



# Procedural sedation in the ICU and emergency department

*Nikhil Chawla, Adjoa Boateng, and Ranjit Deshpande*

## Purpose of review

Procedures are increasingly being performed in the acute care setting, outside of the operating rooms (OR). This article aims to review the current literature on out-of-OR procedural sedation with a focus on the ICU and emergency department, highlighting the following topics: multidisciplinary team approach, choice of pharmacologic agent, sedation scales, current safety guidelines, anticipating complications, appropriate monitoring and necessary resources.

## Recent findings

Subjective assessment of sedation using sedation scales is controversial. Addition of ketamine and dexmedetomidine to propofol for sedation improves patient and proceduralist satisfaction. The short-acting benzodiazepine remimazolam shows promise in initial phase 2 trials. Use of capnography for monitoring during sedation is being challenged by new literature from the emergency department setting. Hypoxia is the most common adverse event with procedural sedation, and the risk of pulmonary aspiration is low.

## Summary

Multimodal/synergistic sedation under a multidisciplinary team provides the best patient satisfaction. Collection and analysis of physiological data and outcomes of patients undergoing procedural sedation is necessary to maintain compliance with regulatory bodies. There is a paucity of comprehensive guidelines for conducting research in procedural sedation; therefore, it is being currently addressed by the Sedation Consortium.

## Keywords

capnography monitoring, conscious sedation, patient safety measures and monitoring, procedural sedation

## INTRODUCTION

The provision of sedation for procedures outside of the operating room (OR) has grown exponentially for both diagnostic and therapeutic purposes. The ICU and emergency department (ED) are two of the most common locations with a need for sedation services. Procedural sedation and analgesia (PSA) is defined as the administration of agents with sedative or dissociative properties, which facilitate the completion of painful procedures, ensuring safety and comfort for the patient [1]. Myriad techniques have been employed to achieve the balance of sedation, analgesia and safety. The need for sedation services in the ICU primarily centres on placement of intravascular catheters for haemodynamic monitoring, bronchoscopies, tracheostomies, endoscopies and/or medication administration [2]. In the ED, the most frequently performed procedures are orthopaedic manipulation, abscess incision and drainage, wound debridement and direct current cardioversion [1]. For each procedure, the pros and cons of sedation in the out-of-OR

setting must be weighed against sedation in the OR suite, with a focus on patient safety and optimal outcomes.

## SEDATION SCALES

The successful use of PSA depends on meeting certain patient-related endpoints, namely hypnosis/unconsciousness, analgesia, amnesia and anxiolysis. A host of different sedation strategies can be used to achieve optimal conditions, but they need to be targeted on the basis of evaluation of the patient's level of sedation. The evaluation of depth of sedation differs among patients from the ICU and ED,

Department of Anesthesiology, Yale University, New Haven, Connecticut, USA

Correspondence to Ranjit Deshpande, MD, Assistant Professor, Department of Anesthesiology, Yale University, 333 Cedar Street, TMP-3, New Haven, CT 06510, USA. E-mail: Ranjit.Deshpande@yale.edu

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**KEY POINTS**

- No single sedation scale has been shown to be superior for monitoring patients and evaluating depth of sedation.
- Capnography remains an essential monitor for anaesthesiologists administering procedural sedation, but its use is controversial among emergency medicine physicians, owing to lack of demonstrable benefit and cost-effectiveness.
- Hypoxia is a common complication of procedural sedation, but pulmonary aspiration risk remains low in patients undergoing procedural sedation.

due to the presence of many confounding variables in a critically ill patient. In addition, in the ED, providers tend to focus on appropriate analgesia, while in the ICU, there is more attention to both analgesia and sedation.

Subjective assessment of sedation has employed scales such as the Ramsay scale, modified Ramsay scale, Richmond Agitation-Sedation Scale, Observer’s Assessment of Alertness/Sedation (OAA/S), modified OAA/S and visual analogue scale (VAS). A systematic review by Williams *et al.* [3<sup>11</sup>] analysed the clinical scales and measures used in studies of PSA for adults in 245 articles. The authors found that most studies analysed only one or two aspects of scale validity with results specific to the clinical setting. The study failed to identify a scale for the sole purpose of evaluating PSA; the diversity of procedures requiring sedation poses a challenge for developing such a tool.

Objective measurement of cerebral function, primarily in critical care settings, is attainable by the bispectral index (BIS), patient state index (PSI), cerebral state monitor and the response entropy monitor. These monitors use various algorithms to process data, ultimately outputting a number to reflect depth of sedation. However, universal use of these methods has not been accepted due

to the many factors that alter signals in the critically ill patient.

