

Postoperative monitoring in adult cardiac surgery patients

With the INVOS™ regional oximeter

Cardiac surgery patients are at risk of significant cerebral desaturation after surgery. In fact, up to 73 percent of high-risk patients monitored with INVOS™ technology desaturate in the ICU.¹⁻³ In addition to basic vital signs, invasive postoperative hemodynamic monitoring may include:

- Arterial catheters for blood pressure
- Pulmonary artery catheters for cardiac filling
- Mixed venous oxygen saturation
- None of these methods provide a direct reflection of cerebral oxygen supply or content.

Monitoring cardiac surgery patients with near-infrared spectroscopy after the OR is an emerging practice. Researchers have studied postoperative monitoring between four and 72 hours – or until extubation – to quantify the incidence and burden of cerebral desaturation.¹⁻⁴ Interventions employed during postoperative hypotensive episodes may include intravenous fluids and/or blood products, which have been shown to increase cerebral rSO₂ in some cases.³

This clinical evidence guide explores the utility of postoperative monitoring with INVOS™ technology to help identify continued cerebral desaturation and hemodynamic instability in the ICU.



CVICU nurses see value in extending intraoperative cerebral oxygen saturation monitoring into the ICU

Cerebral perfusion monitoring in adult patients following cardiac surgery: an observational study
SLATER T, STANIK-HUTT J, DAVIDSON P. (US)

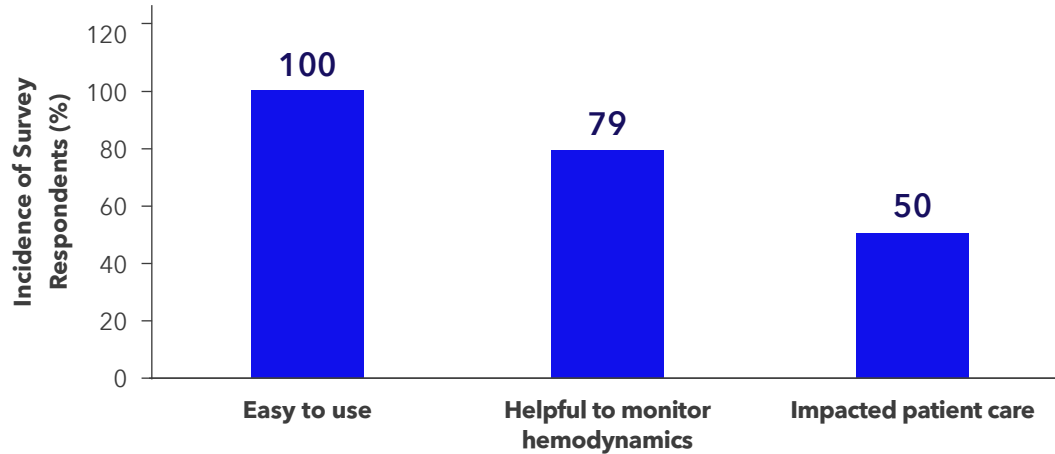


Figure: CVICU nurses' perceptions of using INVOS™ technology to monitor cerebral oxygen saturation postoperatively in cardiac surgery patients who received monitoring in the OR

Patients experienced a steady decline in cerebral rSO₂ values during the four hours after surgery:

60%

desaturated during the postoperative period



63% average preoperative baseline rSO₂

55%

average four-hour postoperative rSO₂

Single center prospective observational trial to assess the acceptability by CVICU nurses of employing postoperative monitoring in cardiac surgery patients using INVOS™ monitoring technology

In the study, patients undergoing aortic valve surgery (N=35), with or without other concomitant procedures, were monitored with INVOS™ technology in the OR and for four hours postoperatively in the ICU. Concomitant CABG procedures were performed in 17 percent of patients. The postoperative care team included intensivists, nurse practitioners, nurses, physician assistants, second year surgical residents, or critical care fellows. The team was trained using a 20- to 30-minute PowerPoint presentation on how and why to use near infrared spectroscopy.

Baseline (OR) cerebral oximetry readings were verbally reported to the ICU care team by the anesthesia provider upon handoff. The care team entered oximetry values every 15 minutes for four hours. Cerebral desaturation events were registered if they occurred twice in a 60-minute period.

The findings

Of the nurses surveyed on their perceptions of the usability and impact of INVOS™ technology on patient care:

- 100 percent reported the INVOS™ monitoring system as easy to use
- 79 percent reported it as helpful for monitoring hemodynamic trends
- 50 percent believed the data provided by the monitor impacted patient care
- 26 percent reported an increase in cerebral oximetry values with intervention for hypotensive episodes
- 6 percent reported that manual EMR entry of oximetry values interfered with patient care

The study showed that acceptability should improve if the monitor was kept in a visible spot and oximetry values were automatically uploaded to the EMR.

