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A Cross-Sectional Study: Chest Tube Drainage Practice Patterns among Canadian Thoracic Surgeons Following Pulmonary Surgery

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Abstract

Background: High chest tube drainage following lung surgery is a rate-limiting step to discharge, increasing length of hospital stay. There is a paucity of evidence-based clinical research on safe maximal daily chest tube drainage prior to removal. **Objectives:** To describe the practice patterns of Canadian thoracic surgeons with respect to daily chest tube drainage after routine pulmonary surgery. **Methods:** A self-reported electronic questionnaire was administered to members of the Canadian Association of Thoracic Surgeons (CATS). Data was tabulated on the primary outcome of acceptable maximal daily pleural output prior to chest tube removal, and secondary outcomes of: years in clinical practice, academic versus community setting and rational for chest tube management. Descriptive and univariate analysis was conducted for each response by maximal daily pleural drainage category. **Results:** A total of 124 surveys were distributed. Response rate was 56%, with a 93% completion rate. Acceptable maximal pleural drainage among surgeons was highly variable. Rationale for tube removal was also variable, including individual clinical experiences (n = 23, 33%), evidence based guidelines (n = 18, 26%), and group practice pattern (n = 12, 17%). Academic surgeons comprised 72% of respondents. Community based surgeons were more likely to remove tubes at a lower mean volume. Years in clinical practice did not influence acceptable daily pleural drainage. **Conclusion:** There is great variability in post-operative management of chest tube fluid output among Canadian thoracic surgeons. Future research on this topic is warranted, with the aim of developing an evidence-based chest tube management algorithm incorporating daily chest tube drainage volumes as a key variable.

Keywords

Thoracic Surgery, Chest Tubes, Oncology, Pleural Cavity

1. Background

Management following routine thoracic surgical procedures such as lobectomy fundamentally relies on minimizing the adverse event of: recurrent pleural effusion, airleak, and empyema-all of which may require chest tube reinsertion [1]-[7]. Persistent air leak and pleural drainage are two mutually exclusive rate-limiting factors for chest tube removal. It is thus imperative to devote separate study to understand these two important aspects of postoperative chest tube management [8]-[19].

Thoracic surgeons discharge patients when air leak is absent, and pleural drainage is below an acceptable level [17]. With respect to air leak management, there are numerous reported "fast-tracking" algorithms fit to appropriate patient scenarios. These have shown to lead to shorter hospitalization, and lower overall costs without compromising standard of care. While prolonged air leak has been thoroughly studied in the context of lung resection, there is yet to be an established gold standard algorithm for management of high volume chest drain output [10] [12] [13]. Daily chest tube drainage greater than 250 milliliters (ml) is a commonly cited reason by surgeons for delayed discharge [11]. This practice may prolong hospital stay on average by two days, and is not evidence based [11] [12]. Increased length of stay can be extrapolated to higher healthcare costs, discomfort for the patient and increased risk of tube-related complications [11] [12] [16] [20].

Although there are no widely accepted evidenced based guidelines for thoracic surgeons to follow with respect to management of high volume chest drain output, protocols with daily volumes ranging from 200 ml to 450 ml have been reported [21]-[29]. Chest tube removal at pleural drainage volumes in excess of 400 ml/day has been studied by Cerfolio *et al*. In this protocol, chest tube removal at volumes of 450 ml/day was associated with lower rates of indwelling tube duration without increasing the rate of recurrent pleural effusion [4]. In keeping with higher acceptable daily volumes, French *et al*. suggest that pleural drainage should be assessed as a dynamic parameter in relation to individual body weight, because pleural lymphatic flow is depends on this. A conservative suggestion is that maximal daily pleural drainage should be 15% of total lymphatic pleural flow [15].

With no generally accepted protocol in place for management of higher volume pleural drainage, this study aims to determine exactly what daily pleural drainage volumes Canadian thoracic surgeons find acceptable to remove a chest tubes following routine lung resection. In order to develop novel chest tube fast-tracking algorithms in the future incorporating daily drainage as a dynamic variable, we must first understand current practice patterns of thoracic surgeons after routine pulmonary resection.

2. Materials and Methods

A self-administered electronic questionnaire was sent to all 124 active Canadian Association of Thoracic Surgery (CATS) members using the University of Brit-

ish Columbia (UBC) electronic survey tool. To maximize response rate and sample size, the questionnaire was administered three times at one-week intervals.

