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NARRATIVE REVIEW AIRWAY MANAGEMENT

Comprehensive approaches to emergency airway management during procedural sedation; a narrative review

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ABSTRACT

Procedural sedation is utilized across a variety of clinical settings by healthcare professionals to alleviate anxiety, manage pain, and facilitate diagnostic or therapeutic interventions. The primary aim is to maintain patient comfort while minimizing movement and ensuring the procedure proceeds smoothly. Unlike monitored anesthesia care, which requires the presence of an anesthesiologist, procedural sedation can be safely administered by both anesthesiologists and non-anesthesiologists. However, sedation exists on a continuum with general anesthesia, and the depth of sedation can vary, leading to potential complications, including respiratory depression or airway obstruction. Given the unpredictable nature of patient responses to sedative agents and the associated risks, it is essential to establish robust protocols for monitoring and managing sedation-induced complications, particularly in emergency airway management. Continuous monitoring, pre-procedure assessment, and the availability of airway management tools such as supraglottic device or tracheal intubation using videolaryngoscope are crucial for maintaining patient safety. This review highlights the importance of emergency airway management systems, recent advancements in airway devices, and the critical role anesthesiologists play in improving procedural sedation safety. Effective training programs, simulation-based education, and clear protocols are essential for equipping healthcare providers to respond to sedation-related emergencies, ensuring optimal patient outcomes.

Keywords: airway management; procedural sedation; respiratory complications; simulation-based education; sedation safety

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1. INTRODUCTION

Procedural sedation is performed by a diverse range of healthcare professionals across various clinical settings.[1] The primary objective of procedural sedation is to administer sedative or analgesic medications to reduce patient anxiety, manage pain, and achieve an appropriate level of amnesia or decreased awareness. Additionally, it is essential to minimize patient movement during the procedure, allowing clinicians to perform diagnostic or therapeutic interventions without disruption.[2]

Unlike monitored anesthesia care, which mandates the presence of an anesthesiologist, sedation for invasive procedures can be delivered by both anesthesiologists and non-anesthesiologists.[3] This practice is widely used for a variety of clinical purposes across all age groups. However, sedation operates on a continuum with general anesthesia and carries inherent risks, including the

potential for serious complications, some of which can be life-threatening. Predicting an individual patient's response to sedation is difficult due to variations in drug metabolism and individual reactions. Although the goal is to maintain a specific depth of sedation, the actual level may fluctuate and, in some cases, deteriorate rapidly.

Despite its widespread use, there are currently few universally established standards outlining the necessary competencies for sedation practitioners, the specific content of sedation training programs, or credentialing guidelines, especially for emergency airway management.[4] In response to these challenges, the American Society of Anesthesiologists (ASA) introduced the "Practice Guidelines for Sedation and Analgesia by Non-anesthesiologists" in 1996, with updates in 2002 and 2018.[5,6] These guidelines stress the importance of continuous monitoring by staff who are not directly involved in the procedure. The ASA guidelines provide critical recommendations for non-anesthesiologists to ensure the safe administration of sedation and analgesia, emphasizing that sedation is part of the broader spectrum of general anesthesia.

Healthcare providers involved in procedural sedation must be vigilant, as the depth of sedation can change unexpectedly depending on various factors.[7] To maintain safety and quality, several key elements must be addressed, including thorough pre-procedure assessments, particularly focusing on the airway, continuous respiratory monitoring (such as verbal communication with the patient), and ensuring that emergency airway management equipment is readily available.[8,9]

In this narrative review, we examine the importance of emergency airway management systems, the latest developments in airway devices, and the role anesthesiologists play in enhancing safety during sedation-related procedures.

1.1. Prevention and Response to Respiratory Complications

The ASA-SED outlines the various levels of sedation and highlights critical factors to consider when administering sedation. Sedation exists on a continuum, from "light sedation," where the patient remains conscious and stable, to "deep sedation", where the patient may not respond to strong stimuli and may experience instability in respiratory and circulatory functions. Patients response to sedation can vary significantly depending on the procedure's invasiveness and the individual's condition, making it difficult to predict outcomes in advance. As a result, even when a patient's breathing appears stable, airway obstruction may still occur if vigilance is not maintained.[10]

It is crucial to continuously monitor the patient's condition and promptly identify any unintended deepening of sedation to intervene appropriately. In cases where deep sedation is anticipated, preparations must be in place for potential respiratory complications. Proper monitoring and readiness for emergency intervention are vital, similar to the crisis management protocols followed during general anesthesia.[11]

