Airway Management

Patient Care Goals

1. Maintain a patent airway.
2. Provide effective oxygenation and adequate ventilation using the least invasive possible method to achieve those goals paired with pulse oximetry and end-tidal capnography (EtCO2) data.
3. Anticipate, recognize, and alleviate respiratory distress.
4. Provide necessary interventions quickly and safely to patients with the need for respiratory support.
5. Anticipate, identify, and plan for a potentially difficult airway.
6. Optimize the patient for any advanced airway attempts

Patient Presentation

Inclusion Criteria

1. Patients with signs of severe respiratory distress/respiratory failure.
2. Patients with evidence of hypoxemia or hypoventilation with medical or traumatic etiology.
3. Patients with tracheostomies (See Tracheostomy Management Guideline).
4. Patients with acute foreign body airway obstruction See (Foreign Body Airway Obstruction Protocol)

Exclusion Criteria

1. Chronically ventilated patients
2. Newborn patients

Patient Management

Implement emergent interventions and monitoring [Refer to Universal Care Guideline]

Assessment

1. History – Assess for:
    a. Time of onset of symptoms
    b. Associated symptoms and triggers for dyspnea (e.g., exertion, exercise, lying flat)
    c. History of asthma or other breathing disorders
    d. Choking or other evidence of upper airway obstruction
    e. History of trauma
    f. Prior similar episodes (e.g., prior intubation, prior ICU stay, prior airway surgery including tracheostomy, anaphylaxis, angioedema). If prior episodes, what has helped in the past (meds, interventions)
    g. Home interventions for symptoms (e.g., increased home oxygen, nebulizer)
    h. Severity of shortness of breath, sensation of dyspnea

2. Physical Examination – Assess for:
    a. Abnormal respiratory rate and/or effort
    b. Use of accessory muscles
    c. Ability to speak words/sentences
    d. Quality of air exchange, including depth and equality of breath sounds
    e. Abnormal breath sounds (e.g., wheezing, rhonchi, rales, or stridor)
    f. Cough
    g. Skin color (cyanosis or pallor), presence of diaphoresis
    h. Mental status, including anxiety
    i. Airway obstruction with foreign body or swelling (e.g., angioedema, posterior pharyngeal and laryngeal infections)

j. Signs of a difficult airway (short jaw or limited jaw thrust or mobility, small thyromental space, upper airway obstruction, large tongue, obesity, large tonsils, large neck, craniofacial abnormalities, excessive facial hair, tracheostomy scar or evidence of other neck/facial surgery, trismus)
k. Signs of fluid overload (e.g., ascites, peripheral edema)
l. Traumatic injuries impairing upper and lower airway anatomy and physiology:
    a. Facial injuries
    b. High spine injury (affecting phrenic nerve/intercostals)
    c. Neck injury (expanding hematoma, tracheal injury)
    d. Chest wall injury (bruising), including rib and sternal fracture, paradoxical chest motion, subcutaneous air, sucking chest wound

Monitoring

1. Patients with significant respiratory distress should have continuous pulse oximetry and waveform capnography monitoring for both assessment and for guiding therapy.
2. Pulse oximetry is indicated to assess oxygenation.
3. Quantitative waveform capnography
    1. Is indicated:
        a. For assessment and monitoring of ventilatory status in patients with significant respiratory distress, with or without airway adjuncts.
        b. To assist in decision-making for patients with respiratory difficulty of unclear cause (e.g., bronchospasm vs. pulmonary edema) and to help direct therapy.
        c. To evaluate acid-base status in critically ill patients.
    2. Is **not** indicated for every patient with shortness of breath. Rather, it is a monitoring and decision-making tool for patients with significant respiratory distress where interpretation of the capnography waveform and EtCO2 values assist in determining the appropriate course of treatment for the patient as well as the patient's response