The primary outcome of interested captured was mean acceptable maximal 24-hour pleural drain output prior to chest tube removal. Secondary variables captured included: years in thoracic surgical practice, community versus academic practice setting, average annual number of pulmonary resections, and number and caliber of chest drains placed after routine lobectomy for lung cancer.

Descriptive and univariable analyses were conducted using Stata13 statistical software (StataCorp. 2013. College Station, TX: StataCorp LP). The primary outcome being mean maximal acceptable amount of chest tube drainage observed in the preceding 24 hours, prior to chest tube removal. Categorical data variables examined for their effect on the primary outcome of interest using the Chi square test for association included: years in practice and thoracic surgical practice, rational for chest tube removal algorithm used in clinical practice, and community versus academic practice setting. A two-tailed t-test for association was used for comparison of continuous variables.

3. Results

The survey was administered to 124 CATS members. A total of 70 (56%) surgeons responded, with 65 (93%) surveys filled to completion. The frequencies of respondent practice characteristics are summarized in Table 1. Maximal acceptable daily pleural drain output prior to removal for the majority was 200 - 299 ml or 400 - 499 ml (n = 21, 30% for each respectively). The majority of respondents where in thoracic surgical practice for over 20 years (n = 21, 30%), with an academic clinical setting (n = 51, 73%), and leave one 28 French chest drain after routine pulmonary lobectomy for lung cancer (n = 44, 63%).

When comparing acceptable daily pleural drainage by practice setting, the majority of academic surgeons removed tubes closer to 400 ml. Community-based surgeons tended towards lower drainage amounts of 200 ml daily. As summarized in Table 2, there was very strong evidence ($p = 0.0005$) that Canadian thoracic surgeons in academic practice settings are more likely to remove chest tubes with higher mean daily output compared to community thoracic surgeons.

The analysis for thoracic surgeon characteristics associated with chest tube removal with high daily output (>400 ml) is summarized in Table 3. There was strong evidence of an association between chest tube removal with high daily output (>400 ml) and the reported algorithm rationale ($p = 0.002$), and academic practice setting ($p = 0.002$). There was no evidence of association of years in practice with chest tube removal at higher daily output ($p = 0.255$).

4. Discussion

Variability in Practice Patterns:

The findings of the current study illustrate the wide variability in practice patterns of Canadian thoracic surgeons with respect to acceptable maximal daily

Table 1. Chest tube practice characteristics after routine pulmonary resection for thoracic surgeon respondents.

Variable		n (%)
		70 (100)
Maximal acceptable daily pleural drain output prior to removal (ml)	<200	5 (7.14)
	200 - 299	21 (30.0)
	300 - 399	16 (22.86)
	400 - 499	21 (30.0)
	>500	4 (5.71)
	Missing	3 (4.29)
Pleural drain removal >400 ml/24 hours	<400	42 (60.0)
	>400	25 (35.71)
	Missing	3 (4.29)
Rational pleural drain removal algorithm used in clinical practice	Algorithm from thoracic training	15 (21.43)
	Individual experience based algorithm	23 (32.86)
	Evidence based algorithm	18 (25.71)
	Group practice based algorithm	12 (17.14)
	Missing	2 (2.86)
Pleural drains left after routine pulmonary lobectomy	One 28 French	44 (62.86)
	Two 28 French	15 (21.43)
	One 28 French, and One 14 French	6 (8.57)
	One 24 French	2 (2.86)
	One 14 French	1 (1.43)
	Missing	2 (2.86)
Years in thoracic surgical practice	Still in Thoracic Training	7 (10.0)
	1 - 5 years	13 (18.57)
	6 - 10 years	12 (17.14)
	11 - 20 years	17 (24.29)
	21+ years	21 (30.0)
Practice type	Academic*	51 (72.86)
	Community	19 (27.14)

*University academic appointment required as an employment condition. ml = milliliters.

Table 2. Thoracic surgeon respondent mean acceptable daily chest tube output prior to removal after routine pulmonary resection.

