Complete Summary

GUIDELINE TITLE

Application of continuous positive airway pressure to neonates via nasal prongs, nasopharyngeal tube, or nasal mask — 2004 revision & update.

BIBLIOGRAPHIC SOURCE(S)

American Association for Respiratory Care. Application of continuous positive airway pressure to neonates via nasal prongs, nasopharyngeal tube, or nasal mask--2004 revision & update. Respir Care 2004 Sep;49(9):1100-8. [113 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. Application of continuous positive airway pressure to neonates via nasal prongs or nasopharyngeal tube. Respir Care 1994 Aug;39(8):817-23.

COMPLETE SUMMARY CONTENT

SCOPE

DISEASE/CONDITION(S)

Impaired pulmonary function that may occur with:

- Respiratory distress syndrome
- Pulmonary edema
- Atelectasis
- Apnea of prematurity

- Recent extubation
- Tracheal malacia or other similar abnormality of the lower airways
- Transient tachypnea of the newborn

GUIDELINE CATEGORY

Treatment

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 the application of continuous positive airway pressure to neonates and infants by nasal prongs (NCPAP), nasopharyngeal tube (NP-CPAP), or infant nasal mask (NM-CPAP)

TARGET POPULATION

Neonates and infants requiring the application of continuous positive airway pressure

INTERVENTIONS AND PRACTICES CONSIDERED

The application of continuous positive airway pressure to neonates and infants by nasal prongs (NCPAP), nasopharyngeal tube (NP-CPAP), or infant nasal mask (NM-CPAP) administered with a commercially available circuit used in conjunction with a continuous-flow source, infant ventilator, or a suitably equipped multipurpose ventilator

MAJOR OUTCOMES CONSIDERED

Therapeutic efficacy of CPAP

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

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

The application of continuous positive airway pressure to neonates and infants by nasal prongs (NCPAP), nasopharyngeal tube (NP-CPAP), or infant nasal mask (NM-CPAP) administered with a commercially available circuit used in conjunction with a continuous flow source, infant ventilator, or a suitably equipped multipurpose ventilator

Description/Definition

Continuous positive airway pressure (CPAP) is the application of positive pressure to the airways of the spontaneously breathing patient throughout the respiratory cycle. For the most part, neonates are preferential nose breathers, which easily facilitates the application of nasal CPAP. This is accomplished by inserting nasopharyngeal tubes, affixing nasal prongs, or fitting a nasal mask to the patient. The device provides heated and humidified continuous or variable flow from a circuit connected to a continuous gas source, mechanical ventilator designed for neonates, or a suitably equipped multipurpose ventilator, set in the CPAP mode.

CPAP maintains inspiratory and expiratory pressures above ambient pressure, which should result in an increase in functional residual capacity (FRC) and improvement in static lung compliance and decreased airway resistance in the infant with unstable lung mechanics. This allows a greater volume change per unit of pressure change (i.e., greater tidal volume for a given pressure change) with subsequent reduction in the work of breathing and stabilization of minute ventilation (V_E). CPAP increases mean airway pressure, and the associated increase in FRC should improve ventilation-perfusion relationships and potentially reduce oxygen requirements. Additionally CPAP may expand, or stent, upper airway structures preventing collapse and upper airway obstruction.

Settings

NCPAP, NP-CPAP, and NM-CPAP are applied by trained personnel in acute and subacute care hospitals.

Indications

- Abnormalities on physical examination--the presence of increased work of breathing as indicated by an increase in respiratory rate of >30% of normal, substernal and suprasternal retractions, grunting, and nasal flaring; the presence of pale or cyanotic skin color and agitation
- Inadequate arterial blood gas values--the inability to maintain a P_{aO2} greater than 50 torr with F_{IO2} of $\leq$0.60 provided V_E is adequate as indicated by a P_{aCO2} level of 50 torr and a pH $\geq$7.25
- The presence of poorly expanded and/or infiltrated lung fields on chest radiograph

- The presence of a condition thought to be responsive to CPAP and associated with one or more of the clinical presentations described above:
    - Respiratory distress syndrome
    - Pulmonary edema
    - Atelectasis
    - Apnea of prematurity
    - Recent extubation
    - Tracheal malacia or other similar abnormality of the lower airways
    - Transient tachypnea of the newborn
- Early intervention in conjunction with surfactant administration for very low birth weight infants at risk for developing respiratory distress syndrome
- The administration of controlled concentrations of nitric oxide in spontaneously breathing infants

Contraindications

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

Hazards/Complications

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

Limitations of Device

- NCPAP, NP-CPAP, and NM-CPAP applications are not benign procedures, and operators should be aware of the possible hazards and complications and take all necessary precautions to ensure safe and effective application.
- Mouth breathing during NCPAP, NP-CPAP, and NM-CPAP may result in loss of desired pressure and decrease in delivered oxygen concentration.
- NCPAP harnesses and attachment devices are often cumbersome and difficult to secure and may cause agitation and result in inadvertent decannulation.
- Excessive head rotation or neck extension may alter the position of NP-CPAP tube placement or obstruct upper airway structures resulting in diminished or altered pressure, flow, and effective CPAP.
- Severe respiratory distress syndrome (RDS), septicemia during NCPAP administration, and pneumothorax are risk factors associated with NCPAP failure.

