

Preliminary analysis of the feasibility of continuous non-invasive delivery of oxygen monitoring in cardiac surgery patients

Authors

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Aim

Goal-directed therapy is essential to ensure optimal outcomes post-cardiac surgery. While patients are monitored closely intraoperatively, it is difficult to sample cardiac output (CO) and haemoglobin (Hb) continuously postoperatively. Advances in technology has enabled real-time non-invasive continuous CO and Hb monitoring, thus avoiding invasive methods like pulmonary arterial catheterization which carry risks e.g. sepsis [1, 2].

The Edwards ClearSight[®] (ECS) and Masimo SET Pulse CO-Oximetry[®] (MSPC) systems are validated as safer and faster compared to invasive CO monitoring and laboratory Hb sampling respectively [3,4]. Oxygen delivery can be calculated using the oxygen flux equation ($1.34 \times \text{Hb} \times \text{CO} \times \text{Oxygen saturation (SpO}_2)$). Hence, we propose an algorithm that simultaneously integrates CO readings from the ECS with Hb and SpO₂ readings from the MSPC to produce real-time DO₂ trend.

Methodology

The ECS and MSPC sensors were placed on the patient prior to surgery for ≤ 8 hours or until extubation. Monitoring was paused during bypass and resumed afterwards. Pre-induction, the study monitors were connected to a laptop for continuous streaming of CO, SpO₂ and Hb values via PuTTY, enabling the integration of inputs to generate a real-time DO₂ graph (Figure 1).

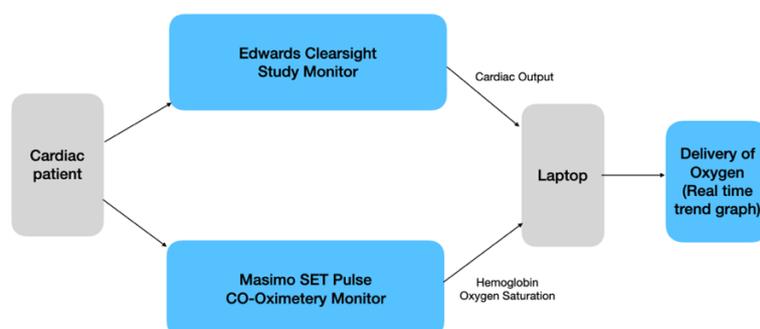


Figure 1. Diagram of DO₂ monitoring set up

Results

The algorithm was successfully implemented in 56 out of 60 patients and individual continuous DO_2 trend graphs were obtained (Figure 2). Downward trending DO_2 was observed postoperatively in patients that developed acute kidney injury (AKI) (Figure 3). DO_2 values obtained ranged from 240.3L/min (SD= 131.8, $S^2=17381.9$) to 1218L/min (SD= 490.3, $S^2=240397.0$) with an average monitoring duration of 6.3 hours.

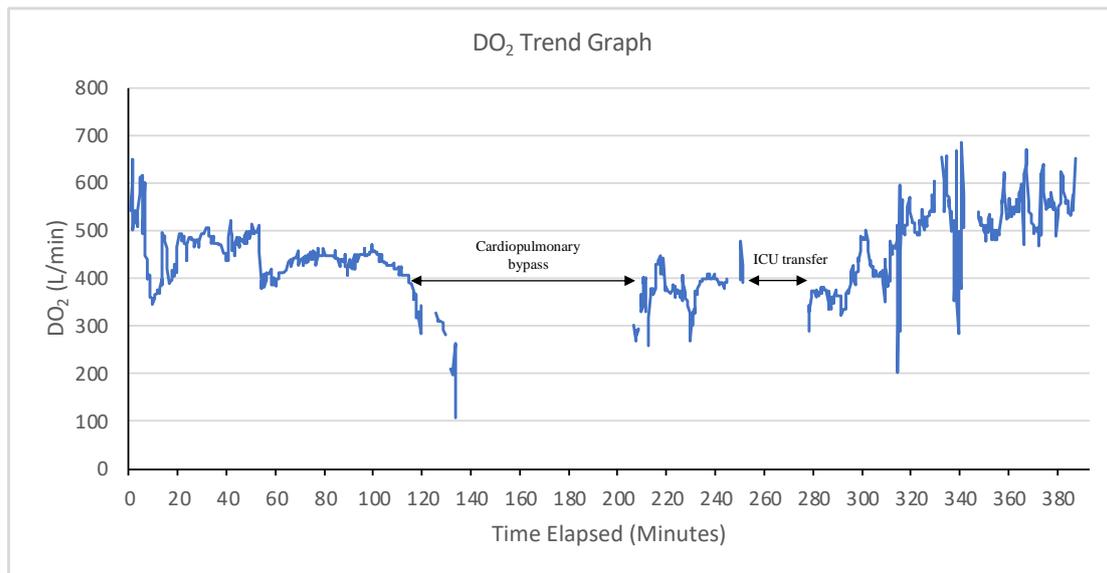


Figure 2. Generation of individual DO_2 trend graph with no reported AKI

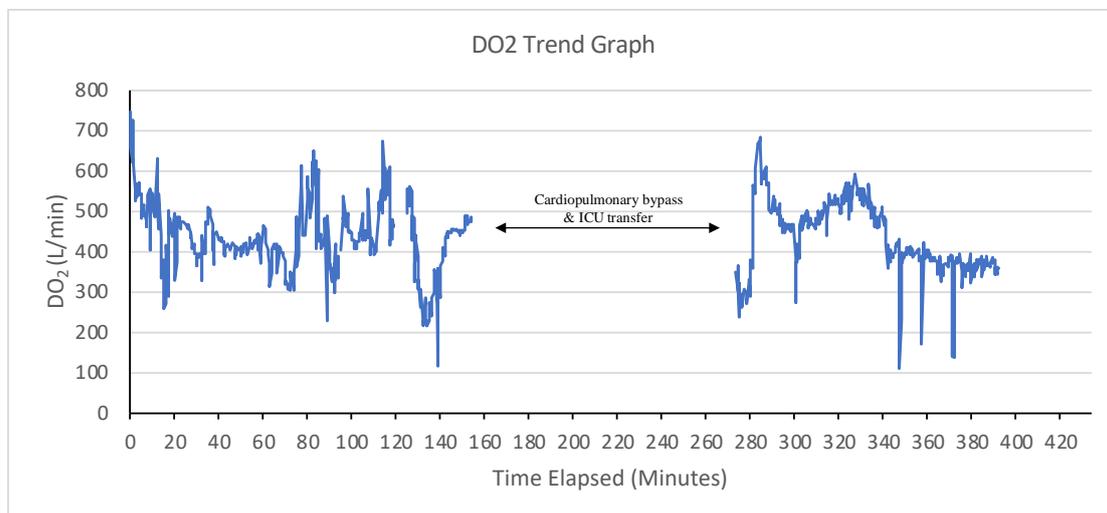


Figure 3. Generation of individual DO_2 trend graph with reported AKI

Four patients were dropped due to undetectable CO signal. Two patients developed cyanotic fingers from wearing the ECS sensor for an average of 5.5 hours while one patient reported skin trauma from wearing MSPC sensor for >9 hours. Paired sample t-test between postoperative laboratory Hb values and corresponding MSPC Hb readings found no significant difference ($p > 0.05$).

Conclusion

We have demonstrated the feasibility of the study set-up in monitoring continuous DO₂ which will enable goal-directed therapy for optimal outcomes post-cardiac surgery.

Word count:

300

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