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Decision-Making in Pleural Drainage Following Lung Resection in Children: A Western Pediatric Surgery Research Consortium Survey

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ABSTRACT

Introduction: Studies of adults undergoing lung resection indicated that selective omission of pleural drains is safe and advantageous. Significant practice variation exists for pleural drainage practices for children undergoing lung resection. We surveyed pediatric surgeons in a 10-hospital research consortium to understand decision-making for placement of pleural drains following lung resection in children.

Methods: Faculty surgeons at the 10 member institutions of the Western Pediatric Surgery Research Consortium completed questionnaires using a REDCap survey platform. Descriptive statistics and bivariate analyses were used to characterize responses regarding indications and management of pleural drains following lung resection in pediatric patients.

Results: We received 96 responses from 109 surgeons (88 %). Most surgeons agreed that use of a pleural drain after lung resection contributes to post-operative pain, increases narcotic use, and prolongs hospitalization. Opinions varied around the immediate use of suction compared to water seal, and half routinely completed a water seal trial prior to drain removal. Surgeons who completed fellowship within the past 10 years left a pleural drain after wedge resection in 45 % of cases versus 78 % in those who completed fellowship more than 10 years ago ($p = 0.001$). The mean acceptable rate of unplanned post-operative pleural drain placement when pleural drainage was omitted at index operation was 6.3 % (± 4.6 %).

Conclusions: Most pediatric surgeons use pleural drainage following lung resection, with recent fellowship graduates more often omitting it. Future studies of pleural drain omission demonstrating low rates of unplanned postoperative pleural drain placement may motivate practice changes for children undergoing lung resection.

Level of Evidence: V.

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1. Background

Pleural drains are often placed after lung resection surgery to avoid complications of retained fluid or air leak. Recent adult and pediatric studies have suggested that in most cases, pleural drainage is not necessary and may lead to avoidable pain, narcotic administration, and prolonged hospital lengths of stay [1–3]. In the current era of process streamlining to decrease hospital lengths of stay and costs as well as to minimize patient discomfort and parental stress, elimination of pleural drains may provide significant improvements in peri-operative care. The aim of this study was to characterize utilization of post-operative pleural drains in children undergoing lung resection. This information would then inform standardization of peri-operative surgical care in these patients with an intent to eliminate pleural drainage in a majority.

2. Methods

2.1. Survey development

The survey was designed to gain a more thorough understanding of how pediatric surgeons manage pleural drainage following resectional lung surgery, which we defined as those patients who underwent a lobectomy, segmentectomy, or wedge resection. Additionally, we aimed to characterize what distinct factors influence surgical management decisions as well as observe changes in practice patterns as it related to their year of fellowship graduation. Most survey questions asked the respondents to rate how they felt regarding a particular statement using a Likert scale from 1 (strongly agree) to 5 (strongly disagree). The survey was pre-tested by five surgeons in the original study design group.

Information therefore was gathered on how surgeons felt pleural drain placement impacted patient's post-operative pain and length of stay. We asked open-ended questions to characterize what the acceptable rate of unplanned pleural drain placement would be if initial post operative placement was omitted. We also inquired what data each surgeon would require to change their practice patterns. The entire survey is available in [Supplemental Materials](#).

2.2. Survey population and administration

The survey was distributed to all practicing pediatric surgeons at the ten institutions comprising the Western Pediatric Surgery Research Consortium (WPSRC [westernpedsurg.com]). Study data were collected and managed using REDCap (Research Electronic Data Capture) electronic data capture tools hosted at the University of Washington [4,5]. REDCap is a secure, web-based software platform designed to support data capture for research studies, providing 1) an intuitive interface for validated data capture; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for data integration and interoperability with external sources. Email reminders were sent to maximize survey responses. No incentives were offered. The survey consisted of 16 questions taking less than

10 min to complete. This study was approved by the Seattle Children's Research Institute (STUDY00004094). Consent was implied by completion of survey.

2.3. Data analysis

Data are presented with descriptive statistics. Comparisons were made using Pearson's chi squared analysis for categorical variables. A p-value of <0.05 was considered significant. All analyses were performed using Stata 15.1 (StataCorp LLC, Austin, TX).

3. Results

The survey response rate was 88 % (96 responses of 109 surveys administered). A little more than half of surgeons had been in practice for ≥ 10 years (55, 57 %).

Concerning pleural drainage after lung resection, only 11 % of respondents agreed or agreed strongly that it was obligatory after any operation, and 33 % noted that pleural drainage may be omitted if there is no air leak noted intra-operatively ([Table 1](#)). Nearly all respondents agreed that pleural drains contribute to pain (95 %) and narcotic utilization (78 %), while 58 % indicated that pleural drains contributed to prolonged post-operative hospital lengths of stay ([Table 2](#)).