Postoperative cerebral desaturation in the ICU is common in high-risk cardiac surgery patients

Reversal of decreases in cerebral saturation in high-risk cardiac surgery

DESCHAMPS A, LAMBERT J, COUTURE P, ET AL. (CANADA)

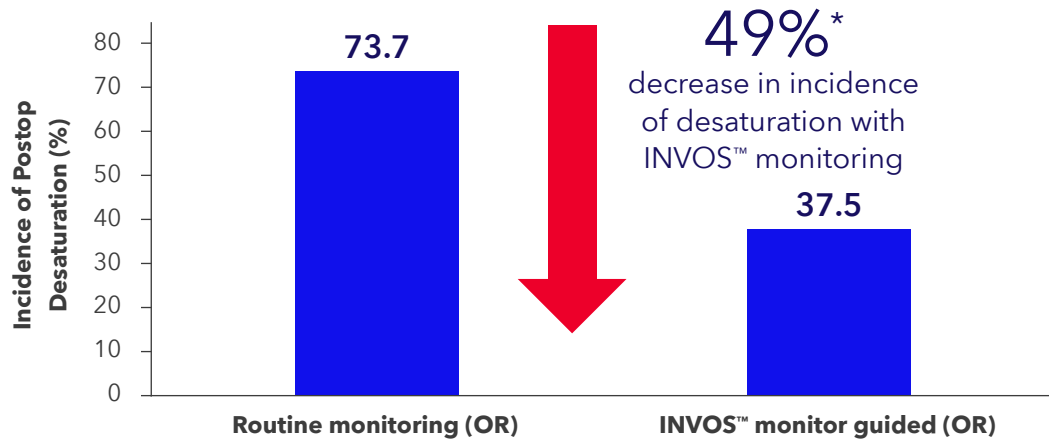


Figure: Incidence of patients experiencing critical postoperative cerebral desaturation after high-risk cardiac surgery (as detected by INVOS™ monitoring technology) in patients who desaturated during surgery ($P < 0.0347$).
*Calculation

Postoperative burden of hypoxia was observed in both OR control and intervention groups, but was lower in patients receiving INVOS™ technology-guided care during surgery:

856.6

% · minutes in the ICU after routine monitoring in the OR



324

% · minutes in the ICU with INVOS™ monitoring and intervention in the OR

Single center two-part trial (Part 2 was a randomized controlled pilot) to verify that using INVOS™ monitoring technology and an interventional protocol to restore cerebral rSO₂ in the OR reduced the burden of hypoxia in the OR and ICU

In the study, patients undergoing high-risk on-pump cardiac surgery (N=48) were randomized to:

- Routine monitoring in the OR
- INVOS™ monitoring and intervention in the OR

Blinded monitoring was continued for all patients into the ICU for 12 hours or until extubation. OR interventions were triggered when rSO₂ decreased >20 percent from baseline for ≥15 seconds (in OR only). High-risk cardiac surgeries included congenital heart defects, thoracic aortic, coronary artery bypass graft (CABG) plus valvular, multiple valve replacement, valvular plus aortic, and redo surgery.

The findings

- Of patients who desaturated in the OR, more patients in the control group also desaturated in the ICU (73.7 percent vs 37.5 percent; $P < 0.0347$)
- Intraoperative monitoring and intervention in the OR appeared to have a protective effect on desaturation in the ICU:
 - Patients who did not experience cerebral desaturation in the OR did not subsequently desaturate in the ICU
 - Total mean desaturation load in the ICU was lower in the intervention group (324 percent desaturation minutes vs. 856.6 desaturation minutes; $P = 0.030$)
- Postoperative cerebral desaturation was common in this high-risk cardiac surgery population
- Intraoperative monitoring and intervention in the OR were associated with a reduction in the total postoperative cerebral desaturation load in the ICU

Burden of cerebral desaturation is significant both during and after high-risk cardiac surgery

Cerebral oximetry monitoring to maintain normal cerebral oxygen saturation during high-risk cardiac surgery

DESCHAMPS A, HALL R, GROCOTT H, ET AL. (CANADA)

