  |         |

**Table 2**

Comparison of outcomes in Group A and B.

|  | Group A (n = 66)* | Group B (n = 64)* | P value |
|--|-------------------|-------------------|---------|
| Pain score on 4th Day  | 2.86 $\pm$ 0.839  | 7.50 $\pm$ 1.272  | 0.034   |
| Amount of fluid drained between Day1 and Day5, ml                                    | 159.3 $\pm$ 125.9 | 179.5 $\pm$ 167.6 | 0.2     |
| Amount of fluid drained between Day1 and Day10, ml (here, n1 = 65 and n2 = 59 taken) | 205.6 $\pm$ 130.2 | 244.5 $\pm$ 174.7 | 0.7     |
| Catheter dwell time, days (here n1 = 65 & n2 = 59 taken)                             | 16.3 $\pm$ 8.3    | 20.6 $\pm$ 10.8   | 0.62    |
| Hospital stay, days (here n1 = 65 & n2 = 59 taken)                                   | 21. $\pm$ 9.9     | 25.6 $\pm$ 13.8   | 0.8     |

Rehman NM et al.<sup>9,12</sup> did not find any significant difference in drainage of pus in both groups. In many other studies, the most common organism in pus culture of patients with ET was Staph. Aureus but in our study the most common organism in pleural fluid culture was pseudomonas found in 14 (10.8%) cases could be due to hospital-acquired infection, as pseudomonas and acinetobacter species are common hospital-acquired infections in our department.

In our study, we found that there was no significant difference in the duration of hospital stay in both groups. In group A, the mean duration of hospital stay was 21 days and in group B mean duration of hospital stay was 25 days ( $p = 0.8$ ) and these results were similar to results got by Najib M Rehman et al. (2010, England),<sup>9</sup> 24 days in small lumen ICD tube versus 31 days in large lumen ICD tube with  $p = 0.37$ , Clemensten et al. (1998, France),<sup>11</sup> 18 days in small lumen ICD tube and 15 days in large lumen ICD tube with  $p = 0.32$  and Megan R. Lewis et al. (2017 Cardiff, UK).<sup>13</sup> Some of these authors had assessed the effect of size of ICD tube on drainage of pus and length of hospital stay but had not evaluated its effect on pain score. Only 27 patients (16 in group A and 11 in group B) require intrapleural streptokinase, criteria for use of streptokinase was the presence of septations on USG thorax. None of the enrolled patients in both groups required VATS.

#### 5. Strengths of our study

FLACC pain score was used for the objective assessment of pain and discomfort. This was a simple scale that was independent of reporting by parents or children. Objective ultrasound criteria were used for assessing the pleural fluid volume and the ultrasound assessor was blind to intervention type.

#### 6. Weakness of our study

As this study was conducted in a tertiary care center it leads to selection bias as a patient admitted would have taken prior antibiotics and were very sick so the patient came in a chronic condition of disease so their hospital stay could be more. The study was quasi-randomized as patients were randomized by days of the week. However, there was no significant difference in clinical and laboratory characteristics in both groups. There could have been assessment bias in pain scoring as the assessor was not blinded. This bias could not be avoided in the quasi-randomized study design.

#### 7. Conclusion

Using narrow lumen ICD tube for management of children with ET leads to significantly less discomfort to the child without compromising the drainage of empyema fluid and duration of hospital stay. As pain is of big concern in pediatric patients, therefore we concluded that the use of a small lumen ICD tube for drainage of pus in pediatric empyema should be preferred.

### Ethics approval

Approval of the ethics committee of our institution (King George Medical University, Lucknow) was obtained for this study (Reference code 97th ECM II B-Thesis/P117).

### Funding

This research did not any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

### Author contribution

Sunil Kumar: Data collection, data analysis, manuscript writing. ShallyAwasthi: Study design, interpretation, manuscript writing. Nishant Verma, Sarika Gupta: Data analysis, manuscript writing.

### Data availability and transparency

Data are available on reasonable request. The data contained within this study can be obtained by writing to the corresponding author (SK) at email: [sunilkumarrims09@gmail.com](mailto:sunilkumarrims09@gmail.com).

### Declaration of competing interest

Neither author has any conflict of interest to declare.

### Acknowledgements

I want to say thanks to all the faculty members of Pediatrics department of King George Medical University Lucknow.

### References

- McAllister DA, Liu L, Shi T, et al. Global, regional, and national estimates of pneumonia morbidity and mortality in children younger than 5 years between 2000 and 2015: a systematic analysis. *Lancet Global Health*. 2019 Jan 1;7(1):e47–e57.
- Hamm H, Light RW. Parapneumonic effusion and empyema. *Eur Respir J*. 1997;10:1150–6.
- Harris M, Clark J, Coote N, et al. British Thoracic Society guidelines for the management of community acquired pneumonia in children: update 2011. *Thorax*. 2011 Oct 1;66(Suppl 2):iii1–23.
- Singh M, Singh SK, Chowdhary SK. Management of empyema thoracic in children. *Indian Pediatr*. 2002;39(2):145–157.
- Satpathy SK, Behera CK, Nanda P. Outcome of parapneumonic empyema. *Indian J Pediatr*. 2005 Mar;72(3):197–199.
- Rao MS, Chandra PS. A study of paediatric empyema thoracis presentation in a tertiary care hospital in Visakhapatnam, India. *Int J Contemp Pediatr*. 2018 Feb 22;5(2):572.
- Yu H. Management of pleural effusion, empyema, and lung abscess. In: *Seminars in Interventional radiology*. Vol. 28. 2011 Mar. No. 01, pp. 075–086. © Thieme Medical Publishers.
- Light RW. Parapneumonic effusions and empyema. *Proc Am Thorac Soc*. 2006;3:7580.
- Yu H. Management of pleural effusion, empyema, and lung abscess. *Semin Intervent Radiol*. 2011 Mar;28(1):75–86. <https://doi.org/10.1055/s-0031-1273942>. PMID: 22379278; PMCID: PMC3140254.
- Rahman NM, Maskell NA, Davies CW, et al. The relationship between chest tube size and clinical outcome in pleural infection. *Chest*. 2010 Mar 1;137(3):536–543.
- Voepel-Lewis T, Shayevitz JR, Malviya S. The FLACC: a behavioral scale for scoring postoperative pain in young children. *Pediatr Nurs*. 1997;23(3):293–297.
- Clements P, Evald T, Grode G, Hansen M, Jacobsen GK, Faurichou P. Treatment of malignant pleural effusion: pleurodesis using a small percutaneous catheter. A prospective randomized study. *Respir Med*. 1998 Mar 1;92(3):593–596.
- Rahman NM, Pepperell J, Rehal S, et al. Effect of opioids vs NSAIDs and larger vs smaller chest tube size on pain control and pleurodesis efficacy among patients with malignant pleural effusion: the TIME1 randomized clinical trial. *JAMA*. 2015 Dec 22;314(24):2641–2653.
- Lewis MR, Micic TA, Doull IJ, Evans A. Real-time ultrasound-guided pigtail catheter chest drain for complicated parapneumonic effusion and empyema in children—16-year, single-centre experience of radiologically placed drains. *Pediatr Radiol*. 2018 Sep;48(10):1410–1416.