One of the primary concerns with excessive sedation is the risk of respiratory depression or airway obstruction, which can lead to hypoxia.[12] Therefore, detecting signs of hypoxia or hypoventilation through continuous observation and monitoring is the first priority in managing excessive sedation.[13] Once these signs are identified, medical staff should administer high-flow oxygen and employ basic airway management techniques, such as the triple airway maneuver, to address upper airway obstructions. In more severe cases, assisted ventilation using devices such as oral, nasal, or supraglottic airways may be necessary.[14,15] Additionally, if opioids or midazolam were used in the sedation, administering an antagonist can reverse respiratory depression and be life-saving. Key measures we propose include the following:

1. Establish a robust medical safety system that integrates continuous monitoring and emergency airway management tools to detect respiratory suppression early.
2. Develop clear protocols to rapidly activate the response system when respiratory depression from excessive sedation occurs.
3. Equip each department with a dedicated sedation rescue kit, which should include not only standard drugs and devices but also a range of airway management tools (e.g., supraglottic devices) and antagonists (e.g., flumazenil or naloxone).
4. Implement a specialized airway rescue plan to address airway obstruction and respiratory depression effectively. In the following discussion, we will explore the strategies for emergency airway management during procedural sedation.

1.2. Techniques, Devices, and Emergency Preparedness

Effective airway management during sedation is essential for patient safety. As sedation deepens, the patient's ability to maintain a patent airway and normal respiratory function may be compromised.[16] The risk of respiratory depression or airway obstruction increases

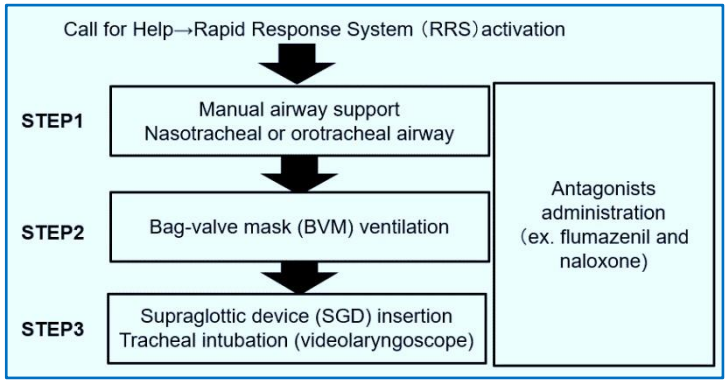

Figure 1: Emergency airway management conceptual diagram for excessive sedation.

with the depth of sedation, making continuous monitoring and timely intervention crucial.[17]

Initially, it is important to evaluate the patient's overall condition and identify factors that may increase the risk of airway complications, such as obesity, existing respiratory disorders, or anatomical abnormalities that could narrow the airway. Based on the sedation depth, appropriate preparations for airway management should be made. While light sedation may require minimal intervention, deeper sedation or levels approaching general anesthesia may necessitate more advanced techniques.

We propose three basic airway management steps for airway rescue to excessive sedation (Figure). The most fundamental airway management technique is the head tilt-chin lift maneuver, which helps prevent the tongue from blocking the airway. In addition to this, oxygen supplementation and continuous monitoring of vital parameters such as oxygen saturation and carbon dioxide levels are critical. Oxygen can be delivered through nasal cannulas or masks to prevent hypoxia.[18] Furthermore, orotracheal or nasotracheal insertion may be effective for airway release.

If these basic measures such as manual airway release or nasotracheal airway insertion fail to maintain adequate respiration, or if deep sedation significantly suppresses the patient's spontaneous breathing, manual ventilation with a bag-valve mask (BVM) may be required. In cases where severe airway obstruction or respiratory depression is anticipated, endotracheal intubation might be necessary to ensure a secure airway. Since intubation is an invasive procedure, it should be performed by trained professionals during sedation.

Supraglottic airway devices (SGDs) are useful for both general anesthesia and managing cases of airway obstruction or difficult ventilation. These devices, which include laryngeal masks, provide an effective alternative to more invasive techniques such as endotracheal intubation. SGDs are particularly valuable in emergency situations or when ventilation is challenging, as they help to alleviate airway obstruction in the pharyngeal region. Over the past two decades, numerous types of SGDs have been developed, with the laryngeal mask being one of the most widely used due to its simplicity and effectiveness.[19,20] It is recommended as an alternative to intubation in cardiopulmonary resuscitation guidelines and is a common component of emergency airway management kits in hospitals.[21] In cases of oversedation leading to respiratory depression, SGDs can assist in maintaining ventilation when bag-valve-mask ventilation is insufficient.[22]

When performing intubation outside of the operating room, positioning the laryngoscope blade in the vallecula can be complicated by factors such as patient movement or chest compressions during resuscitation efforts, which can misalign the oral, pharyngeal, and laryngeal axes, making it more difficult to visualize the glottis.[23,24] To address these challenges, devices like the Airwayscope®, Airtraq® , and McGRATH® MAC have been developed to simplify intubation and improve success rates, even for less experienced users.[25,26] Ongoing research and development in emergency airway management, particularly in the context of sedation, will help to further enhance patient safety in the future.

