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Brief Report

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Variability in paediatric cardiac postoperative chest tube management

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Abstract

Limited evidence exists to guide chest tube management following cardiac surgery in children. We assessed chest tube practice variation by surveying paediatric heart centres to prepare for a multi-site quality improvement project. We summarised management strategies highlighting variability in criteria for chest tube removal between and within centres. This lack of standardisation provides an opportunity for quality improvement.

Postoperative chest tubes in children contribute to significant discomfort,[1] and for some patients prolonged use contributes to length of stay. Despite the ubiquitous placement of chest tubes in children after cardiothoracic surgery, chest tube management is rarely discussed in the literature. In fact, there is no evidence based on expert consensus criteria, such as rate of pleural fluid drainage, to guide timing of chest tube removal in children.[2] In contrast, for adult patients, some centres have demonstrated a reduction in length of stay following liberalisation of pleural fluid drainage volume criteria.[3,4] There is a paucity of data to inform chest tube suction methods, approach to radiographic monitoring before and after removal,[5,6] and safe timing of hospital discharge following chest tube removal. In the absence of evidence, practice is based on local tradition or opinion. Further, the degree of variation in postoperative management of chest tubes is unknown. We hypothesised that there exists ongoing inter- and intra-centre variation in the management of postoperative chest tubes in paediatric heart centres.

Methods

We surveyed paediatric heart centres participating in the Paediatric Acute Care Cardiology Collaborative to explore the management of postoperative chest tubes in the absence of chylothorax. The 17-item survey included questions on management strategies for univentricular versus biventricular repairs, criteria for removal, and evaluation after removal (Table 1). The survey was pilot-tested in three centres and iteratively refined. Surveys were emailed to all 33 participating Paediatric Acute Care Cardiology Collaborative centres in August, 2017.

Results

Completed surveys were returned by 28 centres (88%). In all, 24 centres (85%) reported having a defined chest tube management strategy, whereas four centres (14%) did not. Unique management strategies for patients with univentricular versus biventricular circulation were reported by seven centres (25%), whereas a single chest tube removal strategy for all patients was endorsed by 16 (57%). Of those with unique protocols, all required a lower rate of pleural drainage before removal for univentricular patients compared with biventricular patients. An additional six centres (21%) used different management strategies depending on attending surgeon preference, and therefore they had additional variability in practice from day-to-day and practitioner-to-practitioner. Of note, respondents were asked to select all options that applied, and multiple respondents reported adhering to more than one management strategy. Of the 24 centres that have a defined management strategy, only nine have documented these protocols in writing.

Management variability extended to chest tube suction methods, volume criteria for removal, frequency of chest radiographs before and after removal, and discharge timing after chest tube removal. Specifically, 19 centres (68%) reported that chest tubes were always connected to wall suction: 10 centres (36%) initially connected chest tubes to wall suction and transitioned to off-wall and nine centres (32%) connected chest tubes to

Table 1. Survey questions.

1. Please indicate the hospital for which you are filling out the survey:
2. Management approach
a. Our management strategies are the same for all patients
b. We have separate management strategies for 1V versus 2V repairs → if yes, include comment box for explanation
c. We have separate management strategies for different grouping of surgeries → if yes, include comment box for explanation
d. Depends on the surgeon
e. We don't have a management strategy for CT management and removal
f. Don't know
3. Does your centre have a written guideline for CT management and removal? Yes/No
4. Management of suction for pleural effusion (not pneumothorax)
a. CTs are always connected to wall suction
b. CTs start on wall suction and then are taken off the wall
c. CTs are always off the wall for suction
d. CTs are connected to JP drains
e. Other (please specify)
5. Volume criteria for CT removal: Please describe any criteria related to output volume that your centre uses to decide when a CT can be removed safely. Be sure to specify any differences for specific patient populations identified above (i.e. 1V versus 2V). *Example: Individual CTs can be removed when they have had 3 cc/kg of output in a 24-hour period*
6. Who on your team typically pulls CTs? Select all that apply
a. CT surgical fellow
b. CT surgery PA/NP
c. Cardiology PA/NP
d. Cardiology fellow
e. Cardiology resident
f. CT surgeon
g. Bedside RN
h. Other (please specify)
7. Please describe options for sedation for CT removal available at your centre, including any CT removals that occur in the ICU. *Example: in ICU, sedation done per bedside nurse with CT PA removing tube. On acute care unit, can do moderate sedation in a procedure room with a dedicated sedation team or light sedation at bedside with bedside nurse and CT PA*
8. Do you routinely have single-ventricle patients use oxygen until the chest tubes are removed after the Glenn or Fontan? Yes/No
9. Comments on when oxygen is used for Glenn or Fontan:
10. How often do you obtain a CXR on the day of CT removal before removal?
a. Yes, almost always
b. Sometimes (specify when)
c. No, usually not
11. How often do you obtain a CXR on the day of CT removal after removal?
a. Yes, almost always
b. Sometimes (specify when)
c. No, usually not
12. How often do you obtain a CXR the morning after the last tube is pulled (if patient stayed the night)?