Assessment of Need

Determination that valid indications are present by physical, radiographic, and laboratory assessments

Assessment of Outcome

CPAP is initiated at levels of 4-5 cm H_2O and may be gradually increased up to 10 cm H_2O to provide the following

- Stabilization of F_{IO2} requirement $\leq$0.60 with P_{aO2} levels >50 torr and/or the presence of clinically acceptable noninvasive monitoring of oxygen (P_{tcO2}),

while maintaining an adequate V_E as indicated by P_{aCO2} of 50-60 torr or less and pH $\geq$7.25
- Reduction in the work of breathing as indicated by a decrease in respiratory rate by 30-40% and a decrease in the severity of retractions, grunting, and nasal flaring
- Improvement in lung volumes and appearance of lung as indicated by chest radiograph
- Improvement in patient comfort as assessed by bedside caregiver
- Clinically significant reduction in apnea, bradycardia, and cyanosis episodes

Resources

- Equipment
    - Endotracheal tubes (positioned in the nasopharynx and secured by taping, with placement verified by laryngoscopy or palpation) or commercially available nasal prongs, bilateral nasopharyngeal tubes, or specially designed nasal masks with accompanying harness and accessories may be used for CPAP administration
        - Unilateral nasopharyngeal prongs may be less effective in preventing extubation failure than bilateral short prongs.
    - Continuous flow air-oxygen gas source; commercially available continuous-flow infant ventilators equipped with CPAP mode; CPAP flow driver with fluidic nasal interface, or suitably equipped multipurpose ventilator, with integrated or adjunct low and high airway pressure alarms, oxygen concentration analyzer with low and high alarms, loss of power and gas source alarms.
        - A continuous gas flow source requires a mechanical pressure limiting device, or a flow or threshold resistor, which includes the use of an underwater threshold resistor (e.g., Bubble CPAP).
    - Lightweight CPAP or ventilator circuits with servo-regulated humidification system
    - Continuous noninvasive oxygenation monitoring by pulse oximetry or transcutaneous monitor with high and low alarm capabilities is recommended (continuous transcutaneous CO_2 monitoring may also be utilized).
    - Continuous electrocardiographic and respiratory rate monitor, with high and low alarm capabilities, is recommended.
    - Suction source, suction regulator, and suction catheters for periodic suctioning to assure patency of nasal passages and of endotracheal tubes used for NP-CPAP are necessary.
    - Resuscitation apparatus with airway manometer and masks of appropriate size should be available.
    - Gastric tube for periodic decompression of stomach and chest tubes should be available.
- Personnel: The application of NCPAP, NP-CPAP, and NM-CPAP should be performed under the direction of a physician by trained personnel who hold a recognized credential (e.g., CRT, RRT, RN) and who competently demonstrate:
    - Proper use, understanding, and mastery of the technical aspects of CPAP devices, mechanical ventilators, and humidification systems

- Knowledge of ventilator management and understanding of neonatal airway anatomy and pulmonary physiology
- Patient assessment skills, with an understanding of the interaction between the CPAP device and the patient and the ability to recognize and respond to adverse reactions and complications
- Knowledge and understanding of artificial airway management, training in the procedures of placing endotracheal tubes in the nasopharynx
- The ability to interpret monitored and measured blood gas values and vital signs
- The application of Standard Precautions
- Proper use, understanding, and mastery of emergency resuscitation equipment and procedures
- The ability to assess, evaluate, and document outcome

