

## AARC Clinical Practice Guideline

### Transcutaneous Blood Gas Monitoring for Neonatal & Pediatric Patients—2004 Revision & Update

#### TCM 1.0 PROCEDURE:

Transcutaneous monitoring of oxygen ( $P_{tcO_2}$ ) and carbon dioxide ( $P_{tcCO_2}$ ) in neonates, infants, and small children—this guideline does not address the application of transcutaneous monitoring in adults and older children.

#### TCM 2.0 DESCRIPTION/DEFINITION:

Transcutaneous monitoring measures skin-surface  $P_{O_2}$  and  $P_{CO_2}$  to provide estimates of arterial partial pressure of oxygen and carbon dioxide ( $P_{aO_2}$  and  $P_{aCO_2}$ ). The devices induce hyperperfusion by local heating of the skin and measure the partial pressure of oxygen and carbon dioxide electrochemically.<sup>1-8</sup>

#### TCM 3.0 SETTING:

Transcutaneous monitoring may be performed by trained personnel in a variety of settings including (but not limited to) hospitals, extended care facilities, and patient transport.<sup>9,10</sup>

#### TCM 4.0 INDICATIONS:

- 4.1 The need to monitor the adequacy of arterial oxygenation and/or ventilation<sup>11-13</sup>
- 4.2 The need to quantitate the response to diagnostic and therapeutic interventions as evidenced by  $P_{tcO_2}$  and/or  $P_{tcCO_2}$  values<sup>11,12,14,15</sup>

#### TCM 5.0 CONTRAINDICATIONS:

In patients with poor skin integrity and/or adhesive allergy, transcutaneous monitoring may be relatively contraindicated.<sup>11</sup>

#### TCM 6.0 HAZARDS/COMPLICATIONS:

$P_{tcO_2}$  and/or  $P_{tcCO_2}$  monitoring is considered a safe procedure, but because of device limitations, false-negative and false-positive results may lead to inappropriate treatment of the patient.<sup>12,16-18</sup> In addition, tissue injury may occur at the measuring site (eg, erythema, blisters, burns, skin tears).<sup>1,9,12,19</sup>

#### TCM 7.0 DEVICE LIMITATIONS/VALIDATION OF RESULTS:

$P_{tcCO_2}$  is an indirect measurement of  $P_{aCO_2}$  and, like  $P_{aO_2}$ , does not reflect oxygen delivery or oxygen content. Complete assessment of oxygen delivery requires knowledge of hemoglobin, saturation, and cardiac output. In a similar way,  $P_{tcCO_2}$  is an indirect measurement of  $P_{aCO_2}$  but knowledge of delivery and content is not necessary to use  $P_{tcCO_2}$  as an indicator of adequacy of ventilation.

7.1 Factors, agents, or situations that may affect readings, limit precision, or limit the performance or application of a transcutaneous monitor include

##### 7.1.1 Technical

7.1.1.1 The procedure may be labor intensive, although newer designs make application quicker and simpler.<sup>20</sup>

7.1.1.2 Prolonged stabilization time is required following electrode placement.<sup>20,21</sup>

7.1.1.3 Manufacturers state that electrodes must be heated to produce valid results; however, clinical studies suggest that valid results may be obtained with  $P_{tcCO_2}$  electrodes operated at lower than recommended temperatures or with no heat.<sup>19,22</sup>

7.1.1.4 The theoretical basis for mandatory heating of the  $P_{tcO_2}$  electrode is established.<sup>2,23</sup>

7.1.1.5 Improper calibration, trapped air bubbles, damaged membranes are possible and may be difficult to detect.<sup>14,24,25</sup>

7.1.2 Clinical: The following factors may increase the discrepancy between arterial and transcutaneous values

7.1.2.1 The presence of hyperoxemia ( $P_{aO_2} > 100$  torr)<sup>22,23,25</sup>

7.1.2.2 The presence of a hypoperfused state (shock, acidosis)<sup>9,18,26,27</sup>

**7.1.2.3** Improper electrode placement or application<sup>9</sup>

**7.1.2.4** Vasoactive drugs<sup>9,18</sup>

**7.1.2.5** The nature of the patient's skin and subcutaneous tissue (skinfold thickness, edema)<sup>9,18,28</sup>

**7.2** Validation: Arterial blood gas values should be compared to transcutaneous readings taken at the time of arterial sampling in order to validate the transcutaneous values. This validation should be performed initially and periodically as dictated by the patient's clinical state.<sup>9,25,29</sup>

