International Journal of Nursing
Peer Reviewed | Open Access | Free Online Journal | www.ijnonline.com
Published Biannually | ISSN: 2279-0195.

ORIGINAL ARTICLE

Use of Double Lumen Central Venous Catheters for the Drainage of Pleural Effusion in Paediatrics: A Prospective Observational Study

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ABSTRACT

Background: The objective of this study was to evaluate the safety and effectiveness of the use of double lumen central venous catheter for the drainage of uncomplicated pleural effusions in paediatric patients post cardiac surgery.

Methods: A prospective observational study was performed in a Cardiac Surgical Intensive Care Unit of a tertiary hospital in the Middle East. The procedure involved the insertion of a double lumen central venous catheter at the bedside without ultrasound guidance. Catheter placement was confirmed through radiological examination.

Results: Forty seven patients were included in the study. The average age of the sample was 9.76 months. The average amount of fluids drained was 481.17 ml. One case (2.13%) had pneumothorax on insertion. Three cases (6.38%) had line dislodgment and one of them (2.13%) required line re-insertion. Three cases (6.38%) were reported to have mild pleural effusion within 24 hours post line removal that did not require further intervention. No cases (0%) have developed pleural effusion within the next 24 hours after line removal. No safety issues were recorded including the risk of miss-using the line for other reasons (e.g. medication administration).

Conclusion: The use of double lumen central venous catheter to drain pleural effusion is considered a safe and effective practice in an intensive care setting. Future studies should aim to recruit larger samples with comparative methodology to achieve more representative findings.

Keywords: *Central Venous Catheter; Paediatric Cardiac Surgery; Congenital Heart Disease; Pleural Effusion; Complications; Safety Measures..*

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Introduction:

The incidence of Pleural Effusion (PE) post cardiac surgery is high (Singh et al., 2003). Presence of a PE may compress underlying lung tissue resulting in atelectasis and impaired gas exchange. This may extend the need for mechanical ventilation, delay extubation and increase patients' length of stay. In pediatric patients, uncomplicated PE is managed either by thoracentesis via a small gauge needle, the insertion of standard chest tubes or by using small bore pig-tail drains. The hypothesis of this study is that using double lumen central venous catheters for the drainage of PE will result in effective removal of PE with fewer complications. There are few published studies that have covered this topic. Singh et al. (2003) is the only published paper with similar goals. Singh et al (2003), however, was able to recruit only 10 participants in their study. The objective of this study is to add to the existing body of literature regarding this common complication in cardiac surgical patients. The clinical environment in the Organization where the study was conducted would allow for higher subject participation and hence statistical significance. The main goal of this study is to demonstrate that using central venous catheters for pleural drainage is both safe and effective.

Aim

The aim of this research project is to investigate the safety of the use of double lumen Central Venous Catheters (CVC) for the drainage of PE in pediatric patients in a Cardiac Surgery Intensive Care Unit (CSICU).

Outcome indicators will include the following: Insertion complications (Pneumothorax, hemothorax, pulmonary edema, lung injury) within the first 24 hours post catheter insertion, resolution of PE as seen on X-Ray, dislodgement of catheter, blockage of catheter, accidental disconnection to the drainage system, duration of catheter, infection at insertion site, effective fluid drainage post insertion, PE recurrence within 24 hours post catheter removal, cost and any other safety measures associated with this practice (e.g. medication administered through (CVC).

Methodology

This study was prospective observational one. The medical records of patients admitted to CSICU who have a CVC inserted for pleural drainage will be examined. An additional data collection tool was utilized to capture extra data fields relevant to the study purposes. All data was entered into a secure database designed for this study. Included Independent Variables were the following: Age in months, gender, diagnosis, date of pleural CVC insertion, date of pleural CVC removal, total line days, total amount of drainage, CVC description including gauge and size and surgical procedures which were grouped according to the Risk Adjustment in Congenital Heart Surgery (RACHS-1) model and Society of Thoracic Surgeons (STS) congenital database (Jenkins, 2004).

Dependent variables included the following: Insertion complications (Pneumothorax, hemothorax, pulmonary edema, lung injury) within the first 24 hours post catheter insertion, resolution of PE as seen on X-Ray, dislodgement of catheter, blockage of catheter, accidental disconnection to the drainage system, duration of catheter, infection at insertion site, effective fluid drainage post insertion, PE recurrence within 24 hours post catheter removal, cost and safety aspects associated with this practice.