Regarding post-operative imaging and pleural drain removal, most respondents indicated that post-operative chest x-ray imaging is a standard of care (73 %) and obtained an additional chest x-ray after pleural drain removal (67 %). Half of respondents applied suction immediately post-operatively (50 %) and 51 % used a water seal trial prior to drain removal ([Table 3](#)).

Finally, surgeons were asked, "What is an acceptable rate of unplanned pleural drain placement in the postoperative period if pleural drain placement at case completion is omitted in the operating room?" The responses ranged from 0 to 25 %, with a mean of 6.3 % (± 4.6 %).

Responses were stratified by years of fellowship completion among respondents (those who completed fellowship within the past 10 years versus those who completed fellowship more than 10 years prior to the survey) ([Table 4](#)). For most questions there were no significant differences between the cohorts; however, a notably lower proportion of more recent graduates replied that they would leave a pleural drain in cases of wedge resection (45 % compared to 78 % in the older cohort, $p = 0.001$).

4. Discussion

This study demonstrated a conservative approach among a representative cross-section of U.S. pediatric surgeons regarding pleural drain utilization after lung resection, with a uniform use after lobar resection (97 %) and a majority after wedge resection (70 %). The response rate of nearly 90 % from a representative geographic cross-section of the United States suggests that surgeon and institutional biases would be diminished. Interestingly, there was lower utilization of pleural drains following wedge resection among younger pediatric surgeons. Contrary to tenets in published adult literature, there was a high rate of chest X-ray utilization both

Table 1
Surgeon attitudes regarding pleural drain utilization.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Pleural drainage is obligatory after any thoracic operation	1 %	10 %	7 %	57 %	24 %
Pleural drainage can be safely omitted when an intraoperative test fails to detect a leak	6 %	27 %	38 %	29 %	0 %

Table 2

Surgeon attitudes regarding pleural drain effect on pain control and length of stay.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Pleural drains contribute to pain	44 %	51 %	2 %	2 %	1 %
Pleural drains contribute to narcotic utilization	26 %	52 %	16 %	6 %	0 %
Pleural drains contribute to prolonged post-operative length of stay	24 %	34 %	28 %	14 %	0 %

Table 3

Surgeon attitudes regarding post-operative pleural drain care.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Immediate post-operative chest x-ray is standard of care	22 %	51 %	10 %	10 %	6 %
Suction is preferred over water seal immediately post-operatively	13 %	40 %	31 %	17 %	0 %
Staged pleural drain removal after a water seal trial is standard of care	10 %	41 %	28 %	17 %	4 %
Post-removal chest x-ray is standard of care	14 %	37 %	18 %	21 %	12 %

on immediate post-operative X-rays (73 %) and X-rays after chest tube removal (67 %) [6,7]. Despite pediatric literature supportive of pleural drain removal directly from suction [8], 51 % of respondents used a water seal trial prior to chest tube removal, extending post-operative hospital lengths of stay and chest X-ray utilization. While most literature on long-term cancer risks associated with exposure to ionizing radiation focuses on computed tomography and fluoroscopy, elimination of any exposure – including chest X-rays – is an appropriate goal in keeping with the As Low As Reasonably Achievable (ALARA) principles, especially among children [9–11].

Pleural drainage following lung resection has long been considered a standard of care to provide egress for air, serous fluid, chyle and blood. However, pleural drains are painful and can lead to avoidable use of narcotic analgesics and prolonged lengths of stay [12–14]. Although it has been hypothesized that pleural drain

placement prolongs hospitalization and increases the need for narcotic pain medication, this has not been objectively studied. The past decade has seen increasing numbers of studies demonstrating safety in pleural drainage omission in select adult patients undergoing peripheral wedge and even anatomic lobar resection [1–3,15]. This conclusion has also been suggested in few studies in children [16–18]. The omission of a pleural drain following lung resection align with the tenets of Enhanced Recovery After Surgery (ERAS), which seeks to decrease pain, cost, and hospital lengths of stay in part by eliminating unnecessary drainage catheters [19–22].

Differences in the care of pediatric compared to adult patients are germane to the consideration of pleural drainage omission. On one hand, children may be more susceptible to pain associated with an indwelling pleural drain and receive narcotics with downstream pejorative effects (constipation, cost, length of stay). There is also

Table 4Responses stratified by fellowship era^a.

