Complete Summary

GUIDELINE TITLE

Transcutaneous blood gas monitoring for neonatal & pediatric patients — 2004 revision & update.

BIBLIOGRAPHIC SOURCE(S)

American Association for Respiratory Care. Transcutaneous blood gas monitoring for neonatal & pediatric patients--2004 revision & update. Respir Care 2004 Sep;49(9):1069-72. [38 references]

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: American Association for Respiratory Care (AARC). AARC clinical practice guideline. Transcutaneous blood gas monitoring for neonatal & pediatric patients. Respir Care 1994 Dec;39(12):1176-9.

COMPLETE SUMMARY CONTENT

SCOPE
METHODOLOGY - including Rating Scheme and Cost Analysis
RECOMMENDATIONS
EVIDENCE SUPPORTING THE RECOMMENDATIONS
BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS
CONTRAINDICATIONS
IMPLEMENTATION OF THE GUIDELINE
INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES
IDENTIFYING INFORMATION AND AVAILABILITY
DISCLAIMER

SCOPE

DISEASE/CONDITION(S)

Pulmonary disease

GUIDELINE CATEGORY

Risk Assessment

CLINICAL SPECIALTY

Pediatrics
Pulmonary Medicine

INTENDED USERS

Respiratory Care Practitioners

GUIDELINE OBJECTIVE(S)

- To improve the consistency and appropriateness of respiratory care and serve as a guide for education and research
- To provide clinical practice guidelines on transcutaneous monitoring of oxygen (P_{tcO2}) and carbon dioxide (P_{tcCO2}) in neonates, infants, and small children

TARGET POPULATION

Neonates, infants, and small children who need to be monitored to assess the adequacy of arterial oxygenation and/or ventilation, or who need to have the response to diagnostic and therapeutic interventions quantitated as evidenced by transcutaneous monitoring of oxygen (P_{tcO2}) and/or transcutaneous monitoring of carbon dioxide (P_{tcCO2}) values.

Note: This guideline does not address the application of transcutaneous monitoring in adults and older children.

INTERVENTIONS AND PRACTICES CONSIDERED

Transcutaneous blood gas monitoring

MAJOR OUTCOMES CONSIDERED

Not stated

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

Not stated

NUMBER OF SOURCE DOCUMENTS

Not stated

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Not stated

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Not applicable

METHODS USED TO ANALYZE THE EVIDENCE

Systematic Review

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

Not stated

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Not stated

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Not applicable

COST ANALYSIS

A formal cost analysis was not performed and published cost analyses were not reviewed.

METHOD OF GUIDELINE VALIDATION

External Peer Review
Internal Peer Review

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

Consultants to the Working Group may review the initial draft of the guideline. After completion by the Working Group, the draft is reviewed by the entire Steering Committee and then by a Review Panel (i.e., persons engaged in all facets of the delivery of respiratory care who have volunteered to review drafts of the Guidelines before publication).

The 2004 update was approved by the 2003 Clinical Practice Guideline (CPG) Steering Committee.

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

Procedure

Transcutaneous monitoring of oxygen (P_{tcO2}) and carbon dioxide (P_{tcCO2}) in neonates, infants, and small children-this guideline does not address the application of transcutaneous monitoring in adults and older children.

Description/Definition

Transcutaneous monitoring measures skin-surface P_{O2} and P_{CO2} to provide estimates of arterial partial pressure of oxygen and carbon dioxide (P_{aO2} and P_{aCO2}). The devices induce hyperperfusion by local heating of the skin and measure the partial pressure of oxygen and carbon dioxide electrochemically.

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.

Indications

- The need to monitor the adequacy of arterial oxygenation and/or ventilation
- The need to quantitate the response to diagnostic and therapeutic interventions as evidenced by P_{tcO2} and/or P_{tcCO2} values

Contraindications

Refer to the "Contraindications" field or see the original guideline document for information.

Hazards/Complications

Refer to the "Potential Harms" field or see the original guideline document for information.

Device Limitations/Validation of Results

P_{tcO2} is an indirect measurement of P_{aO2} and, like P_{aO2}, 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_{tcCO2} is an indirect measurement of P_{aCO2} but knowledge of delivery and content is not necessary to use P_{tcCO2} as an indicator of adequacy of ventilation.

