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Poiseuille Flow Through Chest Tubes: A Scoping Review

Student[a]**:** Karen Lin | **Supervisor(s)**[b]**:** Dr Claire Parkin

Abstract

Background: Chest tubes are used daily to treat patients with chest pathologies such as haemothorax. However, there is much uncertainty around the fluid dynamics of chest tubes. Traditionally, authors have described fluid dynamics in chest tubes using Poiseuille's law. However, in recent years authors have been challenging the applicability of Poiseuille's law to chest tubes. It has been the norm for large-bore chest tubes to be used for larger fluid volumes such as haemothoraces because in theory, the larger the tube, the more efficient the drainage. Recently, however, there has been a shift to using smaller-bore catheters which are better tolerated by patients. It remains unclear what catheter size is best suited for drainage of fluids in differing chest pathologies. This scoping review was conducted to determine the current understanding of the hydrodynamics of fluid flow through chest tubes as well as addressing the long-standing debate on chest tube size.

Methods: The scoping review used the PRISMA Extension for Scoping Review (PRISMA-ScR) checklist. Core key words were identified and Boolean Operator and Medical Subject Headings (MeSh) were used to search a range of databases to yield both peer-reviewed journal articles and grey literature. The literature identified went through a two-stage review process by the author and project supervisor, using Rayyan. To extract data, a thematic analysis was carried out on the final chosen papers.

Results: A total of 922 papers were identified from the search. After title and abstract review and further critical appraisal, a total of 15 final papers were included in the final scoping review. Primarily, these consisted of narrative studies summarising current practices, as well as several in-vitro laboratory experiments studying fluid dynamics through chest tubes. There was a general lack of literature on this topic overall. There was an increase in papers published between 2005-2010 but generally, over a 30-year period there has not been a big focus on this topic.

Conclusions: The scoping review has re-examined fluid flow through chest tubes that has been defined in the literature, particularly around Poiseuille's law and flow. Many have concluded that the location and position of chest tubes and the clinical environment do not allow for Poiseuille flow to fully develop. Poiseuille's law was also found to not be predictive of actual flow rates in different size chest tubes. Authors found discrepancies between

predicted and measured flow rates. These discrepancies were attributed to the interruption in flow due to holes, kinks, positioning and other features of chest tubes, like three-way taps, which create resistance within the circuit. This review also looked at comparing small-bore chest tubes to large-bore chest tubes where common practice has been to insert large chest tubes for haemothorax or empyema based on principles of Poiseuille's law. This review found that many authors are now in favour of using smaller-bore catheters due to lack of evidence that larger bore tubes offer any clinical advantage over smaller bore tubes.

Keywords: Poiseuille's Law | Poiseuille's Flow | Chest Drain | Chest Tube | Thoracic Catheter | Catheter / Tube Size | Fr Gauge | Flow Rate

[a] 4th Year Medical Student, Kent and Medway Medical School, Canterbury, United Kingdom

[b] Associate Professor in Medical Education, Kent and Medway Medical School, Canterbury, United Kingdom

Main contact email: k.lin425@kmms.ac.uk