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First Clinical Experiences with Non-Pulsatile Optical Diffusion Tissue Oximetry during Cardiopulmonary Bypass

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Introduction:

In patients undergoing cardiac surgery (CS), monitoring of central tissue oxygenation and perfusion during cardiopulmonary bypass (CPB) is impossible, in part due to the absence of pulsatile flow. Visible-light optical diffusion oximetry (ODO), which measures perfusion-sensitive capillary-weighted hemoglobin saturation (StO₂%), was tested in CS patients during CPB.

Methods:

In 5 patients undergoing cardiac surgery a buccal surface probe measuring mucosal StO₂% was placed after induction of anesthesia. The system (T-Stat, Spectros, Portola Valley) emits low power, continuous, broadband visible light, which is spectroscopically analyzed after diffusing through tissue. It measures every 50 ms, is insensitive to motion, and does not require pulsatile flow to operate. Pulse oximetric saturation (SpO₂%), HR, and MAP were recorded in parallel.

Results:

ODO continuously showed stable measurements of tissue oxygenation throughout the surgical procedure, including the period of CPB; in contrast, pulse oximetry failed completely during CPB. StO₂% closely followed changes in pump flow, responding within seconds. There was no interference by mild hypothermia.

Conclusion:

This is the first report on the clinical use of non-pulsatile visible-light optical diffusion oximetry as a tool to monitor tissue perfusion during CPB. As arterio-venous saturation difference is inversely related to blood flow at constant demand, changes in StO₂% during CPB directly reflect changes in cardiac output when the arterial oxygen saturation is stable. Currently this is the only available monitor of mucosal tissue oxygenation in non-pulsatile conditions. Further studies will have to determine ranges of the normal/abnormal ODO values in relation to cardiac output.