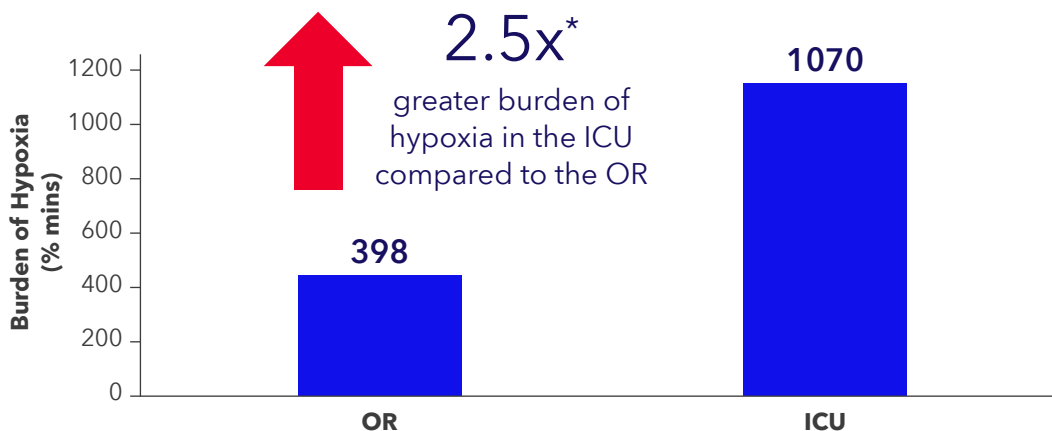


Figure: Burden of hypoxia detected both intra- and postoperatively in the routine care group (blinded cerebral NIRS monitoring) for high-risk cardiac surgery patients (not a statistical comparison)

*Calculation

A significant proportion of patients experienced cerebral desaturation in the ICU:



32.8% desaturated > 20% from baseline in the ICU

32.8%

desaturated > 20% from baseline in the ICU after desaturating > 10% in the OR

19.4%

desaturated > 20% from baseline in the ICU after desaturating > 20% in the OR

Multicenter NORMOSAT randomized controlled trial to verify that using various NIRS monitoring technologies and an interventional protocol to restore cerebral rSO₂ in the OR could successfully reverse cerebral desaturations more often than routine care

In the study, adult patients undergoing high-risk on-pump cardiac surgery (N=201) were randomized to:

- Routine monitoring in the OR
- NIRS cerebral oximetry monitoring and intervention in the OR (INVOS™ technology was used in 62 percent of patients compared to other brands of NIRS devices)

Blinded NIRS monitoring was continued for all patients in the ICU for 12 hours or until extubation. High-risk cardiac surgery included CABG plus valvular surgery (70 percent), multiple valve replacement, and redo surgery. OR interventions were triggered when rSO₂ decreased >10 percent from baseline for >15 seconds.

The findings:

- Results from the ICU include:
 - 1,120 desaturation episodes (>20 percent from baseline) among 66 of 201 patients (32.8 percent)
 - Approximately 5.6 desaturation events per patient
 - A burden of hypoxia (time spent under baseline) of 1070 percent · minutes
 - >10 percent desaturation in the OR experienced by all 66 patients who desaturated in the ICU
- Postoperative cerebral desaturation was common in this high-risk cardiac surgery population

Monitoring and intervention in the ICU reduces the duration of cerebral desaturation after cardiac surgery

Cerebral oximetry and postoperative delirium after cardiac surgery: a randomized, controlled trial
LEI L, KATZNELSON R, FEDORKO L, ET AL. (CANADA)

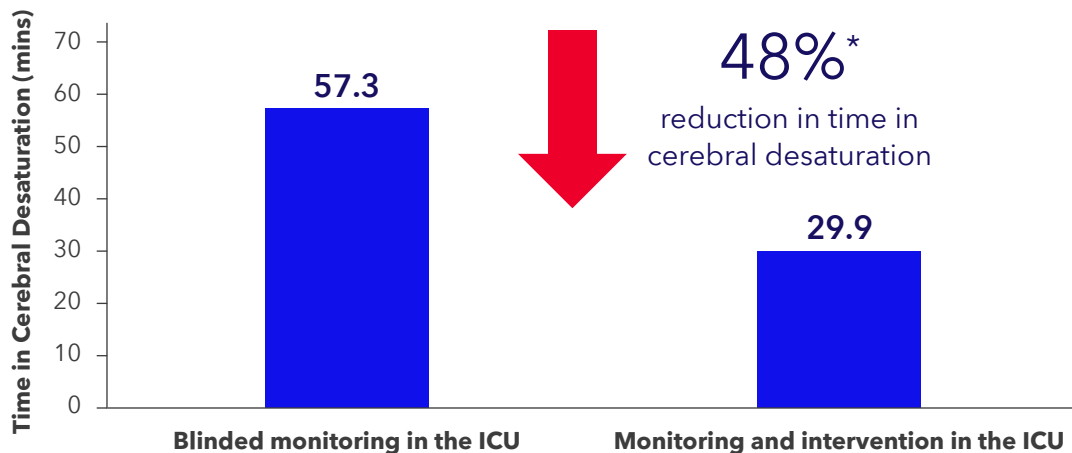


Figure: Time spent experiencing cerebral desaturation in the blinded monitoring group compared to the monitoring and intervention group

*Calculation

Patients experienced significant cerebral desaturation in the ICU:



Single center randomized controlled trial to assess the association between INVOS™ monitoring technology and an interventional protocol to restore cerebral rSO₂ in the OR and ICU, and postoperative delirium

In the study, elderly patients (≥60 years old) undergoing cardiac surgery (N=249) were randomized to:

- Routine monitoring in the OR and ICU
- INVOS™ monitoring and intervention in the OR and ICU

INVOS™ monitoring was continued in the ICU up to 24 hours. Cardiac surgeries included CABG (~50 percent), CABG plus valvular surgery (~40 percent), valves alone, multiple valve replacement, ascending aortic or arch, and redo surgery. Interventions were triggered when rSO₂ decreased >25 percent from baseline for ≥1 minute.