Treatment and Interventions

1. Generally, the approach is to implement the interventions below in an escalating fashion to meet the patient care goals above
2. **Administer oxygen if needed** for air hunger or respiratory distress and titrate to a target SPO2 of 94–98%. Depending on patient presentation, this may be accomplished with nasal cannula **[EMR]**, nonrebreather **[EMR],** BVM **[EMR]**, NIPPV **[EMT-O, AEMT-R].**
    1. Even in apneic patients, starting passive oxygenation while escalating interventions are implemented may be useful.
    2. During CPR, maximal oxygen supplementation should be provided.
    3. Consider humidified oxygen for patients with tracheostomy (See Tracheostomy Management Guideline).
3. **Open and maintain patent airway.** If needed:
    1. Provide head tilt/chin lift, or jaw thrust if concern for potential spinal injury.
    2. Suction airway.
    3. Oropharyngeal airways (OPA) or nasopharyngeal airways (NPA) can be placed if needed to maintain a patent airway and make BVM ventilation more effective.
        a. OPA are used for patients without gag reflex [EMR].
        b. NPA are used for patients with gag reflex [EMR].
    4. Patient positioning can significantly impact respiratory mechanics. Patients with severe bronchospasm should be left in the position of comfort (perhaps tripod) whenever possible. Elevating the head or padding (shoulders, occiput) can assist with opening airway and respiratory mechanics. This can both improve the ability to ventilate and limit aspiration.
    5. For patients with tracheostomy in respiratory distress, see Tracheostomy Management Guideline.
4. Use **bag-valve-mask (BVM) ventilation** [EMR] in the setting of respiratory failure or arrest. Whenever possible, the patient's head should be elevated up to 30 degrees.
    1. Two-person, two-thumbs-up BVM ventilation is preferred.

2. PEEP should be used with BVM.
    a. 5 cmH20 is generally an appropriate initial PEEP setting
    b. Increase PEEP in stepwise fashion (2–3 cmH20 at a time) as necessary, allowing time for the patient to equilibrate with each change before further adjustments are made. The goal is to reach the lowest PEEP needed to adequately ventilate the patient. Higher PEEP results in greater negative hemodynamic impact.
        i. Consult **Medical Consultation** should be considered for higher PEEP levels (greater than 10–15 cmH20).
    c. Continuous wave-form capnography monitoring should be placed in line [**EMT-O, PARA-R**].
        i. In patients without primary pulmonary pathology (i.e., acute respiratory distress syndrome (ARDS), COPD), maintain EtCO2 target of 40mmHg (35-45mmHg range).
        ii. Patients with specific disease processes such as acute acid-base disorders (i.e., DKA, lactic acidosis due to severe sepsis or trauma), acute respiratory failure due to primary pulmonary pathology, or post-cardiac arrest will have different EtCO2 parameters due to their underlying disease.
        iii. In patients with severe head injury with signs of herniation (unilateral dilated pupil or decerebrate posturing), modest hyperventilation to EtCO2 no less than 30 mmHg may be considered for a brief time in consultation with MEDICAL CONTROL.
    d. Tidal volume:
        i. Ventilate with just enough volume to see chest rise, approximately 6–8 mL/kg ideal body weight.
        ii. Over-inflation (e.g., excessive tidal volume) and overventilation (e.g., excessive minute ventilation) are both undesirable and potentially harmful.
    e. Rate
        i. Adult: 10–12 breaths/minute
        ii. Child: 20–30 breaths/minute
        iii. Infant: 20–30 breaths/minute
    f. Continuously monitor EtCO2 to guide tidal volume and minute ventilation [**EMT-O, PARA-R**].

