Association for Radiologic & Imaging Nursing

Clinical Practice Guideline: Capnography

Overview:

Radiology and Imaging Nurses provide procedural sedation to a variety of patients. The administration of procedural sedation in the interventional radiology and diagnostic imaging suites presents a unique set of circumstances that can be challenging for the procedural sedation nurse. These include

- high acuity patients
- inaccurate/incomplete patient assessment
- limited visualization due to imaging equipment
- impaired visualization due to sterile drapes
- awkward patient positioning
- complex, lengthy procedures
- providers who must step into a separate room to limit exposure to radiation (Anderson et al., 2007)
- hyper-oxygenated patients

Advancements in technology such as capnography, the monitoring of the partial pressure of expired carbon dioxide ($PetCO_2$), provide nurses with a means to ensure the improvement of care delivery, provide a safe environment, and effectively achieve successful procedural sedation.

- The use of pulse oximetry as a surrogate measure for ventilation fails to adequately identify ventilatory effort by the virtual of its intended measurement.
- Capnography can detect almost immediate ventilatory changes, and in an apneic patient this will appear as a flat line. This can be especially useful when visual assessment of a patient during a procedure is limited or obscured.
- The addition of capnography along with standard monitoring during procedural sedation can greatly enhance the procedural nurses' ability to safely monitor and sedate a patient and decrease the incidence of adverse respiratory events (ARE) within this unique and evolving environment.
- Changes from the baseline capnographic waveform should prompt timely interventions by the sedation nurse to avoid the progression to a hypoxic event.

The use of supplemental oxygen during procedural sedation may prolong the recognition of apnea due to hypoventilation/apneic oxygenation. Capnography provides a real-time assessment of ventilation and is superior to the pulse oximetry when assessing hypoventilation/apneic oxygenation. (See www.arinursing.org for the ARIN (2016) Capnography Position Statement.)

Target Audience:

- Radiology and Imaging Nurses engaging in procedural sedation practices.
- Healthcare practitioners administering pharmacotherapies for sedation, analgesia, and anxiolysis.

Nursing Considerations:

The use of capnography aims to decrease adverse events, more specifically adverse respiratory events (ARE), within the delivery of procedural sedation. AREs include, but are not limited to: hypoxemia, hypercapnia, tachypnea, disordered ventilation, apnea, and respiratory failure.

Practice recommendations for the use of capnography are as follows:

1. Pre-procedure

- In addition to standard assessments prior to procedural sedation: assess patient positioning requirements and/or limitations; orthopnea, sleep apnea, obesity, physical limitations due to orthopedic or surgical issues.
- Pay particular attention to these contributing co-morbidities which may impact capnography assessment: COPD/asthma, severe cardiac disease, CKD/ESRD, sleep apnea
- Educate the patient regarding monitoring technology used during their procedure

2. Intraprocedure

- Position the patient according to procedural needs while maintaining optimal airway access
- In addition to standard monitoring devices: cardiac monitor, NIBP, SpO2, RR, apply capnometry sampling device and adjust to patient's requirements i.e. face mask oxygen, tracheostomy/laryngectomy collar, mouth breathing patient
- Ensure clear visualization of the cardiac monitor with adequate display of vital signs and capnography. Adjust equipment and/or surgical drapes as necessary to ensure visualization of the patient. Maintaining close monitoring of capnography and vital signs is paramount in the early detection of ensuing adverse respiratory events.
- Optimize capnography sampling device to deliver accurate waveform/capnogram
- Review monitoring alarm settings* and ensure alarms are audible
    - Low alarm limit: 8
    - High alarm limit: 26
    - Limits need to reflect the patient's current respiratory rate
- Capnography Interpretation
    - Is the $PetCO_2$ waveform present?
        - If absent, check pulse, airway, or for accidental disconnection
    - Does $PetCO_2$ waveform start and end at the baseline?
        - If not, consider air trapping/breath stacking, moisture in adapter
    - What is the height, width and frequency (quality of respiration) of the waveform?
        - Wide and tall: bradypnea/hypercapnia

