INVOS™ System Inservice Guide for Pediatric Use

COVIDIEN

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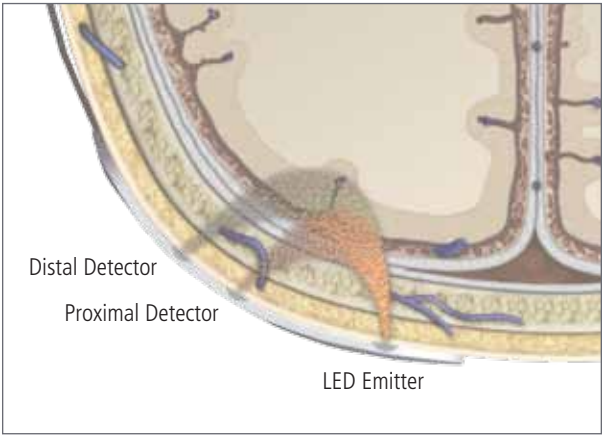
The INVOS™ System: A Window to Perfusion Adequacy

The noninvasive INVOS™ System reports the venous-weighted regional hemoglobin oxygen saturation (rSO_2) in tissue under the sensor keys, reflecting the hemoglobin bound oxygen remaining after tissues have taken what they need. Decreases in this venous reserve indicate increased ischemic risk and compromised tissue perfusion.



The INVOS™ System uses two depths of light penetration to subtract out surface data, resulting in a regional oxygenation value for deeper tissues.

Regional Oximetry vs. Other Oximetry

Regional (Capillary) Oximetry (rSO_2)

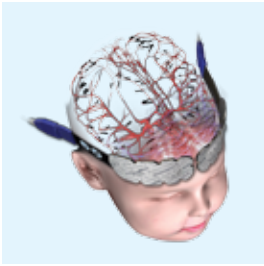
- Noninvasive
- Capillary (venous and arterial) sample
- Measures the balance between O_2 supply and demand beneath the sensor
- End-organ oxygenation and perfusion
- Requires neither pulsatility nor blood flow

Pulse (Arterial) Oximetry (SpO_2)

- Noninvasive
- Arterial sample
- Measures O_2 supply in the periphery
- Systemic oxygenation
- Requires pulsatility and blood flow

Central (Venous) Oximetry (SvO_2)

- Invasive
- Venous sample
- Measures O_2 surplus in central circulation
- Systemic oxygen reserve
- Requires blood flow



Key Terms

rSO_2: Regional Oxygen Saturation

INVOS™: In Vivo Optical Spectroscopy

Cerebral Application: Brain area measurement

Somatic Application: Tissue area of measurement

Pediatric rSO_2 Targets and Thresholds

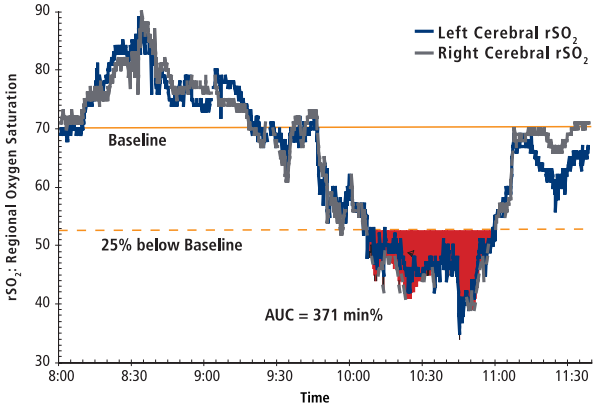
Targets and thresholds are expressed in rSO_2 numerical values and % changes from baseline. Both measures have been proven to provide real-time data accuracy in patients >2.5 kg. With the patient serving as his/her own control, customized clinical decisions are based on each patient's unique physiology and clinical situation.

CEREBRAL

High blood flow, high O_2 extraction

- Typical rSO_2 range: 60-80
- Common intervention trigger: rSO_2 <50 or 20% change from rSO_2 baseline
- Critical threshold: rSO_2 <45 or 25% change from rSO_2 baseline

rSO_2 Changes[2]



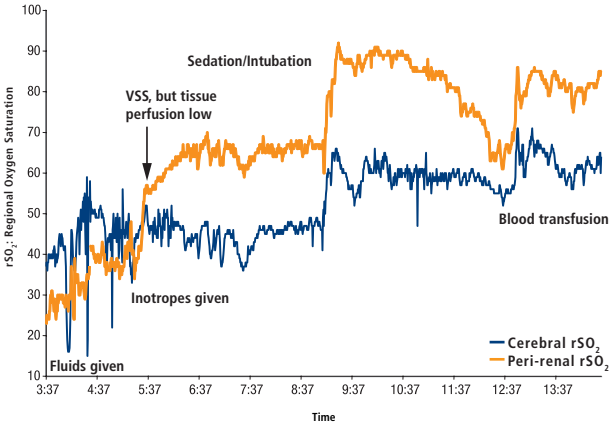
When used as an indication of compromised cerebral oxygenation, interventions to return rSO_2 to baseline using the INVOS™ System have been shown to improve outcomes after surgery in patients >2.5 kg.[1]

SOMATIC/PERI-RENAL

Variable blood flow, lower O_2 extraction

- Peri-renal rSO_2 5-20 points higher than cerebral
- Variances in the cerebral-somatic relationship may be indicative of pathology

Reversal of Shock[3]



Factors Affecting rSO_2

rSO_2 may be affected by a host of variables in conjunction with the patient's condition. Some may include body positioning, muscular activity, circulating blood volume, cardiac function, peripheral vascular resistance, circulating hormones and venous pressure. While each hospital will have its own care protocols, these guidelines have been shown to improve rSO_2.