5. **Non-invasive ventilation (NIPPV)** should be considered early for severe respiratory distress, significant work of breathing or impending respiratory failure [EMT-O, AEMT-R].
    1. NIV options include continuous positive airway pressure (CPAP), bi-level positive airway pressure (BiPAP), bi-level nasal CPAP, and high flow oxygen by nasal cannula (HFNC).
    2. NIV can also be used to improve oxygenation pre-intubation in some patients with respiratory failure.
6. **Non-visualized airways (Supraglottic/Extraglottic)** [**EMR-O; EMT-R**]: Consider the use of an appropriately sized non-visualized airway if BVM (with OPA/NPA) alone is not effective in maintaining oxygenation and/or ventilation. This is especially important in children as prehospital endotracheal intubation is an infrequently performed skill in this age group and has not been shown to improve outcomes over prehospital BVM or non-visualized airways.
7. **Endotracheal intubation** ***[PARA] (***Intubation Protocol***)***
    1. When less-invasive methods (two-person BVM, SGA placement) are ineffective or inappropriate, consider endotracheal intubation to maintain oxygenation and/or ventilation. Other indications may include potential airway obstruction, severe inhalation burns, multiple traumatic injuries, altered mental status with loss of normal protective airway reflexes.
    2. Optimize patient for first-pass success with pre-procedure resuscitation, preoxygenation, positioning, sedatives, and paralytics as indicated by patient presentation and scope.
        a. A bougie may be a helpful adjunct to successful airway placement, especially when video laryngoscopy is unavailable and the glottic opening is difficult to visualize with direct laryngoscopy.
        b. For experienced EMS clinicians, video laryngoscopy may enhance intubation success rates and should be used when available.

3. Monitor clinical signs, pulse oximetry, cardiac rhythm, blood pressure, and waveform capnography for the intubated patient.
4. For adults, the largest tube size possible should be placed in the patient to limit difficulty with mechanical ventilation and high airway pressures. Absent significant airway swelling or underlying anatomic abnormalities, initial tube size (internal diameter in millimeters) for adult females should be 7.5, adult males 8.0. For pediatrics, cuffed tubes are now recommended.
5. Endotracheal tube depth: ETT should places 1-2 cm past the vocal cords
    a. Adults: Typically 21-23cm
    b. Pediatric: Three times the ETT diameter

8. **Post-intubation management**
    1. Inflate endotracheal tube cuff or supraglottic airway cuff with minimum air to seal airway. An ETT cuff manometer can be used to measure and adjust the ETT cuff pressure to the recommended 20 cmH20 pressure.
    2. Confirm endotracheal tube or supraglottic airway placement with:
        a. End tidal CO2 waveform monitoring
        b. PLUS TWO of more other following
            i. Auscultation of equal, bilateral breath sounds (equal chest rise and fall) with absent epigastrium sounds.
            ii. Direct visualization of tube passing through vocal cord opening.
            iii. Radiographic confirmation prior to transport (Inter-Facility Only)
    3. Continuously monitor placement with waveform capnography during treatment and transport
        a. Make sure waveform is present while maintaining a 35-45 mmHg expired CO2 reading.
    4. Continuously secure tube manually until tube secured with tape, twill, or commercial device
        a. Note measurement of tube at incisors or gum line and monitor frequently for tube movement/displacement
        b. Cervical collar and/or cervical immobilization device may help reduce neck movement and risk of tube displacement
    5. Manual ventilation (see above for rate and tidal volume guidance).
    6. **Mechanical ventilation** should be considered following advanced airway placement if available. See Mechanical Ventilation (Invasive) Guideline.
    7. Intubated patients should be provided appropriate sedation and pain management with sedative and opioid medications
    8. Consider PEEP adjustment to achieve oxygenation and ventilation goals (see above)
    9. Maintain proper sedation and pain control with sedative or opioid medications with sedation titrated to an appropriate target level using RASS score or similar scale. **See Pain Management/Sedation Protocol**
9. **Gastric decompression** via supraglottic airway **[EMR]** or nasogastric or orogastric tube **[PARA]** may improve oxygenation and ventilation, so it should be considered when there is obvious gastric distention
10. When patients cannot be oxygenated/ventilated effectively by previously mentioned interventions, the provider should consider **cricothryroidotomy *[PARA]*** if the risk of death for not escalating airway management seems to outweigh the risk of a procedural complication
11. Transport to the closest appropriate hospital for airway stabilization when respiratory failure cannot be successfully managed in the prehospital setting

