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Systematic Review to Develop the Clinical Practice Guideline for the Use of Capnography During Procedural Sedation in Radiology and Imaging Settings: A Report of the Association for Radiologic & Imaging Nursing Capnography Task Force

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A B S T R A C T

Advances in radiology and imaging technologies and the emergent scope of practice have led to the capacity to provide services to a growing population of high-acuity patients with comorbid conditions. These procedures are often performed with the radiology nurse administering procedural sedation. Monitoring patients is challenging due to certain patient conditions and the unique environment, that is, the radiology procedure suite. The addition of capnography monitoring, along with standard monitoring, is a valuable modality that provides a continuous objective assessment of the patient's ventilatory status even when direct visualization of the patient is compromised. The purpose of this article is to provide clinical practice recommendations for the use of capnography by procedural sedation nurses outside the operating room setting.

Introduction

Radiology and imaging departments are playing an integral role in both the day-to-day care and the complex treatment of many patients. Accordingly, the role of the nurse providing sedation in radiology and imaging departments has become significantly more challenging with the growing complexities of radiologic procedures. This is further magnified by increasing patient age and acuity of the patients being referred to the radiology department. The radiology nurse is tasked with providing procedural sedation in an environment where direct visualization is often hindered by imaging equipment, patient positioning, and placement of sterile drapes. Some imaging modalities require the sedation nurse to step out of the procedure room during certain procedures. This hinders the visual assessment of the patient's airway, and assessing ventilatory status can be difficult under these circumstances.

The practice of delivering procedural sedation in any environment involves inherent risks. The physiologic effects of the various pharmacologic agents used during procedural sedation can lead to a host of adverse events including hypotension, bradycardia, bradypnea, and apnea. Studies have shown the most common adverse events resulting from procedural sedation

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involve the cardiovascular system, ventilatory function, and airway patency (Tobias, 1999). Accurate physiological monitoring with close attention to patient's ventilatory status is paramount to providing safe procedural sedation and reducing the incidence of adverse respiratory events (AREs). Furthermore, radiology and imaging departments are often in remote locations, and emergency personnel may not be in close proximity to the procedure rooms.

Many medical and nursing organizations have endorsed the use of capnography in addition to standard monitoring during procedural sedation, recognizing that capnography provides continuous objective ventilatory information. This allows the nurse to identify and intervene preemptively when alterations in ventilations indicate the potential for ensuing respiratory decompensation.

Background

In 2009, a study, using the American Society of Anesthesiologists (ASA) Closed Claim data base, analyzed injuries and liabilities resulting from anesthesia care provided outside the operating room (Metzner et al., 2009). The results of the study concluded that anesthesia care provided outside the operating room placed the patient at increased risk for AREs. It was recognized that remote procedural locations providing anesthesia care should follow the same guidelines for monitoring standards as those used in the operating room. The ASA revised their position statement in 2011 in response to this study's findings to include capnography as a standard monitor strategy used by nonanesthesia practitioners (Weaver, 2011).

Many organizations have openly embraced the use of capnography as an adjunct to providing safe procedural sedation. In 2013, the Society of Interventional Radiology published a position statement recommending the routine use of capnography during procedural sedation for interventional procedures (Baerlocher et al., 2013). The Association for Radiologic and Imaging Nursing (ARIN) developed a task force in 2015 to conduct an extensive literature review to evaluate the most current evidence regarding the efficacy of capnography during procedural sedation. This resulted in the 2016 publication of the position statement in support of capnography during procedural sedation (Green, Brast, Bland, Long, Robson, Boone, & Jones-Hooker, 2016).

In an effort to continue their advocacy for the use of capnography during procedural sedation, ARIN formed a task force to develop clinical practice guidelines for the use of capnography during procedural sedation. An in-depth literature review was conducted using high-level evidence research detailing the value of capnography and its ability to detect alterations in ventilation during procedural sedation and reduce the incidence of AREs, as well as identify down falls, cost-effectiveness, and overall patient outcomes involving the use of capnography. The purpose of this literature review is to develop a comprehensive CPG to provide a resource to guide the radiology nurse in the use of capnography as an adjunct to standard hemodynamic monitoring.

