Commentary: Taking the next step in cardiopulmonary bypass management

Andrew J. Lodge, MD,a and Travis Siffring, MS, CCP, FPPb

Cardiopulmonary bypass (CPB) is a system familiar to us all. Many of us use it virtually on a daily basis while we are going about the business of performing our jobs as surgeons. Although incredible advances in perfusion science have been made during the past several decades, it has struck me in recent years that despite the advances in technology of all sorts, our current heart-lung machines still seem relatively large, complicated masses of machinery and tubing that occupy a relatively large footprint in the cardiac operating room. I think back to the early CPB machines, such as the one from our institution pictured in Life Magazine back in 1957 (Figure 1) and wonder why we have not come further. When I compare the (admittedly much simpler) extracorporeal membrane oxygenation circuits that we use today that are portable and have built-in on-board monitoring, it makes me wonder why we have not come further with making a simpler and more compact heart-lung machine.

In addition to the perfusion equipment itself, a critical aspect of applying CPB technology is monitoring the circuit and the patient. In the report by Condello and colleagues1 in this issue of the JTCVS Techniques, different strategies for the management of CPB using different target parameters are compared. In 1 group (“control”), the cardiac index was adjusted according to a set mixed venous oxygen saturation (SvO2) target. In contrast, in the other (“study”) group, the indexed oxygen delivery (DO2i) was adjusted according to a target indexed oxygen extraction ratio (O2ERi). The latter strategy is somewhat more sophisticated and accounts for more variables. The findings of their study included less elevated lactate levels and glucose levels in the group managed with DO2i and O2ERi.1 It has been suggested that less elevated lactate levels can lead to lower postoperative creatinine levels and shorter mechanical ventilation time and intensive care unit lengths of stay. However, such differences between the 2 groups were not detected in their study.

Some of the limitations of the study include some variables for which there was no control, such as the inclusion of both open and closed circuits and the use of both central and peripheral cannulation. Importantly, the study used a consecutive patient series in which the control group represented an earlier period than the study group.1 This calls into question whether an era effect could have been involved because variables other than the CPB management strategy could have changed over time and affected the observations.

Although not all groups, especially in North America, have access to, or currently use, continuous DO2 during CPB, its use could have advantages because SvO2 might...
be less sensitive to changes in various tissue beds. The most common correction for a lower SvO2 and, presumably, for a higher O2ERi, would be to increase the overall CPB flow. Indeed, in the study by Condello et al,1 the nadir cardiac index on CPB was 2.6 L/min/m² compared with 2.4 L/min/m² in the control group, which was significantly different. Because the DO2i and O2ERi incorporate more variables, it could have led the perfusionists to increase the pump flow in response to changes that were not observed with simple SvO2 monitoring. In addition, in the patients in the study group, if an increase in pump flow alone did not improve the O2ERi, other variables contributing to oxygen delivery could have been modified.

In conclusion, the findings from their study make intuitive sense and corroborate the observation that many investigators in surgery and critical care have reported about oxygen delivery and consumption dynamics in patients.2-4 Should these findings be validated in a contemporaneous prospective or even randomized studies, it should lead to a justification for more widespread use of more contemporary sophisticated monitoring, which might, in turn, lead to improved patient outcomes.

References
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FIGURE 1. Cardiac surgical procedure at Duke University Medical Center in 1956 using large cardiopulmonary bypass apparatus as shown in Life Magazine in 1957.