Patient Safety Considerations

1. Suctioning to limit aspiration is a priority, since it is associated with development of hospital acquired pneumonia and related increases in ICU stay and mortality.
2. Avoid excessive pressures or tidal volumes during BVM ventilation. The goal is to avoid barotrauma as well as overventilation and related reduction of venous return/preload/cardiac output.
3. Routine use of sedation is not recommended for treatment of anxiety in patients on NIV. Anxiety

should be presumed due to hypoxia or inadequate minute ventilation and treated primarily with ventilatory support.
4. Endotracheal intubation should only be used if less invasive methods do not meet patient care goals.
5. Once a successful SGA placement or intubation has been performed, obstruction or displacement of the tube can have further negative effects on patient outcome. Tubes should be secured with either a commercial tube holder or tape.
6. Meticulous attention should be paid to avoiding hypoxia and hypotension during intubation attempts to limit patient morbidity and mortality.
7. Waveform capnography should be placed prior to the first breath through an invasive airway to confirm placement.
8. Once initiated and patient is tolerating mask, DO NOT discontinue CPAP/BiPAP until patient is on the emergency department stretcher and hospital CPAP/BiPAP is immediately available for patient to be switched over, or physician is at bedside and requesting CPAP/BiPAP be discontinued. Breaking the mask seal causes a significant decrease in airway pressures and may lead to abrupt decompensation due to atelectasis and alveolar collapse.
9. If patient deteriorates on CPAP/BiPAP (e.g., worsened mental status, increasing $EtCO_2$, vomiting), remove CPAP/BiPAP and escalate airway management options as above.
10. If an endotracheal tube becomes dislodged, SGA should be strongly considered.
11. Pediatric airway management requires appropriately sized tools and adjuncts based on patient size/age.
    1. Skill in BVM ventilation and NIV application should be emphasized in pediatrics.
    2. SGA are reasonable primary and secondary adjuncts if needed.
    3. Pediatric endotracheal intubation has unclear benefit in the prehospital setting.
    4. Pediatric endotracheal tube placement and maintenance requires significant training to achieve and maintain competency

Notes and Educational Pearls Key Considerations

1. Oxygen is a drug with an appropriate dose range and undesirable effects from both too much and too little supplementation. Effective oxygenation meets the oxygen saturation (SpO_2) target set for that specific patient in the context of their acute and chronic medical condition(s). Permissive hypoxia ($SPO_2 \geq 90\%$) may be appropriate in patients with COPD or other complex respiratory pathology.
2. Adequate ventilation provides sufficient minute ventilation to meet the patient's acute respiratory and metabolic needs and is generally titrated to an $EtCO_2$ goal.
3. Paramedics are less likely to attempt endotracheal intubation in children than adults with cardiac arrest and are more likely to be unsuccessful when intubating children. Complications such as malposition of the ET tube or aspiration can be nearly three times as common in children as compared to adults.
4. Continuous waveform capnography is an important adjunct in the monitoring of patients with respiratory distress, respiratory failure, and those treated with positive pressure ventilation. It should be used as the standard to confirm placement of all advanced airways. It can also be helpful in the respiratory distress patient without an invasive airway to assess for causes of respiratory distress, adequacy of ventilation, progression toward respiratory failure, monitoring of BVM ventilation, as well as numerous other applications that provide insight into acute metabolic and infectious disease processes. Continuous waveform capnography:
    1. Should be used for patients with invasive airways for:
        a. initial verification of correct airway placement.
        b. continuous evidence of correct tube placement.
        c. adjusting ventilatory rate:
            i. to maintain $EtCO_2$ 35–45 in most patients.
            ii. to appropriately but not excessively hyperventilate patients with signs of herniation only to maintain $EtCO_2$ 30–35 (no lower than 30).
            iii. to gradually decrease $EtCO_2$ in chronically and acutely severely hypercarbic patients including post-arrest
    2. Is strongly encouraged in patients in cardiac arrest:

