

[1471.199] NIRS Technology Detects a Decrease in Intestinal Blood Flow Caused by Hypovolemia

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BACKGROUND: A non-invasive method for monitoring changes in tissue perfusion might improve care for ELBW infants. Tissue O₂ consumption = K x [SaO₂-SvO₂] x BF, where K is the amount of O₂ bound to hemoglobin, BF is tissue blood flow, and [SaO₂-SvO₂] is the oxygen saturation gradient between arterial and venous blood. If oxygen consumption is constant, a decrease in BF will cause an increase in [SaO₂-SvO₂]. SaO₂ can be monitored by pulse oximetry. Since tissue O₂ saturation (NIRS-StO₂) measured by NIRS technology reflects a mixture of SaO₂ and SvO₂, SvO₂ can be calculated from SaO₂ and NIRS-StO₂. OBJECTIVE: To determine the effect of hypovolemia (HV) on portal venous blood flow (PVBF), SaO₂, SpvO₂ (portal venous) and intestinal NIRS-StO₂.

DESIGN/METHODS: PVBF was measured using the dye dilution method in rats with aortic, portal venous (PV) and superior mesenteric artery (SMA) catheters. Evan's blue dye (EBD) was infused into the SMA. Aortic and PV blood were analyzed for EBD. PVBF = Infusion rate of EBD / EBD (PV-A). These studies were repeated under HV (removal of 20% of blood volume). In a second group of rats, a CASMED NIRS probe was placed on the abdomen. While monitoring NIRS-StO₂, aortic and PV blood were analyzed for SO₂ using co-oximetry. These studies were repeated under HV. Calculations: assuming that intestinal O₂ consumption was not affected by HV, PVBF_{cont} x [SaO₂-SpvO₂]_{cont} = PVBF_{HV} x [SaO₂-SpvO₂]_{HV}. PVBF_{cont} / PVBF_{HV} = [SaO₂-SpvO₂]_{HV} / [SaO₂-SpvO₂]_{cont}. Preliminary studies indicate that intestinal NIRS-StO₂ reflects 57% portal venous and 43% arterial blood. Using this relationship, **calculated SpvO₂ (CSpvO₂) = (NIRS-StO₂ - 0.43 x SaO₂) / 0.57.**

RESULTS: The PVBF_{cont} / PVBF_{HV} measured by dye dilution was (2.1(0.5) n=3). Values = mean(SEM)

The effect of hypovolemia on SO₂ (percent)

	SaO2	SpvO2	CSpvO2	SaO2-SpvO2	SaO2-CSpvO2
Control	91(1)	67(5)	63(6)	24(4)	28(5)
Hypovolemia	93(1)	36(5)	40(4)	57(6)	53(4)

values = mean (SEM), n=4

Using changes in [SaO₂-SpvO₂] or [SaO₂-CSpvO₂], the PVBF_{cont} / PVBF_{HV} was (2.5(0.3) n=4) and (2.1(0.4) n=4), respectively.

CONCLUSIONS: HV decreased PVBF by 50% determined by both the dye dilution and [SaO₂-SpvO₂] method. The NIRS CSpvO₂ was similar to measured SpvO₂. This is the first direct evidence that changes in [SaO₂-CSpvO₂] are indirectly proportional to intestinal blood flow. We speculate that continuous monitoring of [SaO₂-CSpvO₂] by pulse oximetry and NIRS technology can be used to detect clinically significant changes in tissue perfusion.

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