Performance Evaluation of pH Measurements Made Using Origin™ for Integration with Chest Tube Drainage Systems

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Introduction

Chest tubes are routinely used following cardiothoracic surgeries[1,2]. **To date, there is no standardized method for chest tube management, particularly when considering criteria for their removal** [1,2]. Prolonged chest tube use increases the risk of iatrogenic infection, length of stay (LOS), pain, and reduces mobility[1,3].

Conversely, premature removal of drains can cause fluid buildup, which hinders pulmonary function. **Continuous pH and impedance monitoring of chest drainage can facilitate quantitatively informed and prudent decision-making when determining the optimal time for tube removal.**

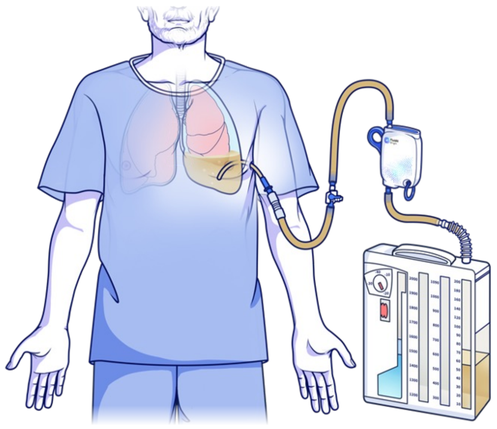


Figure 1. Schematic showing inline attachment of Origin™ to traditional chest drainage systems.

Integration of Origin™ with Traditional Chest Tubes

Risk of Iatrogenic Infection

Duration of chest tube drainage

Length of stay

Patient pain

Patient mobility

Risk of prolonged air leaks

Cost of hospitalization

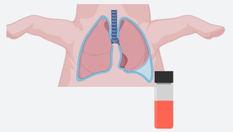
Impedance sensors can be used to objectively monitor and track postoperative air leaks[4]. reducing the risk of prolonged air leaks pH sensors can be used to infer the inflammatory processes associated with empyema and other postoperative cardiopulmonary complications[5].

FluidAI Medical developed a non-invasive, sensor-based platform (Origin™) that can be modified to connect in-line to traditional/analog chest drainage systems for real-time 24-hour monitoring of drained effluent**. This study assesses the ability of Origin™ to accurately measure the pH of pleural fluid compared with the widely used Radiometer ABL800 Flex blood gas analyzer (BGA).**

Methods

Thoracotomy was performed on 9 Yorkshire pigs (Mean Age: 4 Months, Mean Weight : 31 kg)

Pleural fluid was collected from the left and right pleural spaces.



The pH of each sample was analyzed using Origin™ and BGA.

Pearson's correlation, linear regression analysis, and Bland- Altman (BA) analysis were used to compute inter-technique agreement.

Results

The Pearson coefficient (r = 0.965, p<0.05) and the coefficient of determination (r^2= 0.931, p<0.05) indicated a strong linear correlation between pH data collected using the two systems within a measuring range of 6.000-8.200. The linear regression model had a slope of 0.820 and an intercept of 1.037.

BA analysis revealed that the mean estimated bias ± standard deviation between pH measurements obtained using *Origin*™ and BGA was 0.382 ± 0.084, (95% CI: 0.293 – 0.470). The reported upper and lower limits of agreement were 0.547 (95% CI: 0.386 – 0.708) and 0.216 (95% CI: 0.055 – 0.377) respectively.

Conclusion

***Origin*™ can seamlessly integrate with existing traditional/analogue chest drainage systems. pH measurements made using *Origin*™ strongly correlate with BGA measurements.**

Continuous pH and impedance analysis of pleural effluent using *Origin*™ can help improve the management of traditional chest tube drainage systems.

References

[1] Utter GH. The rate of pleural fluid drainage as a criterion for the timing of chest tube removal: theoretical and practical considerations. *Ann Thorac Surg*. 2013;96(6):2262-2267. doi:10.1016/j.athoracsur.2013.07.055
[2] Anderson D, Chen SA, Godoy LA, Brown LM, Cooke DT. Comprehensive Review of Chest Tube Management: A Review. *JAMA Surg*. 2022;157(3):269-274. doi:10.1001/jamasurg.2021.7050
[3] Kwiatt M, Tarbox A, Seamon MJ, et al. Thoracostomy tubes: A comprehensive review of complications and related topics. *Int J Crit Illn Inj Sci*. 2014;4(2):143-155. doi:10.4103/2229-5151.134182
[4] DeArmond DT, Das NA, Restrepo CS, et al. Intrapleural Impedance Sensor Real-Time Tracking of Pneumothorax in a Porcine Model of Air Leak. *Semin Thorac Cardiovasc Surg*. 2020;32(2):357-366. doi:10.1053/j.semtcvs.2019.10.004
[5] Houston MC. Pleural fluid pH: diagnostic, therapeutic, and prognostic value. *Am J Surg*. 1987;154(3):333-337. doi:10.1016/0002-9610(89)90623-5