Inclusion Criteria

The study has included all patients from newborn up to five years old who underwent cardiac surgery at the Heart Centre of the Organization, and who had a double lumen CVC inserted for PE.

Exclusion Criteria

The study has excluded:

- All patients post cardiac surgery that had a CVC inserted for ascitis.
- Patients with pre-existing coagulation anomalies (bleeding, PTT > 120 sec.).
- Patients with active sepsis.

Preparation and procedure for catheter insertion

The procedure was performed with the patient lying in a semi-recumbent manner. The ipsilateral arm was raised over the examination. The site of insertion was determined by physical examination. The skin was prepared with 0.05% chlorhexidine and was then draped in a sterile manner. Local anesthetic (3–5 ml of 1% lidocaine) was infiltrated from the subcutaneous plane down to the parietal pleura with a 21 G needle. The catheter utilized for the procedures were size 4 or 5 French (Fr.) according to patient's size. Arrow® Two-Lumen Indwelling Catheter: 4 Fr. x 2" (5 cm) and 5 Fr. x 3-1/8" (8 cm) Polyurethane (Figure 1) used in conjunction with a wire and dilator, and connected through a three-way stopcock to two drainage bags. After determining the insertion site, a needle was inserted through the intercostal space over a rib until

with a gentle aspiration with syringe a pleural fluid was located and aspirated. A guide wire was introduced through the needle. Subsequently, the needle was removed, and the tract was dilated prior to the insertion of a two-lumen catheter was placed in the pleural space. Care was taken that the dilator should not be inserted more than the expected distance from the chest wall to parietal pleura, in order to decrease the risk of lung injury. Finally, the catheter was connected to a three-way stopcock and attached to a bile bag HS-U-400 Hyupsung®. Catheter drainage success was defined as improvement in the PE by image findings in the chest radiograph. Failure was defined as the persistence or exacerbation of clinical and radiological findings related to PE. Catheter-associated insertion complications included hemothorax, pneumothorax, hepatic perforation, empyema, a kink in the catheter, disconnection of the tubing, and subcutaneous hematoma.

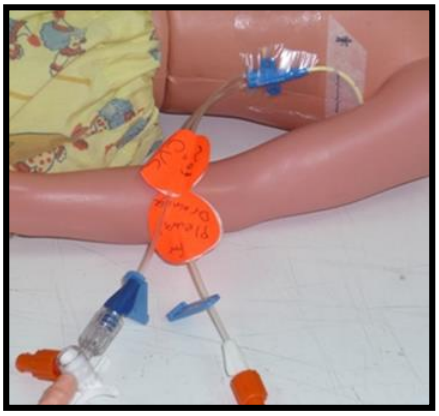

Figure 1. Arrow Two-Lumen Indwelling Catheter: 4 Fr. x 2" (5 cm)

Nursing Considerations

The practice of using double lumen CVCs has been identified by the nursing staff of this Organization as an area that might induce a potential mismanagement. To ensure a safe practice in handling those lines, several steps have been introduced (Figure Two):

- Lines were labeled with unique colorful labels to distinguish them from traditional CVCs.
- One port of the CVC used for pleural fluid drainage was labeled as “Not a CVC”, and the second port was labeled as “For Pleural Drainage”.
- The connections between the line, the three-way stopcock, and the drainage bag were secured with adhesive tape.
- Unused ports were attached to different claves to prevent easy access.
- Several educational session have been conducted in the clinical area about the safety aspects of handling those lines.
- A hospital-wide safety notification was sent to all nursing affairs members to increase the awareness about this practice.

Figure 2. Patient Safety Alert

Statistical Considerations

As this is an observational study with no intended comparisons, no power or Type 1 error calculations were required. In order to increase validity of the results the study was conducted over 6 months with the intention to recruit as many participants as possible. Data was analyzed utilizing the SPSS (Statistical Package for the Social Sciences) system.

Ethical Considerations

This research project was conducted in accordance with the ethical principles contained in the Declaration of Helsinki (2000), the ICH (International Conference on Harmonization) Harmonized Tripartite Good Clinical Practice Guidelines, the policies and guidelines of the Research Advisory Council (RAC) at KFSH&RC and the laws of Saudi Arabia.

This study proposed no additional interventions to patients participating in this study. As this proposal was primarily about collecting data with no clinical interventions, it posed no risk to patients. The study risk-benefit ratio is considered to be very favorable.