Max daily drain output (ml)		Mean (SD)**	P = value*
Practice type	Academic	334.3 (14.82)	0.0005
	community	229.4 (23.11)	

*Two tailed T-test for continuous variables. **Mean 24 hour chest tube output prior to chest tube removal after routine lobectomy for academic versus community thoracic surgeons. SD = standard deviation. ml = milliliters.

chest tube drainage volume prior to removal. Reasons for the observed practice variability are likely multifactorial, influenced by the surrounding clinical practice environment and biases "learned" in thoracic surgical training. The practice environment and clinical culture may impact ease of access to the limited evidence based literature of the topic of pleural drainage. Prevailing attitudes and "surgical dogma" that the nature of chest tube management postoperatively is a generally mundane and routine topic may also make thoughtful inquiry less likely [11] [12].

Table 3. Thoracic surgeon respondent characteristics by low (<400 ml/day) versus high (<400 ml/day) pleural drain output after routine pulmonary resection.

Variable		Low output <400 ml/24 h n (%)	High output >400 ml/24 h n (%)	P-value*
Rational pleural drain removal algorithm:	Training	12 (29.3)	3 (12.0)	0.002
	Individual	17 (41.5)	5 (20.0)	
	EBM	4 (9.76)	13 (52.0)	
	Group	8 (19.51)	4 (16.0)	
Practice type	Academic**	26 (61.9)	24 (96.0)	0.002
	Community	16 (38.1)	1 (4.0)	
Years in practice	Training	3 (7.1)	4 (16.0)	0.255
	1 - 5 years	7 (16.7)	5 (20.0)	
	6 - 10 years	9 (21.4)	3 (12.0)	
	11 - 20 years	7 (16.7)	8 (32.0)	
	21+ years	16 (38.1)	5 (20.0)	

*Chi-square test of association. **University academic appointment required as an employment condition. ml = milliliters. EBM = evidence based medicine.

Evidence Based Practice and Daily Chest Tube Drainage:

Despite the large amount of prospective data surrounding chest tube management in the context of air leak, there is only one large prospective study, conducted by Cerfolio *et al.*, that incorporates higher volume output into chest tube removal algorithms without increased patient morbidity [12]. When examining rationale behind acceptable daily pleural drainage in the current study, although heterogeneous acceptable volumes were reported, those who stated they followed evidenced based guidelines were more likely to remove chest tubes with higher daily output (400 ml·daily). It thus appears several respondents are referring to Cerfolio's study to guide evidence based clinical practice.

Despite literature on the safety of chest tube removal after lobectomy with output volumes of 400 ml daily, our study suggests evidence of persistent dogmatic attitudes guiding chest tube practice patterns in Canada. The highest respondent reported frequency for rationale guiding practice pattern was "individual experience" (n = 23, 33%). This is consistent with a recent large American surgeon survey conducted by Kim *et al.* [30]. They examined practice patterns among American surgeons using the Society of Thoracic Surgeons database. Our studies reveal consistent results in that surgeons in an academic clinical setting were more likely to remove chest tubes with higher daily output volumes compared to community surgeons.

Study Limitations

The overwhelming majority of respondents in this study were academic practice based thoracic surgeons. Information bias in the form of response bias may thus be present, with community thoracic surgeons under-represented. Academic institutions with thoracic surgical residency training programs, regular teaching rounds, and activities such as journal club discussion may be more likely to be aware of most current literature given the environment supported.

Selection bias may also be present based on our sampling method. The study sample was drawn from the CATS roster membership list. This roster may not

encompass Canada-wide practices, as it only includes thoracic surgeons who have self-selected to be CATS members. If these surgeons are in some way systematically different from non-members, it would make study findings difficult to generalize.

5. Conclusions

There is significant practice variability among Canadian thoracic surgeons with respect to acceptable chest tube drainage volumes following routine pulmonary resection prior to tube removal. Many Canadian surgeons appear to use evidence based literature to guide their chest tube management decisions, however practice based on individual experiences and surgical "dogma" remains. Thoracic surgeons practicing at academic centers were more likely to remove chest tubes at higher mean daily drainage volumes compared to those in community practice.

Future study on this topic is warranted in the context of developing and implementing post-operative pulmonary chest tube management algorithms that include higher mean daily volumes. Such "fast-track" chest tube management algorithms are an important tool to ensure austerity and promote economic sustainability in the Canadian single-payer health care setting.

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