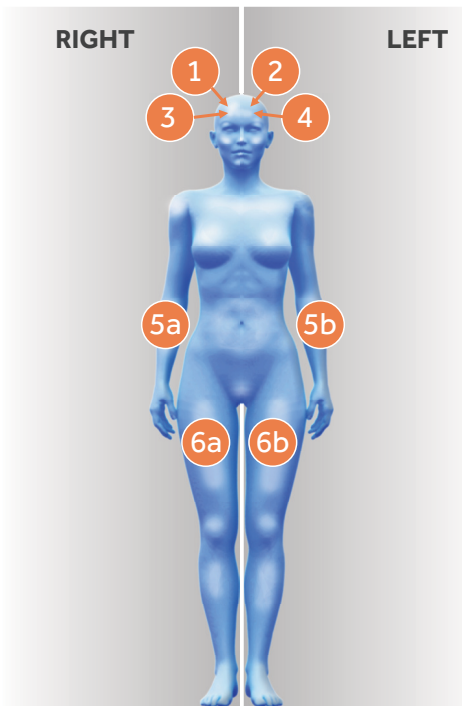
The findings

- The care team was unable to restore rSO₂ values to baseline in 12 percent of patients
- Some patients experienced spontaneous restoration of baseline rSO₂ between 20 minutes and 2.5 hours in the ICU
- Postoperative cerebral desaturation was common and could be mitigated with monitoring and intervention

Low spot-check cerebral rSO₂ values in the postoperative period may inform postoperative delirium risk and severity

Cerebral oximetry as a biomarker of postoperative delirium in cardiac surgery patients

MAILHOTT, COSSETTE S, LAMBERT J, ET AL. (CANADA)



During the three-day postoperative period of spot-check cerebral and peripheral INVOS™ monitoring:



Cerebral oximetry values increased from 50% to 54%



Peripheral oximetry values remained stable at 67%



Higher cerebral rSO₂ was associated with lower odds and less severity of postoperative delirium

Single-center observational study as part of a larger controlled trial to assess postoperative cerebral oximetry values and postoperative delirium

Patients undergoing cardiac surgery who were diagnosed with postoperative delirium (N=30) were enrolled in the study. Cardiac surgeries included CABG (40 percent) and valvular surgery (60 percent). Each day, patients received spot-check cerebral and peripheral (arm and leg) oximetry monitoring with INVOS™ monitoring technology to get single point values. No interventions were performed. Delirium screening was performed three times daily using the Intensive Care Delirium Screening checklist. This was followed by the Confusion Assessment Method – ICU and the Delirium Index to assess severity.

The findings

- Higher postoperative cerebral rSO₂ values were associated with a 27 percent decrease in the odds of delirium occurrence (OR 0.73, CI 0.635 - 0.838)
- Similarly, higher cerebral rSO₂ values were associated with a lower delirium severity index score
- Postoperative monitoring with cerebral oximetry could be considered as adjunct information to inform risk for postoperative delirium

NOTE: The INVOS™ monitoring system should not be used as the sole basis for diagnosis or therapy and is intended only as an adjunct in patient assessment.

1. Slater T, Stanik-Hutt J, Davidson P. Cerebral perfusion monitoring in adult patients following cardiac surgery: an observational study. *Contemp Nurse*. 2017;53(6):669-680.
2. Deschamps A, Lambert J, Couture P, et al. Reversal of decreases in cerebral saturation in high-risk cardiac surgery. *J Cardiothorac Vasc Anesth*. 2013;27(6):1260-1266.
3. Deschamps A, Hall R, Grocott H, et al. Cerebral oximetry monitoring to maintain normal cerebral oxygen saturation during high-risk cardiac surgery: a randomized controlled feasibility trial. *Anesthesiology*. 2016;124(4):826-836.
4. Lei L, Katznelson R, Fedorko L, et al. Cerebral oximetry and postoperative delirium after cardiac surgery: a randomised, controlled trial. *Anaesthesia*. 2017;72(12):1456-1466.
5. Mailhot T, Cossette S, Lambert J, Cournoyer A, Denault AY. Cerebral oximetry as a biomarker of postoperative delirium in cardiac surgery patients. *J Crit Care*. 2016;34:17-23.

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