A waiver of written, informed consent was obtained from the RAC. The research subjects were assigned to an identification number separate from the MRN to ensure that patient information remains anonymous. Data was collected using a pre-designed form (Appendix A). The collected data and all related computer files related to this research were locked in a safe place in the department of Nursing Practice and Research and were available to the RAC for inspection as per the organization guidelines.

Results

A total of forty seven patients were included in the study. The mean age was 9.76 months; the median was 5.00 months with a range between 7 days-48 months. Among the 47 patients, 27 (57.4%) were male and 20 (42.6%) were female. Included subjects were 6 patients within category RACHS 1, 17 patients on category 2, 19 patients in category 3, 3 patients in category 4, and 2 patients in category 6. The following table summarizes the demographics of the included sample:

Table 1. Sample Demographics

Description	Results	Percentage
Total No. of cases	49	100%
Average Age	9.76 Months	
Youngest Included	7 Days	
Oldest Included	4 Yrs.	
No. of Males	27/47	57%
No. of Females	20/47	43%
Total No. of cases	49	100%
Average Age	9.76 Months	

The pre-catheter insertion coagulation profile was as the following: Protrombin time (PT): mean of 13.9 sec. and median of 14.4 sec., with a range of 9 sec. to 20.1 sec. The Activated Protrombin Time (aPTT): 36.8 sec. with a median of 35.8 sec. with a range of 21.1 sec. to 87.2 sec. The International Normatized Ratio (INR): mean of 1.2 median of 1.3 with a range of 0.9 to 2.6. The insertion line site was in the right pleura in 34 patients (72.34%), left pleura in 13 patients (27.66%). The duration of line days ranged between 0 to 30 days with a mean of 4.66 days and a median of 3 line days. The total amount of fluid drainage was of a mean of 481 mL, with a minimum of 0 mL and a maximum of 3339 mL. In terms of insertion complications there was only one pneumothorax (2.1%). In-situ complications were found as follows: Line dislodgment in 3 patients (6.4%), line blockage in 1 patient (2.1%). Complications within 24 hours after removal of the catheter were mild pleural effusion in 3 patients (6.4%), chylothorax in 1 patient (2.1%). None of the cases (0%) required the insertion of new line within 24 hours form the initial line removal. Two cases (4.26%), however, have required the re-insertion of a new line after 24 hours from lines removal.

The table below summarizes the cardiac surgical cases that were included in the study:

Table 2. Cases included in the study

Case	Number	Percentage
Blalock-Tausig (BT) Shunt Procedure	6/47	12.77%
Coaractation of Aorta (CoA) Repair	6/47	12.77%
Arterial Switch Procedure	5/47	10.64%
Atrio-Ventricular (AV) Canal Repair	4/47	8.51%
Fontan Procedure	4/47	8.51%
Glenn Procedure	4/47	8.51%
Ventricular Septal Defect (VSD) Closure	4/47	8.51%
Right Ventricular Outflow Tract Obstruction(RVOTO) Relief	3/47	6.38%
Teratology of Fallot (TOF) Repair	3/47	6.38%
Total Anomalous Pulmonary Valve Drainage (TAPVD) Relief	3/47	6.38%
Norwood Procedure	2/47	4.26%
Aortic Valvotomy	1/47	2.13%
Tricuspid Valve (TV) Repair	1/47	2.13%
Pulmonary Artery (PA) Augmentation	1/47	2.13%

Discussion

Different techniques could be used to drain PE including traditional thoracentesis (Pneumatikos and Bouros, 2008), and using a pig-tail catheter (Bradley et al., 1986). Reported complications associated to those procedures include increase risk of hemothorax, pneumothorax, bleeding, and patients' discomfort (Pneumatikos and Bouros, 2008). The use of double lumen CVC is one alternative which is considered a less invasive procedure and a safe practice as well (Singh et al., 2003). One the other hand, most of the pig-tail catheters are inserted by interventional radiologist under ultrasound guidance which is time consuming (Singh et al., 2003).

There are few studies that have examined the effectiveness of using CVCs to drain PE (Cooper, 1987; and Singh et al., 2003). This study is considered

one of the first studies that have examined this aspect in details with larger sampling size in comparison with the previous two studies. This study has examined different variables that would impact the study findings. The findings of this study have demonstrated that the use of double lumen CVCs is considered a safe and effective procedure to drain uncomplicated PE in intensive care settings. One case (2.13%) was reported to have pneumothorax during the insertion procedure. Other studies that have examined the use of traditional thoracentesis have reported pneumothorax in 7% of the cases (Fartoukh et al., 2002).