Procedural sedation

This guideline is intended for patients undergoing procedural sedation in a hospital or outpatient setting. Procedural sedation can be defined as a technique that provides anxiolysis and/or analgesia for a patient to facilitate the completion of a procedure or imaging modality study. Procedural sedation for the purpose of this guideline includes conscious, moderate, and deep sedation.

Methods and materials

A literature search with preset inclusion/exclusion criteria was conducted by an independent librarian using the PubMed, Embase via the Elsevier platform, Cochrane via the Wiley platform, and Cumulative Index for Nursing and Allied Health Literature via EBSCO databases. The presearch inclusion criteria included all human studies published in English containing the broad concept of capnography with primary patient outcomes. No limitations were imposed in regard to publication date, type of settings, or patient age. The task force recognized that during procedural sedation, the line between moderate and deep sedation can be blurred, as well nurses are involved in all aspects of care, and administer many sedation drugs including propofol. It was therefore the consensus of the task force not to limit sedation drugs used during procedures. The types of studies that were predetermined for inclusion included systematic reviews, meta-analyses, randomized clinical trials (RCTs), as well as prospective and retrospective cohort studies. Excluded publications included case studies, editorials, expert opinion, and case series. The task force decided that the guideline would be developed with high-level evidence (Melnyk & Fineout-Overholt, 2011).

The broad concepts of capnography and patient outcomes were searched, and results were combined using the appropriate Boolean operators (AND, OR). Related terms were also incorporated into the search strategy to ensure all interdependent articles were retrieved. Keywords used to search were (capnography OR “Capnography"[Mesh] OR capnographies OR capnographic OR capnometer” OR “moderate sedation” OR “conscious sedation” OR ″conscious sedation"[Mesh] OR “procedural sedation” OR “end-tidal monitoring” OR “carbon dioxide monitoring” OR PetCO2 OR EtCO2) AND (“patient safety” OR ″Patient Safety" [Mesh] OR “patient outcomes”). A further search involving use of the Google Scholar search engine identified 13 additional online published articles that were current and awaiting print publication. A total of 639 articles were retrieved, and a preliminary evaluation of the abstracts was performed. Each article was examined for relevance and duplication, and each publication's bibliography was inspected for outstanding articles not retrieved in the initial searches. Twenty additional articles were included the evaluation.

To ensure that high-quality articles were selected, two independent teams divided the articles for double examination. The teams then compared each list and came to consensus of relevant articles.

The articles that met the criteria were placed into a literature matrix with each study's aim, methodology, results, and conclusions identified (Table 1). To further ensure that the identified articles were of high quality, each study was scored according to Melnyk and Overholt's Levels of Evidence (2011). The Preferred Reporting Item for Systematic Reviews and Meta-Analyses (PRISMA) checklist was used to assist the task force to critically appraise the presented research. A PRISMA flow diagram was completed to outline the flow of the article appraisal process (Figure 1).

Critical Appraisal Skills Programme (CASP) was used by the task force to further assess internal validity, external validity, and relevance of the results from each study. The CASP tool to appraise the evidence of systematic reviews was used to ensure valid results by including appropriate study designs such as RCTs with precise results relevant to procedural sedation (CASP, 2017a). Validity of RCT articles were assessed using the RCT CASP tool. This checklist assisted identifying any potential bias by looking for blinded studies, equal randomized control group, and statistically significant results (CASP, 2017b). The third CASP tool examining cohort studies was used for the remaining articles. This checklist assisted to ensure study validity by ensuring measures to minimize bias were in place, all confounding variables were accounted for, and precise results (CASP, 2017c). It is felt that the CASP tools assisted