        - Narrow and short: tachypnea/hypocapnia
    - What is the waveform pattern?
        - Waveform returns to baseline (if no, consider air trapping/breath stacking, moisture in adapter)
        - Note shape of waveform: sloping (loss of alpha angle), notching, prolonged (altered beta angle)
- Evaluate respirations, numeric capnographic value and capnograms. Identify and intervene for any impending adverse respiratory events:
    a. Check and adjust capnography sampling device as needed
    b. Encourage deep breaths
    c. Manage pain and/or anxiety
    d. Adjust airway i.e. chin lift or reposition head
    e. Tactile stimulation to increase arousability
    f. Assist ventilations with Bag-Valve-Mask, consider nasal or oral airway
    g. Consult with physician/proceduralist/advanced practice provider regarding use of reversal agents
    h. Consider need for emergent intubation
- Documentation *
    - Preprocedure
        - Baseline vital signs, including respiratory rate
        - Capnogram
        - $PetCO_2$ value
        - Use of accessory muscles
    - Intraprocedure
        - Note changes in rate and waveform
        - Provide continuous capnographic monitoring
        - Every 5 minutes, document capnometry value/presence or absence of a waveform according to organization policy
        - Evaluate the capnograms and intervene appropriately**
        - Document intervention(s) performed

3. Post procedure

- Monitor patient until discharge criteria is met or transferred to recovery area *
- Provide clear and complete Hand Off on transfer of patient*
- Change capnography sampling device and components per manufacturer recommendation

*Per institution guidelines

** refer to article by Brast, Bland, Jones-Hooker, Long and Green (2016).

References

Brast, S., Bland, E., Jones-Hooker, C., Long, M. & Green, K. (2016). Capnography for the Radiology and Imaging Nurse: A Primer. *Journal of Radiology Nursing, 35*(3), 173-190.

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Appendix A

5 Step Practical Method for Rapid Capnography Interpretation	
Question 1:	
Waveform Assessment	**Rationale**
Is there a PetCO2 Waveform?	If no waveform or loss of waveform, is your patient pulseless or not ventilating due to accidental disconnection or extubation.
If YES, what is the height, width and frequency (RR)?	The height, width and frequency represent the quality of respiration. Is the capnogram wide and tall? • Bradypnea/hypercapnia Is the capnogram narrow and short? • Tachypnea/hypocapnia Is there a pattern to the waveform? • Loss of airway, • Shock state.
Question 2:	
Waveform Assessment	**Rationale**
What is the shape of the waveform? Do you see a steep rise in Phase II with a plateau? Is there any sloping, notching or a prolonged Phase III?	You expect to see a steep rise in Phase II followed by a plateau. If this is altered, the expiratory phase and alveolar gas exchange are altered, and the relationship between ventilation to lung perfusion is changed. **Sloping** (loss of alpha angle): consider bronchospasm, kinked artificial airway or foreign body. Greater the shark fin appearance, the greater the severity. **Notching**: uncoordinated respiratory effort

	as a result of neuromuscular blockade wearing off. The greater the notch, the lighter the neuromuscular blockade and asynchronous the ventilatory effort. **Prolonged** (altered beta angle): consider leak in the system, normal variant in patient with reduced thoracic compliance (obese patients or late pregnancy) or V/Q mismatch.
Question 3:	
Waveform Assessment	**Rationale**
Finally, does the waveform have a steep return to the baseline?	Represents the initiation of the inspiratory phase. If Phase IV fails to return to the baseline: a) Air trapping or breath stacking, b) Consider moisture in adaptor, c) Calibration error.
Question 4:	
Waveform Assessment	**Rationale**
What is your PetCO2 trend & PaCO2/PetCO2 Gradient?	Evaluating the trend will provide graphic representation of a patient's ventilatory status over the course of time. a) Do you see a downward stepping trend that will make you suspicious for a shock syndrome? b) Do you see a trend for great quality CPR? c) Do you see an upward stepping trend consistent with an increasing metabolic demand or change in temperature (early sepsis, hypo/normothermia to hyperthermia)? d) Is your PetCO2 reading correlated to an ABG? a. What is the gradient of your PaCO2/PetCO2?

Question 5:	
Clinical Correlation	**Rationale**
Does your capnographic assessment correlate to your clinical assessment?	Is there agreement in assessment, or are there assessment disparities between capnographic assessment (PetCO2, RR, waveform, PaCO2/PetCO2 and trending data) and the patient's clinical assessment or history/presentation? As a standard of practice, multiple subjective and objective assessment criteria is required to confirm endotracheal tube placement due to no single technique having a proven 100% accuracy (Pauze & Burton, 2009).

Brast, S., Bland, E., Jones-Hooker, C., Long, M. & Karen Green. (2016) Capnography for the Radiology and Imaging Nurse: A Primer. Journal of Radiology Nursing, Vol. 35, Issue 3. 173 – 190.