**7.2.1** During validation studies in patients with functional shunts, electrode site and arterial sampling site should be on the same side of the shunt.<sup>12,30</sup>

**7.2.2** When disparity exists between transcutaneous and arterial values and the clinical presentation of the patient, possible causes should be explored before results are reported. Monitoring at alternate sites, recalibration, or appropriate substitution of instruments may reduce discrepancies. If such steps do not remedy the disparity, transcutaneous results should not be reported; instead a statement describing the corrective action should be included in the patient's chart and some other mode of monitoring should be established (eg, pulse oximetry and/or arterial blood analysis). The absolute limits that constitute unacceptable disparity vary with patient condition and specific device. Clinical judgment must be exercised.

**7.3** To help assure consistency of care based on transcutaneous blood gas readings, the operator should verify that

**7.3.1** High- and low-limit alarms are set appropriately

**7.3.2** Appropriate electrode temperature is set

**7.3.3** Electrode placement is appropriate and systematic electrode-site change occurs

**7.3.4** Specific manufacturer's recommendations for maintenance, operation, and safety are complied with

**TCM 8.0 ASSESSMENT OF NEED:**

**8.1** When direct measurement of arterial blood is not available or accessible in a timely fashion,

$P_{tcO_2}$  and/or  $P_{tcCO_2}$  measurements may temporarily suffice if the limitations of the data are appreciated.<sup>11</sup>

**8.2** Transcutaneous blood gas monitoring is appropriate for continuous and prolonged monitoring (eg, during mechanical ventilation, CPAP, and supplemental oxygen administration).<sup>11,12,24</sup>

**8.3**  $P_{tcO_2}$  values can be used for diagnostic purposes as in the assessment of functional shunts (eg, persistent pulmonary hypertension of the newborn, PPHN, or persistent fetal circulation) or to determine the response to oxygen challenge in the assessment of congenital heart disease.<sup>30-33</sup>

**TCM 9.0 ASSESSMENT OF OUTCOME:**

**9.1** Results should reflect the patient's clinical condition (ie, validate the basis for ordering the monitoring).<sup>3,5,7,13,29</sup>

**9.2** Documentation of results, therapeutic intervention (or lack of), and/or clinical decisions based on the transcutaneous measurements should be noted in the medical record.

**TCM 10.0 RESOURCES:**

**10.1** Equipment: Transcutaneous monitor, electrodes, calibration gases, and associated expendable supplies—the monitor should have been validated by the manufacturer, using appropriate quality control procedures and clinical reliability studies

**10.2** Personnel: Licensed or credentialed respiratory care practitioners or other credentialed persons with equivalent training and demonstrated ability to exercise the necessary clinical judgment, assess the patient, and perform the essential tasks of calibration and application.<sup>9,18</sup>

**TCM 11.0 MONITORING:**

The monitoring schedule of patient and equipment during transcutaneous monitoring should be integrated into patient assessment and vital signs determinations. Results should be documented in the patient's medical record and should detail the conditions under which the readings were obtained.

**11.1** The date and time of measurement, transcutaneous reading, patient's position, respiratory rate, and activity level

**11.2** Inspired oxygen concentration or supplemental oxygen flow, specifying the type of oxygen delivery device

**11.3** Mode of ventilatory support, ventilator, or CPAP settings

**11.4** Electrode placement site, electrode temperature, and time of placement

**11.5** Results of simultaneously obtained  $P_{aO_2}$ ,  $P_{aCO_2}$ , and pH when available

**11.6** Clinical appearance of patient, subjective assessment of perfusion, pallor, and skin temperature

### TCM 12.0 FREQUENCY:

Transcutaneous blood gas monitoring should be continuous for development of trending data. So-called spot checks are not appropriate.<sup>3,11,12,34</sup>

### TCM 13.0 INFECTION CONTROL:

No special precautions are necessary, but Standard Precautions (as described by the Centers for Disease Control) are recommended.<sup>35-38</sup>

**13.1** The device probe should be cleaned between patient applications according to manufacturer recommendations.

**13.2** The external portion of the monitor should be cleaned according to manufacturer's recommendations whenever the device remains in a patient's room for prolonged periods, when soiled, or when it has come in contact with potentially transmissible organisms.

*Revised by Steven E Sittig RRT-NPS, Mayo Clinic, Rochester, Minnesota, and approved by the 2003 CPG Steering Committee*

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