The procedure did not require the use of water seal system, and a regular bile bag drainage was connected to the line instead. The system was placed below the patient's level and was left for gravity drainage. Drained fluids were measured every 12 hours at the end of every nursing shift. This practice did not induce further complications or deterioration in patients' physiological status. It should be outlined that such practice is considered a cost effective one in comparison with the water seal system.

The study has revealed many advantages of using double lumen CVCs to drain PE. The incidence of line blockage was reported in one case only which eliminates the fear from having frequent lines blockage with this procedure. One line kept in-situ for 30 days without any reported incidents of blockage, dislodgment, or infection. PE was resolved effectively in most of the included cases which suggest that this procedure is effective in draining PE. The medical team has also used this procedure to treat pneumothorax in seven cases. Pneumothorax was resolved in all seven cases. There were no reported cases of miss-using the lines by the nursing staff. No medications or fluids were administered by mistake though those lines. The increased awareness of nurses about this practice has helped in eliminating those risks. Finally, this procedure is considered a cost-effective in comparison with the traditional techniques.

In summary, this study provided data on the use of double lumen CVCs to drain PE and pneumothorax in patients post cardiac surgical procedures. The study has shown many advantages of utilizing this technique including effectiveness of the procedure and associated safety aspects of using those lines.

Study Limitations

There are some limitations to this study that should be taken in consideration. This study included a relatively small sample, and future studies should recruit larger samples. There was no comparative group in the study. Therefore, the inclusion of a comparative group would help in having more reliable and powerful findings.

Conclusion and recommendations

The use of double lumen CVC is a safe and effective approach to drain uncomplicated PE. There was no safety issues associated with this practice. Few complications have been reported throughout the study. Future studies should aim to include larger sample size and comparative groups.

Acknowledgment

The authors are grateful to the following persons who have help in getting this study successfully completed on a timely manner. This includes:

- Research Advisory Council (KFSH&RC-Riyadh)
- Members of the Research & Informatics Office of the Heart Centre.
- Cardiovascular Nurses (Victoria Smith, Cindy Kloth, Bincy Francis, Mohammed Ibhais, Nisha Varughese, Jane Ntsoane, Binu Zacharias, Grace Abraham, Tiong Lay Khing, Rejani Mathew, Anju Ramanan, Sindhu Thomas, Nerissa Barcelon, Sreekumari Parukutty, Emad Abdelrahman, Ally Varughese, Mohd Alomari, and Shiny Augustin) who have offered great help in data collection.
- Dr. Avedis Kalloghlian (Medical Director-CSICU) for his support throughout the study. Dr. Kalloghlian is a pioneer in the utilization of this procedure in CSICU.
- Dr. Elias Saad (Cardiologist/Intensivist-CSICU) for all the help and support in data analysis and drafting this paper.

REFERENCES

1. Bradley, P. et al. (1986). Pleural drainage using modified pigtail catheters. Critical Care Medicine, 14(6), pp. 575-576.
2. Cooper, C. M. (1987). Plural aspiration with a central venous catheter [letter]. Intensive Care Medicine, 25, p. 1029.
3. Fartoukh, M., Azoulay, E., Galliot, R., Jean-roger, L.G. and Al, E. (2002) clinically documented pleural effusions in medical ICU patients: How useful is routine thoracentesis? Chest, 121(1), pp. 178-84.
4. Fisher, J and Guarrera, J. (2007). Modified thoracentesis technique using a triple lumen catheter. The American Journal of Surgery 194, pp. 406-408.
5. Grodzin, C.J. and Balk, R.A. (1997) Indwelling small pleural catheter needle thoracentesis in the management of large pleural effusions. Chest, 111(4), pp. 981-8.
6. Jenkins, K. (2004) Risk adjustment for congenital heart surgery: the RACHS-1 method, Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu, 7, pp. 180-184.

7. Maskell, N., Medford, A. and Gleeson, F. (2010). Seldinger hest drain insertion: simpler but not necessarily safer. Thorax, 65(1).
8. Medford, A and Maskel, N. (2005). Pleural effusion. Postgraduate Medical Journal, 81, pp. 702-710.
9. Pneumatikos, I. and Bouros, D. (2008) Pleural Effusions in Critically Ill Patients. Respiration, 76(3), pp. 241-8.
10. Singh, K., Loo, S. and Bellomo, R. (2003). Pleural drainage using central venous catheters. Critical Care, 7(6).
11. Thorp, J. (1987). Pleural aspiration with a central venous catheter. Anesthesia, 42, pp. 896-896.