    a. to monitor quality of CPR.
    b. as an early indicator of ROSC (rapid increase of 10–15 in EtCO2).
    c. to assist in evaluating prognosis for survival.
3. Should be used in spontaneously breathing patients who are:
    a. on NIV.
    b. in severe respiratory distress (e.g., receiving epinephrine, magnesium therapy).
4. In spontaneously breathing patients, waveform capnography can help with assessment of critically ill patients, for example:
    a. assessment of adequacy of ventilation and change in ventilatory status in response to treatment.
    b. differentiating between severe bronchospasm (shark fin waveform) and other
    c. causes of respiratory distress (normal waveform, pulmonary edema).
    d. hypotension due to sepsis or unclear cause (metabolic acidosis with/without compensatory respiratory alkalosis).
    e. status epilepticus to evaluate ventilatory and acid/base status.
    f. evaluation for acidosis in patients with altered mental status and potential diabetic ketoacidosis (metabolic acidosis).

5. Bag-valve-mask (BVM) ventilation:
    1. Appropriately sized masks should completely cover the nose and mouth and maintain an effective seal around the cheeks and chin.
    2. Ventilations should be delivered with only sufficient volume to achieve chest rise. Overventilation is undesirable..
    3. Ventilation rate:
        a. Adult
            i. Support spontaneous respirations if the patient is hypoventilating.
            ii. For apnea, provide one breath every 6 seconds adjusting based on pulse oximetry and digital capnometry or capnography (with the goal of 35–45 mmHg).
        b. Pediatric – infant/child
            i. Support spontaneous respirations if the patient is hypoventilating.
            ii. For apnea, provide 1 breath every 2–3 seconds adjusting based on pulse oximetry and digital capnometry or capnography (with the goal of 35–45 mmHg).
6. PEEP improves oxygenation or decreases risk of developing hypoxemia, by increasing functional residual capacity (FRC), and tidal ventilation and may assist in meeting airway goals by decreasing intrapulmonary shunting of blood and better matching perfused lung to ventilated lung tissue, thus improving arterial oxygenation. It does not open fully collapsed alveoli but re-expands partially collapsed ones. It does not decrease extravascular lung water but redistributes it.
    1. Higher levels of PEEP are particularly useful in patients with acute respiratory distress syndrome (ARDS).
    2. PEEP should be increased slowly by 2–3 cmH20 from 5 cmH20 to a max of 15 cmH20 closely monitoring response and vital sign changes.
    3. Excessive PEEP over distends alveoli, increases dead space and work of breathing, reduces lung compliance, and compresses alveolar capillaries, reducing oxygenation and risking pulmonary barotrauma.
    4. Increased intrathoracic pressure can progressively decrease cardiac output and is most notable when PEEP is greater than 15 cmH20. The higher the level of PEEP (over 5 cmH20), the more likely the patient will experience a variety of adverse consequences, both ventilatory and hemodynamic.
7. Noninvasive ventilation (NIV) (e.g., CPAP or BiPAP):
    1. NIV goals of therapy will vary based on patient presentation and history. More support than is needed to relieve symptoms or "normal" is not necessarily better in these patients. Goals of care may include:
        a. Decreased air hunger
        b. Normalization of respiratory rate (decreased tachypnea)
        c. Normalization of EtCO2. This means a downward trend in a patient with increased

EtCO2. Patients who have end stage COPD may have chronically elevated EtCO2 as high as 50s–60s, and thus tolerate elevated EtCO2 better so normalization may not be a good target

2. The key to successful use of NIV in a patient who has not used it before is coaching and explanation of the process and reassurance of the patient.
3. For any patient on NIV, focus on maintaining a continuous mask seal is essential to maximizing the positive impact of PEEP, particularly at higher levels. Breaking the circuit or removing the mask should be meticulously avoided, as the significant atelectasis will occur which will take time to reverse.
4. Nebulized medications may be administered through a CPAP or BiPAP mask. A specialized T-connector with a spring valve assembly is required to allow maintenance of positive airway pressure.

