



Contributing to Drainology: removing chest drains after pulmonary resection based on air leak alone

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Minimizing length of stay after pulmonary resection is important to avoid post operative complications and promote optimal use of health care resources. Chest drain duration is directly correlated with length of stay after pulmonary resection (1). Air leak is the most common complication after pulmonary resection which prolongs duration of chest tube drainage leading to delays in discharge (1-3). Although a persistent air leak is the most common reason to defer removal of a chest drain, volume of liquid drainage is the second factor considered prior to removal of a chest drain.

The first randomized controlled trial (RCT) reporting clinical outcomes from implementation of digital chest drainage systems were reported in 2008 (4). Since then 11 more studies (5-15) and two meta-analyses (16,17) have been conducted to evaluate the effectiveness of these devices. The data in the literature has shown some discrepancies, but as is intuitive, digital chest drainage systems show a decreasing duration of chest drain and length of stay but do not reduce duration of air leak. With the ability to better detect the resolution of an air leak, the volume of liquid drainage can become a limiting factor to chest drain removal.

The acceptable threshold of liquid drainage in a 24-hour period has been a point of controversy. In 2002, Younes *et al.* did a prospective RCT using a maximum fluid threshold of 200 mL in 24 hours (18). This was followed by Zhang *et al.* in 2014 using a maximum of 300 mL (19)

and then later Xie *et al.* using a maximum of 450 mL in 24 hours (20). Here we see a clear trend of increasing volumes of liquid drainage thresholds being studied in clinical trials over a 13-year period. More recently a meta-analysis of chest drain removal with high-output which included six retrospective and prospective studies following protocolized post-operative care was conducted. This study concludes chest drains can be removed early and with high volume output with minimal need for re-intervention (21).

DrainologyTM is a trademarked term to describe an evidence-based approach to study chest drains. There is no shortage of studies reporting on management of chest drains many of which are done as well-designed RCTs often using strict protocols (22). As RCTs promote an evidence-based approach to the management of chest drains, it remains important to also evaluate and explore implementation of this evidence on thoracic units in a retrospective fashion.

Abdul Khader *et al.* present a 9-year retrospective review of post-operative management of chest drains using only air leak as the criteria for removal (ignoring volume of liquid drainage) (23). Between 2012 and 2021, 797 patients underwent pulmonary resection, excluding pneumonectomies and volume reduction surgery, by a single surgeon. Air leak resolution was determined using digital chest drainage systems and chest drains were removed when the air leak was less than 20 mL/min for 6 hours irrespective of the volume of liquid drainage, except in the setting of blood or chyle. The median duration of drain was

1 [1–2] day with a corresponding median length of stay of 4 [2–6] days. Pneumothorax after drain removal was reported in 141 (17.7%) patients and pleural effusion in 75 (9.4%) patients. However, re-insertion of a chest drain was only required in 17 (2.1%) patients. Although excluded from the study, 107 patients (13.4%) had removal of the chest drain in the operating theatre.

The retrospective nature of this study contributes to the science of drain management by analyzing the implementation of a digital chest drain management pathway. Outside of a strict protocol required for an RCT, chest drains were managed by multiple clinicians (mainly surgical registrars) who were allowed to make clinical decisions but instructed to remove the chest drain when the air leak was resolved (ignoring the volume of liquid drainage). Outcomes show a median duration of chest drainage of 1 day and a low re-intervention rate lending confidence that implementation of this study will be successful on other thoracic surgery units and drain management can be successfully delegated to multiple members of the surgical team.

The relatively high incidence of pneumothorax and pleural effusion after removal of chest drains suggests adverse events were well captured. Most interesting is the very low re-intervention rate (2.1%) despite a relatively high incidence of post drain removal pneumothorax (17.7%) and pleural effusion (9.4%). There are several considerations that can be derived from this data. The first is that the pneumothoraces experienced by the patients were not clinically significant. Brown et al have published a multi-center RCT for management of first primary spontaneous pneumothorax presenting to emergency departments. This study showed that irrespective of X-ray findings spontaneous pneumothorax can be managed without drainage in an asymptomatic patient (24). Although, not within the power of this study, when taken in context of the ample literature supporting digital drainage systems (4–17), one could consider digital drainage systems may accurately rule out clinically significant air leaks that would lead to re-insertion of a drain if it was pre-maturely removed. The second which is one of the aims of this study is that volume of liquid drainage does not predict the occurrence of a symptomatic pleural effusion. And, lastly when clinical factors are integrated into assessment of an X-ray, many patients can avoid the discomfort of re-inserting a chest drain and prolonged chest tube drainage.

Although not included in the study cohort, 107 (9.0%)

patients in the initial data set had their chest drain removed in the operating theater. If an air leak can be ruled out at the end of an operation and volume of liquid drainage is not a factor, some patients do not require a chest drain after the air in the hemithorax has been evacuated, and therefore this is not a factor limiting discharge and they can avoid the discomfort of having the drain *in situ*.

Lung surgery necessitates the need to manage chest drains. The continued study of the science of Drainology™ using both well controlled RCTs and reporting of institution-level retrospective data sets is essential to optimize drain management, avoid adverse events, avoid unnecessary interventions and reduce length of stay. Future work considering in-theater removal of chest drains and evidence-based management of adverse events after tube removal will further advance this science.

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