- Factors, agents, or situations that may affect readings, limit precision, or limit the performance or application of a transcutaneous monitor include
    - Technical
        - The procedure may be labor intensive, although newer designs make application quicker and simpler.
        - Prolonged stabilization time is required following electrode placement.
        - Manufacturers state that electrodes must be heated to produce valid results; however, clinical studies suggest that valid results

may be obtained with P_{tcCO2} electrodes operated at lower than recommended temperatures or with no heat.
        - The theoretical basis for mandatory heating of the P_{tcO2} electrode is established.
        - Improper calibration, trapped air bubbles, damaged membranes are possible and may be difficult to detect.
    - Clinical: The following factors may increase the discrepancy between arterial and transcutaneous values:
        - The presence of hyperoxemia (P_{aO2} >100 torr)
        - The presence of a hypoperfused state (shock, acidosis)
        - Improper electrode placement or application
        - Vasoactive drugs
        - The nature of the patient's skin and subcutaneous tissue (skinfold thickness, edema)
- 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.
    - During validation studies in patients with functional shunts, electrode site and arterial sampling site should be on the same side of the shunt.
    - 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 (e.g., 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.
- To help assure consistency of care based on transcutaneous blood gas readings, the operator should verify that:
    - High- and low-limit alarms are set appropriately
    - Appropriate electrode temperature is set
    - Electrode placement is appropriate and systematic electrode-site change occurs
    - Specific manufacturer's recommendations for maintenance, operation, and safety are complied with

Assessment of Need

- When direct measurement of arterial blood is not available or accessible in a timely fashion, P_{tcO2} and/or P_{tcCO2} measurements may temporarily suffice if the limitations of the data are appreciated.
- Transcutaneous blood gas monitoring is appropriate for continuous and prolonged monitoring (e.g., during mechanical ventilation, continuous positive airway pressure [CPAP], and supplemental oxygen administration).
- P_{tcO2} values can be used for diagnostic purposes as in the assessment of functional shunts (e.g., 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.

Assessment of Outcome

- Results should reflect the patient's clinical condition (i.e., validate the basis for ordering the monitoring).
- Documentation of results, therapeutic intervention (or lack of), and/or clinical decisions based on the transcutaneous measurements should be noted in the medical record.

Resources

- 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.
- 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.

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:

- The date and time of measurement, transcutaneous reading, patient's position, respiratory rate, and activity level
- Inspired oxygen concentration or supplemental oxygen flow, specifying the type of oxygen delivery device
- Mode of ventilatory support, ventilator, or CPAP settings
- Electrode placement site, electrode temperature, and time of placement
- Results of simultaneously obtained P_{aO2}, P_{aCO2}, and pH when available
- Clinical appearance of patient, subjective assessment of perfusion, pallor, and skin temperature

Frequency

Transcutaneous blood gas monitoring should be continuous for development of trending data. So-called spot checks are not appropriate.

Infection Control

No special precautions are necessary, but Standard Precautions (as described by the Centers for Disease Control and Prevention) are recommended.

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

CLINICAL ALGORITHM(S)

None provided

EVIDENCE SUPPORTING THE RECOMMENDATIONS

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The type of supporting evidence is not specifically stated for each recommendation.

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

Effective monitoring of arterial partial pressure of oxygen and carbon dioxide

POTENTIAL HARMS

P_{tcO2} and/or P_{tcCO2} 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. In addition, tissue injury may occur at the measuring site (e.g., erythema, blisters, burns, skin tears).

CONTRAINDICATIONS

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

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Getting Better
Living with Illness

IOM DOMAIN

Effectiveness
Safety

IDENTIFYING INFORMATION AND AVAILABILITY

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American Association for Respiratory Care. Transcutaneous blood gas monitoring for neonatal & pediatric patients--2004 revision & update. Respir Care 2004 Sep;49(9):1069-72. [38 references]

ADAPTATION

Not applicable: The guideline was not adapted from another source.

DATE RELEASED

1994 Dec (revised 2004 Sep)

GUIDELINE DEVELOPER(S)

American Association for Respiratory Care - Professional Association

SOURCE(S) OF FUNDING

American Association for Respiratory Care (AARC)

GUIDELINE COMMITTEE

Not stated

COMPOSITION OF GROUP THAT AUTHORED THE GUIDELINE

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FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

Not stated

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GUIDELINE AVAILABILITY

Electronic copies: Available in Portable Document Format (PDF) from the American Association for Respiratory Care (AARC) Web site.

Print copies: Available from the American Association for Respiratory Care (AARC), CPG Desk, 11030 Ables Ln, Dallas, TX 75229-4593; Web site: www.aarc.org.

AVAILABILITY OF COMPANION DOCUMENTS

None available

PATIENT RESOURCES

None available

NGC STATUS

This summary was completed by ECRI on November 30, 1998. The information was verified by the guideline developer on December 15, 1998. This NGC summary was updated by ECRI on March 21, 2005.

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