1.3. A Competency-Based Approach to Training, Response Systems, and Team Resilience

Competency-Based Medical Education has framed procedural sedation as a complex task requiring the integration of multiple competencies. A standardized framework for competency-based training and credentialing in procedural sedation has also been documented.[27] Non-technical skills, such as communication and decision-making, are also considered critical in patient safety management, including during sedation.[28] Lapses in these skills can elevate the risk of errors, potentially leading to adverse events.

Simulation-based education (SBE) is recognized as an effective tool for improving both technical and non-technical skills, as well as behavior-based crisis management. For instance, SBE can play a pivotal role in educating teams for airway management to excessive sedation, enabling the acquisition of skills necessary for handling sedation-related complications.[29,30] Excessive sedation primarily poses risks such as respiratory suppression or airway obstruction, which can lead to hypoxia. In addressing such incidents, the first step

involves identifying hypoventilation, either through patient monitoring or observation. The medical team's next actions should include activating the rapid response system, administering high-flow oxygen, and managing the airway, potentially using manual techniques or BVM ventilation. If necessary, the use of SGDs or tracheal intubation should follow, led by the rapid response team. In cases involving opioids or benzodiazepines, administering antagonists like naloxone or flumazenil may be appropriate.[31] Developing non-technical skills is crucial for enhancing patient safety.

Given the variability in sedative and analgesic dosages depending on the procedure or institution, SBE in sedation safety must address not only situational awareness but also communication about administered drugs among team members, including those involved in the rescue. In this context, the rapid response SBE for each sedation department should focus on the following safety outcomes: implementing a medical safety system with basic monitoring to detect respiratory suppression, ensuring quick access to airway rescue equipment, and establishing a dedicated rapid response system for respiratory suppression caused by excessive sedation. Additionally, an "excessive sedation" rescue box should be provided in each department, containing resuscitation drugs, airway devices (orotracheal/nasotracheal airways, SGDs, tracheal intubation tools), and antagonists like flumazenil and naloxone.

The application of SBE across sedation departments can help reduce sedation-related complications, thereby improving patient safety. Enhancing the system of sedation safety management requires not only the sharing of interprofessional knowledge about sedation techniques but also a reevaluation of existing protocols.[32,33] Medical staff involved in procedural sedation should be well-versed in sedation principles and safety management. From the perspective of safety systems, training should encompass monitoring responsibilities and clear discharge criteria.[34] Given anesthesiologists' expertise in respiratory physiology, sedation, analgesia, and airway management, they are well-suited to take a leadership role in overseeing sedation safety for invasive procedures throughout the hospital.[35]

Team resilience is another critical competency, and SBE offers a way to develop this within various medical teams. Resilience training should be tailored to the specific contexts of each department and the unique requirements of emergency response teams. Different environments, such as MRI rooms, emergency departments, endoscopy suites, and operating rooms, each present distinct challenge, necessitating customized team training solutions.[31] A key competency in procedural sedation training, therefore, is the development of airway rescue skills alongside non-technical abilities such as communication and situational awareness.

2. CONCLUSION

In conclusion, procedural sedation is an essential practice used across various healthcare settings, requiring vigilance and competency from all healthcare providers involved. The challenges associated with sedation, particularly the potential for respiratory complications, highlight the need for stringent safety measures and continuous monitoring. While non-anesthesiologists can administer sedation, the absence of universally established standards for training and credentialing in this area underscores the importance of adhering to guidelines like those provided by the ASA. These guidelines emphasize critical factors such as pre-procedure assessments, airway management preparedness, and real-time respiratory monitoring to mitigate risks, including airway obstruction or respiratory depression. Effective airway management during sedation is particularly crucial, given that sedation levels can fluctuate unexpectedly. Basic techniques like the head tilt-chin lift maneuver and the use of SGDs can prevent airway obstruction and maintain ventilation. In more severe cases, interventions such as endotracheal intubation may be necessary. The role of SBE in improving both technical and non-technical skills related to sedation cannot be overstated. SBE offers healthcare teams an opportunity to rehearse crisis management scenarios, ensuring that they are prepared to respond rapidly to complications, such as hypoxia or over sedation. Moving forward, the development of standardized training protocols, including the use of rescue kits and rapid response systems, will be essential in enhancing patient safety during procedural sedation. An interdisciplinary approach, with anesthesiologists taking a leadership role in sedation safety, will further support the effective management of sedation-related risks across healthcare settings.

3. Conflict of Interest

None to report.

4. Author's contributions

NK: contributed to manuscript writing and preparation.

MH: supervised the manuscript and gave critical comments.

Both authors approved the final version of the manuscript.

5. Ethics statement

- Approval of the research protocol: N/A
- Informed consent: N/A

• Registry and the registration No. of the study/Trial: N/A

• Animal studies: N/A

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