Optimal hemodynamic conditions for tissue oxygenation in fluid resuscitation

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The effectiveness of fluid resuscitation regimens in hemorrhagic trauma is assessed based on its ability to increase oxygen concentration in tissue. Fluid resuscitation using both crystalloids and colloids fluids, creates a dilemma due to its opposing effects on oxygen transfer. It increases blood flow thereby augmenting oxygen transport but it also dilutes the blood simultaneously and reduces oxygen concentration thereby reducing oxygen transport. In this work we have studied these two opposing effects of fluid therapy on oxygen delivery to tissue. A mathematical model of oxygen diffusion from capillaries to tissue and its distribution in tissue was developed and integrated into a previously developed hemodynamic model. The capillary-tissue model was based on the Krogh structure. Compared to other models, fewer simplifying assumptions were made leading to different boundary conditions and less constraints, especially regarding capillary oxygen content at its venous end. Results showed that oxygen content in blood is the dominant factor in oxygen transport to tissue and its effect is greater than the effect of flow. The integration of the capillary/tissue model with the hemodynamic model that links administered fluids with flow and blood dilution, indicated that fluid resuscitation may reduce oxygen transport to tissue. A measurable parameter that can indicate oxygen supply to tissue in real-time is desired. The model should be further developed and a mitochondrial model should be added to examine NADH as a possible candidate.