Operating Room Interventions to Improve rSO_2[4]

Perfusion imbalance

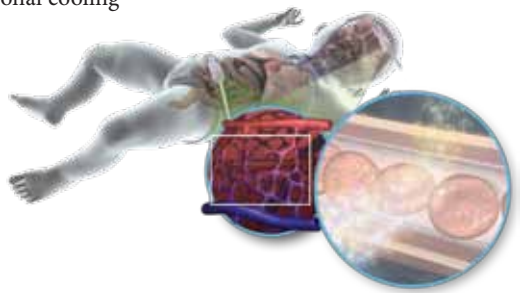
- Blood pressure
- Mechanical obstruction (cannula or head position)
- Increase cardiac output (pump flow)
- Increase circulating volume
- Increase CO_2 to physiologic levels

Dysoxygenation

- Increase FiO_2
- Increase hematocrit
- Reintubate

Limited ischemia tolerance

- Increase anesthetic depth
- Neuroprotective agent
- Additional cooling



In neonates, infants and children, cerebral and somatic rSO_2 provide noninvasive indications of oxygen changes in the cerebral and peripheral circulatory systems and may provide an early indication of oxygen deficits associated with impending shock states and anaerobiosis.[1]

PICU Interventions to Improve Cerebral rSO_2[5-6]

Increase cerebral perfusion pressure

- Increase blood pressure
- Increase systemic vascular resistance
- Increase cardiac output
- Decrease central venous pressure

Increase arterial oxygen content

- Transfuse red blood cells
- Raise arterial partial pressure of oxygen

Reduce cerebral metabolic rate

- Control hyperthermia
- Sedation

Reduce cerebral vascular resistance

- Raise arterial partial pressure of carbon dioxide

PICU Interventions to Improve Somatic rSO_2[4,7-8]

Interventions to improve cardiac output

- Cardiac Output= stroke volume x heart rate
- Preload
- Afterload
- Contractility
- Heart rate and rhythm

Increase hematocrit

Maintain normal temperature

Figure 1 - INVOS™ 5100C System Connections

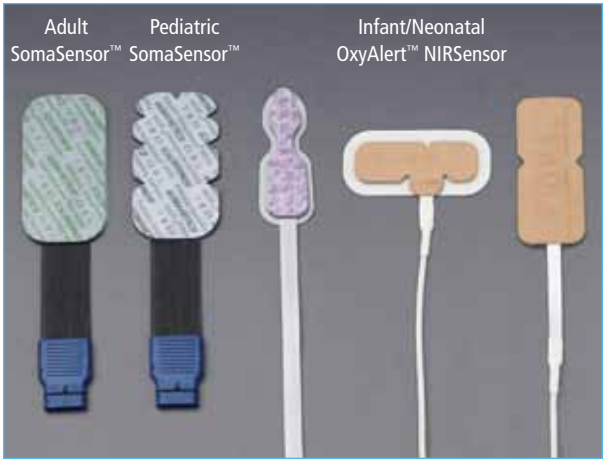


Figure 2 - INVOS System Sensors

Setup and Baselines

- Attach Sensors to Reusable Sensor Cables (*Figure 1*). (Sensor cable can be connected to sensors before or after placement). Different INVOS™ System sensors (adult, pediatric and infant/neonatal) cannot be used on the same monitor (*Figure 2*).
- Turn power ON by selecting the green ON/OFF key. The INVOS™ System performs a 10-second self-test, stopping at the Start Screen.
- Press NEW PATIENT. Monitoring begins displaying the patient's rSO_2 values in white.
- When the patient's rSO_2 values have been displayed for approximately 1 minute, set a baseline. For all channels, press the BASELINE MENU button followed by pressing SET BASELINE.

For extended monitoring, Somanetics recommends using a new sensor every 24 hours or if adhesive is inadequate to seal the sensor to the skin.

Sensor Removal

Use care when removing the sensor from the patient. If difficult to remove, commercially available solvents include:

Uni-solve, Smith and Nephew, Tel 800-876-1261, http://global.smith-nephew.com

Detachol, Ferndale Laboratories, Inc., Tel 248-548-0900, http://www.ferndalelabs.com

3M Remover Lotion, 3M Health Care, Tel 800-228-3957, http://www.3m.com

For complete instructions, warnings and precautions, see the Operations Manual and Instructions for Use inside sensor carton.

Site Selection

Cerebral
Select sensor site on the right and left side of forehead. Placement of the sensor in other cerebral locations, or over hair, may cause inaccurate readings, erratic readings, or no readings at all. Do not place the sensor over nevi, sinus cavities, the superior sagittal sinus, subdural or epidural hematomas or other anomalies such as arteriovenous malformations, as this may cause readings that are not reflective of brain tissue or no readings at all.

To avoid pressure sores do not apply pressure (e.g. headbands, wraps, tape) to sensor.

Somatic
Select sensor site over tissue area of interest (site selection will determine which body region is monitored). Avoid placing the sensor over thick fatty deposits, hair or bony protuberances. Do not place the sensor over nevi, hematomas or broken skin, as this may cause readings that are not reflective of tissue or no readings at all. **When two somatic site sensors are placed, they must be connected into the same preamplifier.**

Placements may include, but are not limited to: renal area: posterior flank (T10-L2, right or left of midline), abdomen, forearm, calf, upper arm, chest and upper leg.

Patient Preparation

- Clean the skin. Dry thoroughly.
- Remove protective backing and apply to skin.
- Apply sensor by smoothing it to the skin from the center outward.

Examples of sensor placements A) cerebral, B) peri-renal and C) abdominal

References
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5. Hoffman GM, *Cardiol Young.* 2005;15(Suppl. 1):149-153.
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