

A novel noninvasive real-time delivery of oxygen monitor in the prediction of post-operative acute kidney injury in the cardiac surgery patient

Authors

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Abstract

Aim: Postoperative acute kidney injury (POAKI) is a common complication of cardiac surgery associated with both short- and long-term adverse outcomes. A low delivery of oxygen (DO₂) during cardiac surgery has been associated with an increase in the likelihood of developing POAKI with critical thresholds reported as less than 280-325ml/min/m² (Raimundo 2015, Ranucci 2018)^{1,2}.

DO₂ is calculated using the oxygen flux equation:

$$DO_2 = 1.34 \times CO \times SpO_2 \times SpHb$$

Currently, invasive cardiac output monitoring and repeated sampling of haemoglobin at regular intervals is used to derive DO₂. However, continuous cardiac output monitoring is not routine and repeated sampling of haemoglobin is impractical.

Advancements in non-invasive continuous cardiac output monitoring (Edward ClearSight) and continuous haemoglobin monitoring (Masimo SET) can derive real-time and continuous DO₂. We tested the feasibility of integrating these two devices to derive the DO₂ and aim to show the association between low DO₂ and POAKI in the cardiac surgical patient.

Methodology: 60 patients met our inclusion criteria and were enrolled in the study. Perioperative risk factors including continuous postoperative DO₂ levels were obtained. The primary outcome was AKI, defined by the AKIN criteria.

¹ Raimundo, M., Crichton, S., Syed, Y., Martin, J. R., Beale, R., Treacher, D., & Ostermann, M. (2015). Low Systemic Oxygen Delivery and BP and Risk of Progression of Early AKI. *Clinical journal of the American Society of Nephrology : CJASN*, 10(8), 1340–1349. <https://doi.org/10.2215/CJN.02780314>

² Ranucci, M., Johnson, I., Willcox, T., Baker, R. A., Boer, C., Baumann, A., Justison, G. A., de Somer, F., Exton, P., Agarwal, S., Parke, R., Newland, R. F., Haumann, R. G., Buchwald, D., Weitzel, N., Venkateswaran, R., Ambroggi, F., & Pistuddi, V. (2018). Goal-directed perfusion to reduce acute kidney injury: A randomized trial. *The Journal of thoracic and cardiovascular surgery*, 156(5), 1918–1927.e2.

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Results: The incidence of AKI was 13%. The integral DO_2 over time post-cardiac surgery was used as a metric of DO_2 in the intensive care unit. Initial data analysis showed potential trends between a low DO_2 across time and the development of AKI, absolute changes and percentage changes in creatinine.

Conclusion: We demonstrated the clinical utility of a non-invasive DO_2 , and its association with POAKI in the cardiac surgical patient. This advancement will better the monitoring of the postoperative cardiac surgical patient and allow timely intervention in the prevention of POAKI. Realtime data also allows for machine learning and implementation of predictive algorithms to derive each patient's threshold DO_2 .

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