Monitoring

- Patient-ventilator system checks should be performed at least every 2 to 4 hours and should include documentation of mechanical settings, alarms, and patient assessments as recommended by the American Association for Respiratory Care Clinical Practice Guideline (AARC CPG) Patient-Ventilator System Checks (MV-SC) and the CPG Humidification during Mechanical Ventilation (HMV).
- Oxygen and carbon dioxide monitoring, including:
    - Periodic sampling of blood gas values by arterial, capillary, or venous route
    - Continuous noninvasive blood gas monitoring by transcutaneous O_2 and CO_2 monitors
    - Continuous noninvasive monitoring of oxygen saturation by pulse oximetry
- Continuous monitoring of electrocardiogram and respiratory rate
- Continuous monitoring of proximal airway pressure (P_{aw}), positive end-expiratory pressure (PEEP), and mean airway pressure (P_{aw})
- Continuous monitoring of F_{IO2}
- Periodic physical assessment of breath sounds and signs of increased work of breathing (see "Indications" section above)
- Periodic evaluation of chest radiographs
- Periodic assessment of nasal septum

Frequency

NCPAP, NP-CPAP, and NM-CPAP are intended for continuous use and are discontinued when the patient's clinical condition improves as indicated by successful outcome assessments (see "Assessment of Outcome" section above).

Infection Control

No special precautions are necessary, but Standard Precautions as described by the Centers for Disease Control and Prevention should be employed.

- Disposable nasal CPAP kits are recommended and are intended for single-patient use.

- Routine disposable circuit changes are unnecessary for infection control purposes when the humidifying device is other than an aerosol generator.
- External surfaces of ventilator should be cleaned according to the manufacturer's recommendations when the device has remained in a patient's room for a prolonged period, when soiled, when it has come in contact with potentially transmittable organisms, and after each patient use.
- Sterile suctioning procedures should be strictly adhered to.

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

- Appropriate utilization of continuous positive airway pressure (CPAP) in neonates and infants
- Improved pulmonary function and clinical status with application of continuous positive airway pressure

POTENTIAL HARMS

Hazards and complications associated with equipment include the following:

- Obstruction of nasal prongs from mucus plugging or kinking of nasopharyngeal tube may interfere with delivery of continuous positive airway pressure (CPAP) and result in a decrease in F_{IO2} through entertainment of room air via opposite naris or mouth.
- Inactivation of airway pressure alarms
    - Increased resistance created by turbulent flow through the small orifices of nasal prongs and nasopharyngeal tubes can maintain pressure in the CPAP system even when decannulation has occurred. This can result in failure of low airway pressure/disconnect alarms to respond.
    - Complete obstruction of nasal prongs and nasopharyngeal tubes results in continued pressurization of the CPAP system without activation of low or high airway pressure alarms.
- Activation of a manual breath (commonly available on infant ventilators) may cause gastric insufflation and patient discomfort particularly if the peak pressure is set inappropriately high.
- Insufficient gas flow to meet inspiratory demand resulting in a fluctuating baseline pressure and an increase in the work of breathing

- Excessive flow results in overdistension from increased work of breathing due to incomplete exhalation and inadvertent positive end-expiratory pressure (PEEP) levels.
- Decannulation or malpositioning of prongs or nasopharyngeal tubes causing fluctuating or reduced CPAP levels
- Aspiration or accidental swallowing of small pieces of the detachable circuit or nasal device assembly
- Nasal excoriation, scarring, pressure necrosis, and septal distortion
- Skin irritation of the head and neck from improperly secured bonnets or CPAP head harnesses

Hazards and complications associated with the patient's clinical condition include:

- Lung overdistension leading to:
    - Air leak syndromes
    - Ventilation-perfusion mismatch
    - CO_2 retention and increased work of breathing
    - Impedance of pulmonary blood flow with a subsequent increase in pulmonary vascular resistance and decrease in cardiac output
    - Gastric insufflation and abdominal distention potentially leading to aspiration
    - Nasal mucosal damage due to inadequate humidification

CONTRAINDICATIONS

CONTRAINDICATIONS

- Although application of continuous positive airway pressure to neonates and infants by nasal prongs (NCPAP), nasopharyngeal tube (NP-CPAP), and infant nasal mask (NM-CPAP) have been used in bronchiolitis, this application may be contraindicated.
- The need for intubation and/or mechanical ventilation as evidenced by the presence of
    - Upper airway abnormalities that make NCPAP, NP-CPAP, or NM-CPAP ineffective or potentially dangerous (e.g., choanal atresia, cleft palate, tracheoesophageal fistula)
    - Severe cardiovascular instability and impending arrest
    - Unstable respiratory drive with frequent apneic episodes resulting in desaturation and/or bradycardia
    - Ventilatory failure as indicated by the inability to maintain P_{aCO2} <60 torr and pH >7.25
- Application of NCPAP, NP-CPAP, or NM-CPAP to patients with untreated congenital diaphragmatic hernia may lead to gastric distention and further compromise of thoracic organs.

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

IOM DOMAIN

Effectiveness
Safety

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

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ADAPTATION

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

DATE RELEASED

1994 Aug (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 22, 2005.

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