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From the Editor

This issue of the *Journal of ExtraCorporeal Technology* contains a variety of original investigations, a review, two cases studies, and the Proceedings from the Symposium on Goal Directed Therapy in Perfusion. The symposium offered an overview of the tools and strategies that have been used to achieve the goal of providing adequate perfusion to the patient during cardiopulmonary bypass (CPB). The goal of providing adequate perfusion has been present since the beginning of the use of CPB to support patients during cardiac surgery. So, it would appear that nothing has changed. Although the goal has not changed, the knowledge and tools used to reach the goal have changed. In general terms, goal-directed therapy uses monitoring of patient parameters to guide clinicians in making decisions regarding a variety of therapies that have been shown to improve patient outcomes. A key to goal-directed therapies is early treatment strategies, or pre-emptive strategies, to minimize the pathophysiological changes that occur with a disease state or intervention (1).

In perfusion, pre-emptive strategies have emphasized the improvement of coagulation management and reduction of circuit size to minimize surface contact and hemodilution. Optimizing circuit size and volume has been undertaken primarily to optimize hemoglobin levels and oxygen delivery and to reduce blood transfusions. The convergence of three technologies has allowed for a shift toward goal-directed therapies in perfusion. These technologies are related to the equipment (pump, circuit components), the digitization of data that allows for the collection of pump and patient variables over the course of CPB, and the ability to measure a diversity parameters that provide information about the delivery and use of oxygen by the body.

The digitization and collection of pump and patient data have provided opportunities to better see patterns and relationships between perfusion variables and patient outcomes. The formation of (and use of) data registries for perfusion data have been, and will continue to be, key to identifying the relationships between the conduct of perfusion and patient outcomes (2–4). Once the relationship is identified, alterations in the conduct of perfusion can be made to determine if the relationship was causal or not. Becoming aware of these relationships can lead to improved patient outcomes.

A major emphasis of goal-directed perfusion (GDP) has been with oxygen delivery. Systemic oxygen delivery has been associated with patient outcomes, such as acute kidney injury (5). Several presentations in the GDP symposium discuss the measurement and importance oxygen delivery to patient outcomes. More importantly, the presenters discuss the limitations of measuring only oxygen delivery and emphasize the need to measure the utilization of delivered oxygen by the tissues. The measurements that allow indirect assessment of total body oxygen utilization include venous oxygen saturation, carbon dioxide production (VCO_2), and blood lactate levels (2,3,6). Including measurements of oxygen utilization provides an opportunity for a more nuanced view of the relationship between CPB conduct and patient outcomes and more opportunities for the continued improvement of the conduct of CPB.

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Continued improvement in the technologies associated with the measurement of delivery and utilization of oxygen at the tissue level will be required to fully understand the impact of CPB on the circulatory system, specifically the vascular endothelium (7). Recent studies in rats and humans have demonstrated that the initiation of CPB disturbs the function of the microcirculation, the place where oxygen exchange occurs. More importantly, this disturbance persists throughout the duration of CPB and is not necessarily reversed with increased oxygen delivery (increased flow rate, increased hemoglobin levels, increase perfusion pressure) (8–11). These results suggest a need to develop pre-emptive strategies. The development

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of such pre-emptive strategies will require a greater understanding of the circulatory system beyond tubes that transport oxygen to the tissues to tubes that actively influence the distribution of blood flow and distribution of oxygen to the tissues as well as technological advancements in measurement from the macrolevel to the microlevel. GDP has provided awareness that perfusion practice has not yet reached the goal of optimal patient outcomes and a road map for continuing improvement toward that goal.

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