

Transcutaneous Monitoring in the NICU: Clinical Utility & Impact



Sentec transcutaneous technology overcomes many of the current limitations and challenges associated with CO₂ measurement in the NICU by providing accurate, continuous, noninvasive CO₂ values regardless of ventilation method or V/Q mismatch. Sentec transcutaneous monitoring provides consistent, independent CO₂ measurement all while promoting neuroprotective efforts to deliver clustered care, protect skin integrity, and reduce the frequency of blood draws.

Carbon dioxide levels are critically important in the NICU for both protecting the brain from intraventricular hemorrhage as well as properly implementing lung protective ventilatory strategies.

Continuous Noninvasive Carbon Dioxide Monitoring in Neonates: From Theory to Standard of Care.

Hochwald O, et al. *Pediatrics*. 2019 Jul;144 (1): e20183640.

This review establishes the connection between abnormal carbon dioxide levels and intraventricular hemorrhage (IVH), as well as the need for titrated ventilatory support to protect neonatal lungs.

Arterial blood gases and capillary heel sticks are the gold standard for accurate PaCO₂ information, but they present issues in the NICU such as blood loss, infection, and pain.

Iatrogenic blood loss in extreme preterm infants due to frequent laboratory tests and procedures.

Counsilman CE, et al. *J Matern Fetal Neonatal Med*. 2019 Oct 6;1-6.

This article represents one of the more recent publications connecting frequent blood sampling to iatrogenic anemia, transfusion, and the associated risks and outcomes. The authors recommend transcutaneous monitoring as part of a multifaceted solution to reduce blood loss in the NICU.

Pain management in newborns.

Hall RW, et al. *Clin Perinatol*. 2014 Dec;41(4): 895-924.

This review article references short and long-term behavioral and neurological adverse outcomes associated with neonatal pain and recommends a rigorous approach to pain reduction, largely aimed at reducing the frequency of blood sampling, an effort to which noninvasive monitoring can contribute.

Attributable cost and length of stay for central line-associated bloodstream infections.

Goudie A, et al. *Pediatrics*. 2014 Jun;133(6): e1525-32.

Some publications (*such as Hall et al, above*) have recommended central lines for patients who require frequent heel sticks to avoid the adverse outcomes associated with repeated painful events, but most institutions limit the number of draws that can be performed from a central line to fewer than desired for CO₂ monitoring, and with good reason. The study of Goudie, et al. found Central Line Associated Blood Stream Infections (CLABSIs) to be associated with ~30 day increase in length of stay for neonates, at a cost increase of ~\$90,000 per patient.

Transcutaneous CO₂ monitoring can help reduce the frequency of blood draws.

Neonatal Transcutaneous Carbon Dioxide Monitoring—Effect on Clinical Management and Outcomes.

Mukhopadhyay S, et al. *Respir Care*. 2016 Jan;61 (1):90-7.

This study at Children's Hospital of Pennsylvania's then level III NICU found the introduction of transcutaneous monitoring to be associated with a ~25% reduction in blood gases for ventilated patients.

While blood gases are the gold standard for accuracy, the value in the measurement is constrained by the fact that it only represents a single point in time, which can misrepresent the patient course. Continuous CO₂ monitoring has been shown to reduce how much time neonatal patients spend outside normal CO₂ ranges, which may contribute to better outcomes.

Impact of Continuous Capnography in Ventilated Neonates: A Randomized, Multicenter Study.

Kugelman A, et al. *J Pediatr*. 2016 Jan;168:56-61.e2.

This study, while performed with capnography, demonstrated that visibility to continuous CO₂ information was associated with significantly less time spent at unsafe CO₂ levels. In addition, the patient group whose CO₂ values were continuously visible to caregivers had a significantly lower rate of IVH and PVL.

End tidal CO₂ can underestimate PaCO₂, is often infeasible and/or inaccurate in the NICU population and is incompatible with lung-friendly high frequency ventilation methods.

Continuous Noninvasive Carbon Dioxide Monitoring in Neonates: From Theory to Standard of Care.

Hochwald O, et al. *Pediatrics*. 2019 Jul;144(1):e20183640.

This review (*also cited above*) effectively explains the advantages of transcutaneous monitoring over end tidal for the neonatal population, including better accuracy for V/Q mismatch, no issues regarding heavy or leaking ET tubes, and CO₂ values independent from ventilation strategy.

Sentec's digital transcutaneous monitoring has been shown to be safe for preterm infant skin.

Transcutaneous Carbon Dioxide Monitoring with Reduced-Temperature Probes in Very Low Birth Weight Infants.

Aly S, et al. *Am J Perinatol*. 2017 Apr;34(5):480-485.

In this publication 50 preterm infants weighing less than 1500g were monitored for 12 uninterrupted hours with Sentec transcutaneous monitoring, and "none of the subjects had any detectable harm to their skin."

Transcutaneous monitoring (TCM) is indicated in the AARC Clinical Practice Guidelines:

AARC clinical practice guideline: transcutaneous monitoring of carbon dioxide and oxygen: 2012.

Restrepo RD, Hirst KR, Wittnebel L, Wettstein R. *Respir Care*. 2012 Nov;57(11):1955-62.

- “ TCM may be performed by trained personnel [...] in the following clinical settings to determine the presence of hypoventilation or respiratory depression: Mechanical ventilation, including conventional modes of ventilation, high frequency ventilation, steady state high frequency jet ventilation, and noninvasive ventilation. ”
- “ TCM is indicated in patients who either lack arterial access or have the need for continuous monitoring of oxygen and carbon dioxide with minimal blood draws. ”
- “ TCM allows the assessment of: adequacy of oxygenation and/or ventilation, response to diagnostic and therapeutic interventions, as evidenced by PtcO₂ and/or PtcCO₂ values. ”
- “ Weaning and extubation decisions may be made based on PtcCO₂ measurement alone. ”

Sentec transcutaneous monitoring is designed to support neuroprotective care in the NICU.



- Site times of up to 8 hours for neonates reduce application frequency and support clustered care protocols.
- Low sensor temperature is safe for neonatal skin. (*see Aly et al, above*)
- Site Protection safety feature lowers sensor temperature when site time has expired.
- Smart Cal Mem feature allows 30 minutes of disconnection from the monitor without recalibration to support enhanced kangaroo care.
- Attachment disposables include options designed specifically for delicate neonatal skin.
- Sensor rotates freely within attachment ring – no pulling or tugging.
- Accurate, continuous transcutaneous CO₂ values can be used to help safeguard sleep by delaying a blood gas until the patient is awake.
- Transcutaneous monitoring has been shown to reduce blood draws, lessening cumulative neonatal pain and stress. (*see Mukhopadhyay et al, above*)