	Total	Recent (≤ 10 years), n (%)	Remote (> 10 years), n (%)	p^b
Pleural drainage is obligatory after any thoracic operation.	96 11 (11)	33 4 (12)	63 7 (11)	1
Pleural drainage can be safely omitted when an intraoperative leak test fails to detect a leak.	32 (33)	13 (39)	19 (30)	0.36
Pleural drains contribute to pain.	91 (95)	32 (97)	59 (94)	0.65
Pleural drains contribute to narcotic utilization.	75 (78)	27 (82)	48 (76)	0.61
Pleural drains contribute to prolonged post-operative lengths of stay.	56 (58)	22 (67)	34 (54)	0.23
Immediate post-operative chest x-ray is standard of care.	70 (73)	27 (82)	43 (68)	0.16
Suction is preferred over water seal immediately post-operatively.	50 (52)	16 (48)	34 (54)	0.61
Staged removal with a water seal trial is standard of care.	49 (51)	17 (52)	32 (51)	1
Post-removal chest x-ray is standard of care.	48 (50)	16 (48)	32 (51)	0.82
Do you routinely leave a pleural drain after wedge biopsy?	64 (67)	15 (45)	49 (78)	0.001
Do you routinely leave a pleural drain after pulmonary lobectomy?	94 (98)	32 (97)	62 (98)	1
What is an acceptable rate of unplanned chest tube placement in the postop period if chest tube placement at case completion is omitted in the operating room? ^c	6.3 $\pm$ 4.6	6.7 $\pm$ 4.2	6.0 $\pm$ 4.8	0.52

^a Numbers represent those respondents answering “Strongly Agree” or “Agree” to the question in a 5-point Likert Scale.

^b Two-tailed Fisher's exact or Pearson's chi-squared testing was applied to categorical variables and students t-test was used for the last question, reporting continuous variables.

^c Mean $\pm$ standard deviation.

likely an element of increased parental/caregiver distress when patients have a pleural drain. On the other hand, placement of a pleural drain post-operatively in the pediatric age group frequently requires sedation and/or return to the operating room, which is a significant burden of care and risk. Because of this second consideration, any paradigm shift away from standardized use of pleural drains must be supported by rigorous evidence.

Multiple adult studies have demonstrated that omission of pleural drainage after thorascopic wedge biopsy results in unplanned post-operative drain placement in 0–5 % of patients. In a systematic review of nine studies, including three randomized trials, Laven et al. found that 3 % (12 of 442) and 1 % (5 of 486) of the patients in no chest tube and chest tube groups, respectively, developed postoperative pneumothoraces requiring placement of a pleural drain. Interestingly, 13 % (48 of 370) and 5 % (19 of 422) of patients in the no chest tube and chest tube groups, respectively developed pneumothoraces on post-operative day 1; most were asymptomatic and resolved without intervention [23].

Although there are no randomized studies in the pediatric literature, several groups have reported their institutional outcomes after pleural drain omission. Ponsky et al. found that only one patient among a convenience sample of 176 undergoing lung biopsy without a chest tube required placement postoperatively [16] while Nadlonek et al. performed a retrospective review of patients undergoing thorascopic lung biopsies and found that 1 in 41 in the chest tube group and 2 in 49 in the no chest tube group required subsequent placement [17]. In a study of 246 pediatric patients undergoing thorascopic lobectomy without a chest tube, Cheng et al. found that none required post-operative chest tube placement and only two (0.8 %) developed post-operative pneumothoraces, both of which resolved without intervention [24]. The group was very selective in choosing those patients least likely to develop an air leak (exclusion criteria included absence of severe chest cavity infection, severe adhesions or underdeveloped interlobar fissure). Further inferential data may be gathered from a study published by our group detailing postoperative care of children undergoing resectional lung surgery. In a retrospective review of 130 patients, Schnuck et al. found that among those undergoing wedge biopsies, 17 % had an air leak on postoperative day one and the median chest tube duration was one day. Among those undergoing lobectomy, 25 % had an air leak on post-operative day one and the median chest tube duration was two days [18]. This suggested that in select patients, pleural drainage may be avoided safely.

Finally, we inquired about surgeon attitudes regarding unanticipated pleural drain placement. The survey demonstrated a 5 % median acceptable rate for subsequent postoperative pleural drain placement in patients that did not have one at the conclusion of the case. This statistic could be used in future studies examining pleural drain utilization and outcomes following inclusion and omission of pleural drains after resectional lung surgery in children.

Limitations of this study include recall bias and those inherent to surveys with Likert scale responses. The respondents all work at large children's hospitals, and thus the approaches described for pleural drain utilization and post-operative management may not be generalizable to other work locales. Selection bias is also possible, although the extremely high survey response rate suggests that at least in the context of Western and Mountain State U.S. hospitals our findings are representative.

Ultimately, streamlining of postoperative care requires a multi-modal approach to challenge dogma and eliminate unnecessary procedures. Drawing from the examples set by the ERAS philosophy in a broad swath of surgical care, we hope to show that

selective elimination of pleural drains in thoracic surgery can help our pediatric patients and improve outcomes, like the experience in adult patients [25,26].

5. Conclusions

Most pediatric surgeons routinely use pleural drainage following lung resection, although practice patterns are changing with more recent pediatric surgery graduates reporting lower utilization rates. Surgeon practices surrounding post-operative chest imaging and pleural drain removal timing remain conservative and may unnecessarily extend hospitalization. Prospective clinical trials of pleural drain omission with low rates of unplanned post-operative pleural drain placement may motivate meaningful change in standard practice patterns.

Conflict of interest

None of the authors has any competing interests.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jpedsurg.2024.01.006>.

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