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Table 1. (*Continued*)

a. Almost always
b. Sometimes (specify when)
c. Usually not
13. If a patient stays more than a few days after the last chest tube is pulled, how often do you get a pre-discharge CXR to assess for recurrence?
a. Almost always
b. Sometimes (specify when)
c. Usually not
14. How often do you obtain a follow-up CXR after discharge?
a. Almost always
b. Sometimes
c. Usually not
d. IF a → when and where do you obtain CXR after discharge?
e. IF b → when and where do you obtain CXR after discharge and how do you decide if a CXR is required?
15. If patients are otherwise medically ready, when do you typically discharge patients after CT removal?
a. Same day
b. Next day
c. Other
16. How often do you discharge patients home with a CT in place?
a. Never
b. Sometimes (please specify when)
c. Often
17. Other comments or details about CT management at your centre:

1V = univentricular circulation; 2V = biventricular circulation; CXR = chest X-ray; JP = Jackson–Pratt; NP = nurse practitioner; PA = physician assistant; RN = nurse

Jackson–Pratt type bulb suction. Multiple respondents reported adhering to more than one suction method. Of the 20 centres (71%) with defined management strategies that also used specific pleural fluid drainage volume criteria (ml/kg/tube/24 hours) to guide removal of chest tubes, there was significant variation in criteria used, as shown in Figure 1. Of those centres that used specific pleural fluid drainage criteria, some also considered length of cardiopulmonary bypass, requirement for blood product administration, and concern for thoracic duct injury when determining timing of chest tube removal. Regarding practices associated with chest tube removal, 25 centres (89%) routinely obtained chest radiographs immediately before removal. Chest radiography to confirm that removal did not cause a pneumothorax was routinely performed on the day of removal in 21 centres (75%). A total of 19 centres (68%) routinely obtained a radiograph the following morning to evaluate for pleural fluid re-accumulation. Finally, for those patients who remain hospitalised several days after chest tube removal, six centres commonly obtained an additional screening radiograph close to time of discharge to evaluate for recurrence in asymptomatic patients. For patients otherwise medically ready to discharge, only six centres permitted discharge on the same day as chest tube removal, whereas 20 centres routinely waited to discharge patients until the following day.

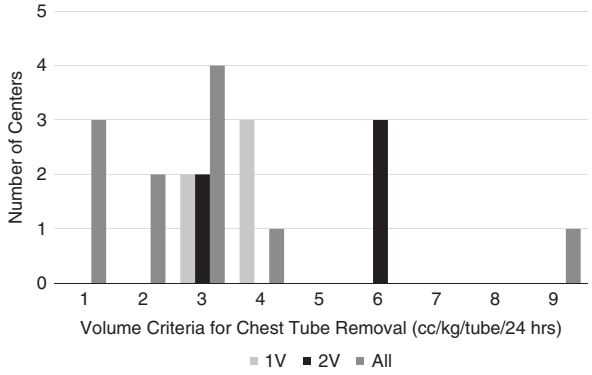

Figure 1. Variation in pleural fluid output volume criteria for chest tube removal across 20 centres.
key: 1V: univentricular circulation; 2V: biventricular circulation.

Discussion

These data suggest significant variability in chest tube management practices among 28 Paediatric Acute Care Cardiology Collaborative centres, including separate management strategies for univentricular and biventricular repairs, criteria for chest tube removal, and radiographic evaluation before and after

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removal. To our knowledge, this is the first report of variation in paediatric chest tube management practices. Most striking in these data is the variability in pleural fluid drainage criteria before chest tube removal; specifically, one centre currently removes chest tubes after achieving 9 ml/kg/tube/24 hours. This centre typically does not include the first 12 hours of post-operative fluid drainage in the removal criteria. Judgement is based on trending the subsequent overnight 8–12 hours of drainage, which helps account for the liberal volume criteria before removal compared with other centres. Our survey was written with 24-hour criteria in mind, which limited capture of this additional variability in centres' interpretation of pleural fluid drainage in shorter intervals. Furthermore, given the heterogenous nature of chest tube management at centres without standardised protocols, we are limited in our ability to compare trends between centres with standardised protocols and centres without written protocols.

Formal identification of clinical variation in practice may indicate variation in outcomes and therefore opportunities to improve the quality of health care. Having demonstrated high variability and lack of standardisation both within and across centres based on self-reported practices, Paediatric Acute Care Cardiology Collaborative in conjunction with the Paediatric Cardiac Critical Care Consortium is pursuing further investigation of chest tube management practices and the associated duration of chest tubes and postoperative length of stay with a 10-site collaborative quality improvement project. Following institutional review board approval or formal quality improvement exemption at each centre, sites have collected baseline data on patients undergoing one of the 10 Society of Thoracic Surgeons benchmark congenital heart surgeries, including chest tube duration, drainage volume in the prior 48 hours, and whether the patient required chest tube reinsertion or re-admission for pleural effusions. If, as we hypothesise, there is demonstrated variability in chest tube duration, we will use a collaborative learning approach[7,8] to identify and test potential best practices for chest tube management. By reducing practice variation, our primary aim will be to decrease chest tube duration with a secondary aim of decreasing total hospital length of stay.

As a new paediatric cardiology learning network in partnership with the Paediatric Cardiac Critical Care Consortium, our larger goal is to generate a reproducible model for collaborative multi-centre quality improvement efforts across critical and acute care teams.

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Conflicts of Interest. None

Ethical Standards. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national guidelines on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008, and has been approved by the institutional committees.

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