8. Orotracheal intubation ***[PARA]***
    1. Checklist use and use of protocolized interventions to optimize the patient physically and physiologically have been shown to both improve success rates of orotracheal intubation as well as decrease peri-intubation complications. Preparation should also include a promptly available plan for alternate airway placement if ETI unsuccessful.

    2. Endotracheal tube sizes

Age	Size (mm) Uncuffed	Size (mm) Cuffed
Premature	2.5	
Term to 3 months	3.0	
3-7 months		3.0
7-15 months		3.5
15-24 months		3.5
2-15 years		[age(yr)/4]+3.5

    3. Approximate depth of insertion = (3) x (endotracheal tube size)
    4. In addition to preoxygenation, apneic oxygenation (high-flow oxygen by nasal cannula) may prolong the period before hypoxia during an intubation attempt
    5. Positive pressure ventilation after intubation can decrease preload and subsequently lead to hypotension - consider providing vasopressor support for hypotension
    6. Significant attention should be paid to adequate preoxygenation to avoid peri- intubation hypoxia and subsequent cardiac arrest
    7. Prompt suctioning of soiled airways before intubation attempt may improve first pass success
    8. Confirm successful placement with waveform capnography. Less optimal methods of confirmation include bilateral chest rise, bilateral breath sounds, and maintenance of adequate oxygenation. Color change on end-tidal CO2 is less accurate than clinical assessment, and wave-form capnography is superior. Misting observed in the tube is not a reliable method of confirmation. Visualization with video laryngoscopy, when available, may assist in confirming placement when unclear due to capnography failure or conflicting information.
    9. Video laryngoscopy may be helpful, if available, to assist with endotracheal intubation
9. Manual vs. Mechanical ventilation: If mechanical ventilation is available, it is preferred to manual ventilation due to the increased consistency of tidal volume and ventilatory rate, and its ability to limit risk of overventilation. [See Mechanical Ventilation (Invasive) Guideline].
10. For patients being transferred from a hospital ventilator to a transport ventilator, the patient's current ventilator settings are generally a reasonable starting point if the patient is being

adequately oxygenated and ventilated based on pulse oximetry and capnography.

11. Anxiety should be presumed due to hypoxia or inadequate minute ventilation and treated primarily with ventilatory support. Routine use of sedation is not recommended for treatment of anxiety in patients on NIV.

Pertinent Assessment Findings

1. Ongoing assessment is critical when an airway device is in place
2. Acute worsening of respiratory status or evidence of hypoxemia can be secondary to displacement or obstruction of the airway device, pneumothorax or equipment failure

Quality Improvement

Associated NEMSIS Protocol(s) (eProtocol.01)

9914133 – Medical-Newborn/Neonatal Resuscitation

Key Documentation Elements

- Initial vital signs and physical exam
- Interventions attempted including the method of airway intervention, the size of equipment used, and the number of attempts to achieve a successful result
- Subsequent vital signs and physical exam to assess for change after the interventions
- Presence of peri-intubation hypoxia, bradycardia, hypotension or cardiac arrest
- Post-intubation with advanced airway, document ETCO2 value and record capnograph wave initially after intubation, with each set of vital signs, when patient is moved, and at the time of patient transfer in the ED

Performance Measures

- Percentage of providers that have received hands-on airway training (simulation or non-simulation-based) within the past 2 years
- Respiratory rate and oxygen saturation are both measured and documented
- Percentage of patients with advanced airway who have waveform capnography used for both initial confirmation and continuous monitoring during transport
- Percentage of patients who were managed upon arrival to the emergency department (ED) with each of the following: Bag-valve-mask, SGA, EGD, or endotracheal intubation
- Percentage of intubated patients with endotracheal tube in proper position upon ED arrival
- First pass intubation success without hypoxia or hypotension.
- Survival upon ED arrival

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