



Capnography Monitoring During Procedural Sedation in Radiology and Imaging Settings: An Integrative Review



■ Michael Long, DNP, CRNA; Karen Green, MHA, BSN, RN, CRN; Erica Bland, BSN, RN, ONC; Christa Jones-Hooker, MSN, RN, CRN; Shawn Brast, MSN, RN, CCRN, NRP, CNIII; Katherine Duncan, BA, RN, CRN; and Evelyn Wempe, MBA, MSN, ARNP, ACNP-BC, AOCNP, CRN

ABSTRACT: Nurses in radiology and imaging settings are administering moderate sedation in highly complex environments to an older sicker population with multiple comorbidities. The ability to monitor ventilation and remain in constant communication with the patient is often compromised. Capnography provides a real-time objective assessment of the patient's ventilatory status and can detect hypopneic ventilation. When added to the current standard of care, it is superior at preventing hypoxemia by promoting more timely nursing interventions. It has been adopted by many nursing and medical associations and should be a standard of care in radiology and imaging settings for patients undergoing moderate sedation. This literature review represents the efforts of a multidisciplinary nursing task force created by the Association for Radiology and Imaging Nursing for the purposes of providing high-level evidence in the formulation of their position statement on capnography for moderate sedation/analgesia. (*J Radiol Nurs* 2016;35:191-197.)

KEYWORDS: Capnography; Moderate sedation; Procedural sedation; Patient safety; Monitoring; Radiology nursing.

INTRODUCTION

Moderate sedation is the depression of consciousness, induced by pharmacologic agents, during which patients respond purposefully to verbal commands and a patent airway is maintained without intervention ([Continuum of Depth of Sedation, 2014](#)). It is important to note that sedation is a continuum with current concepts modified from definitions created in 1985 ([Green & Mason, 2010](#)). Sedation is described by four stages and relates to the responsiveness, airway, and ventilation of a patient. However, these signs are subject to individual interpretation by those administering the sedation. Furthermore, since patients do not necessarily recognize boundaries and movement between the stages can occur, it is important for the nurse to recognize this progression and respond appropriately. This progression is not limited to propofol, a short-acting sedative, and has been identified in practices using only a benzodiazepine/opioid combination ([Patel et al., 2005](#)).

Michael Long, DNP, CRNA, Nurse Anesthetist III, Department of Anesthesiology and Critical Care, Memorial Sloan-Kettering Cancer Center, New York, NY; Karen Green, MHA, BSN, RN, CRN, Staff Nurse, Metro Vascular Center, A Lifeline Vascular Access Managed Center, Philadelphia, PA; Erica Bland, BSN, RN, ONC, Clinical Nurse IV, Operations Coordinator, Interventional Radiology, Memorial Sloan-Kettering Cancer Center, New York, NY; Christa Jones-Hooker, MSN, RN, CRN, Radiology Nurse, Chapel Hill, NC; Shawn Brast, MSN, RN, CCRN, NRP, CNIII, Johns Hopkins Lifeline Educator and Clinical Faculty, Johns Hopkins School of Nursing, Baltimore, MD; Katherine Duncan, BA, RN, CRN, Radiology Nurse, Chapel Hill, NC; Evelyn Wempe, MBA, MSN, ARNP, ACNP-BC, AOCNP, CRN, Miami, FL.

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Corresponding author: Michael Long, 1275 York Avenue, New York, NY 10065. E-mail: longm@mskcc.org

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There are two general benefits of sedation: (1) the relief of pain, discomfort, and anxiety allowing patients to tolerate uncomfortable procedures and (2) the facilitation of procedures in which immobility may be a necessity for completion. This would include uncooperative patients like children and adults affected with neurocognitive disorders or lengthy procedures that are more uncomfortable than painful. Although relatively safe, moderate sedation does not come without risks. Many of the pharmacological agents in use for moderate sedation are respiratory and central nervous system depressants. This depression must be continuously monitored and appropriately managed to avoid a progression toward deeper levels of sedation or general anesthesia.

The inherent risks associated with moderate sedation combined with the increase in procedural cases executed outside of the operating room led the American Society of Anesthesiologists (ASA) to publish practice guidelines for sedation administered by non-anesthesiologists (Gross et al., 2002). The recommendations put forth by the ASA state:

...all patients undergoing sedation/analgesia should be monitored by pulse oximetry...ventilatory function should be continually monitored...Monitoring of exhaled carbon dioxide should be considered for all patients...whose ventilation cannot be directly observed during moderate sedation. (p1008)

This statement was an important impetus to practice because current standards did not include ventilation for monitoring patients undergoing moderate sedation. This creates a challenge in radiology and imaging settings where the patient's ventilatory status may not be within the nurse's field of vision. Capnography provides an alternative method in assessing ventilation that can be remotely visualized when the view of the patient is obscured.

BACKGROUND

Data accumulated from 20 years of ASA Closed Claimed cases suggested that patients sedated outside of the operating room experienced twice the risk in mortality from respiratory related complications (Metzner, Posner & Domino, 2009). This prompted the ASA to revise their position statement on moderate sedation by nonanesthesiologists to require capnography as a standard monitor in 2011 (Statement of Granting Privileges, 2011). It was their opinion that nonanesthesia practitioners engaging in the practice of moderate sedation would benefit from capnography monitoring especially without advanced airway training and expertise should the patient require intervention. This requirement affected professionals and

organizations engaging in moderate-sedating practices especially since institutions are required to have anesthesiology coverage if receiving Center for Medicare/Medicaid Services reimbursement. Not following the ASA position statement creates a medicolegal issue especially with the current state of litigation with malpractice in the United States. This led many to question the validity of this proposed position statement by an outside regulatory professional association and prompted editorials in opposition of the ASA's position (Weaver, 2011; ASGE Capnography Statement, 2012).

For the nurse engaging in sedation practices, it is important to understand the distinction between oxygenation and ventilation, which is often confused as the same process. Oxygenation refers to the oxygen (O_2) saturation of hemoglobin because of the passage of O_2 from the alveoli into pulmonary circulation. Oxygenation is monitored by a pulse oximeter, which calculates the percentage of hemoglobin sites that are bound with O_2 (Tuite and Rosenberg, 2005). Ventilation refers to the elimination of carbon dioxide (CO_2) by breathing. It is monitored by visually observing the patient for normal breathing patterns such as chest expansion or other subjective visual assessments like the quality of chest excursion. On the contrary, capnography, the measurement of end-tidal CO_2 , is a modality that allows the practitioner to monitor ventilation through an objective quantifiable means. Pulse oximetry, although valuable for its assessment of oxygenation, does not provide any information related to ventilation and carbon dioxide levels. Oxygenation can still occur during periods of apnea and may lead the nurse to a false sense of security when titrating pharmacologic agents throughout the procedure. This is often the argument that is expressed by those supporting routine continuous capnographic monitoring for procedural sedation.

Continuous capnographic waveform monitoring represents an additional physiologic parameter that measures ventilation and is available and already in use by anesthesia practitioners. It provides real-time ventilatory status data represented by a waveform every time the patient takes a breath. Capnography is the measurement of CO_2 from respiratory gases exhaled and was first adopted as an anesthetic standard monitor in Holland in 1978 (Committee of the Health Council of the Netherlands, 1978). It has been in use by anesthesia practitioners as a standard monitor for general anesthesia and in 2005 for moderate sedation when it was adopted as a standard monitor for anyone receiving anesthesia.

In response and to enhance patient safety, the Association for Radiologic & Imaging Nursing (ARIN)

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