Similarly, many studies have failed to consistently assess recovery from PSA, a factor that is important for improved efficiency and patient satisfaction. The evidence available limits our ability to recommend these scales, while also demonstrating the need for additional research in this field. It is the opinion of the authors that the American Society of Anesthesiology’s (ASA) statement on continuum of sedation and general anaesthesia (see Table 1) is the best available guide to measuring depth of sedation [4].

**INTRAPROCEDURE MONITORING**

Standard monitoring for PSA and analgesia in the ED consists of pulse rate, electrocardiography, blood pressure, oxygen saturation and respiratory rate. ASA recommendations also include capnography and core body temperature monitoring for patient receiving moderate or deep sedation, unless precluded or invalidated by the nature of the patient, procedure or equipment [5].

Commonly employed direct methods of assessing ventilation include transcutaneous carbon dioxide/capnography monitoring, respiratory acoustic and thoracic impedance monitoring [6]. Thoracic impedance uses electrodes to analyse impedance changes across the respiratory cycle. The limitation of this method is its inability to differentiate between respiratory flow and respiratory effort; thus, a closed chest wall movement against a closed glottis would register as a normal respiratory rate. Acoustic monitoring, on the contrary, detects turbulent air-flow through the larynx to assess ventilation. Studies comparing capnography to acoustic flow have demonstrated equal detection rates of respiratory pauses, though acoustic monitoring is associated with a decreased false-positive error rate [7].

Continuous end-tidal capnography monitoring for PSA is controversial. A systematic review of seven studies encompassing 662 patients having procedural sedation in the ED demonstrated the

**Table 1.** American Society of Anesthesiology’s statement on continuum of sedation and general anaesthesia [4]

	<b>Minimal sedation anxiolysis</b>	<b>Moderate sedation/ Analgesia</b>	<b>Deep sedation/ Analgesia</b>	<b>General anaesthesia</b>
Responsiveness	Normal response to verbal stimulation	Purposeful response to verbal or tactile stimulation	Purposeful response following repeated or painful stimulation	Unarousable even with painful stimulus
Airway	Unaffected	No intervention required	Intervention may be required	Intervention often required
Spontaneous Ventilation	Unaffected	Adequate	May be inadequate	Frequently inadequate
Cardiovascular Function	Unaffected	Usually maintained	Usually maintained	May be impaired

Reproduced with permission from [4].

addition of capnography was to standard monitoring did not affect the frequency of adverse events [8<sup>\*</sup>]. In addition, a recent review of cost-effectiveness showed that continuous waveform quantitative end-tidal CO<sub>2</sub> monitoring is a very costly strategy to prevent catastrophic complications of procedural sedation when applied routinely in ED procedural sedation [9]. A meta-analysis of anaesthesiology literature, on the contrary, showed a 17-fold increase in detection of respiratory depression with the use of capnography [10].

The following monitoring standards are recommended on the basis of review of data and the authors' experience:

- (1) Continuous ECG;
- (2) Continuous pulse oximetry;
- (3) Noninvasive blood pressure every 5 min;
- (4) Measure for ventilation (capnography/impedance monitoring);
- (5) Core body temperature monitoring (optional in cases with possible fluctuations).

## PHARMACOLOGICAL AGENTS

Classically, benzodiazepines and opioids have been used most extensively for moderate sedation by nonanaesthesiologists. These agents remain the most frequently used in procedural suites, with additional variety of medications used in the ICU and ED. Aside from benzodiazepines and opioids, the three most commonly used agents are propofol, ketamine and dexmedetomidine, typically used in combination to provide optimum sedation conditions. Newer agents such as remimazolam are still undergoing phase 2 trials but may offer a viable alternative in the future [11].

The primary benefit of propofol is its ability to achieve similar levels of procedural success with rapid onset and faster recovery to baseline, lower rates of postprocedural re sedation and higher patient satisfaction than benzodiazepines [12]. Propofol has been demonstrated to decrease respiratory events when compared with fentanyl/midazolam. Although propofol has a higher incidence of hypotension when used alone, the occurrence of hypotension is mitigated when propofol is combined with ketamine [13].

Ketamine is known to provide 'dissociative sedation', which along with its potent analgesic properties makes it ideal for non-OR sedation. In a review by Sih *et al.* [14], the use of ketamine for procedural sedation and analgesia in the ED was associated with a more than 90% success rate, as noted by patient satisfaction, adequate analgesia and lack of

procedural recall. The authors found ketamine to be of greater use in patients undergoing longer procedures or with a prior history of substance abuse. The incidence of recovery agitation was reduced by premedication with midazolam. In addition, sub-dissociative doses of ketamine (0.3 mg/kg) have been shown to be safer and similarly efficacious than fentanyl for ED procedural sedation with propofol [15].

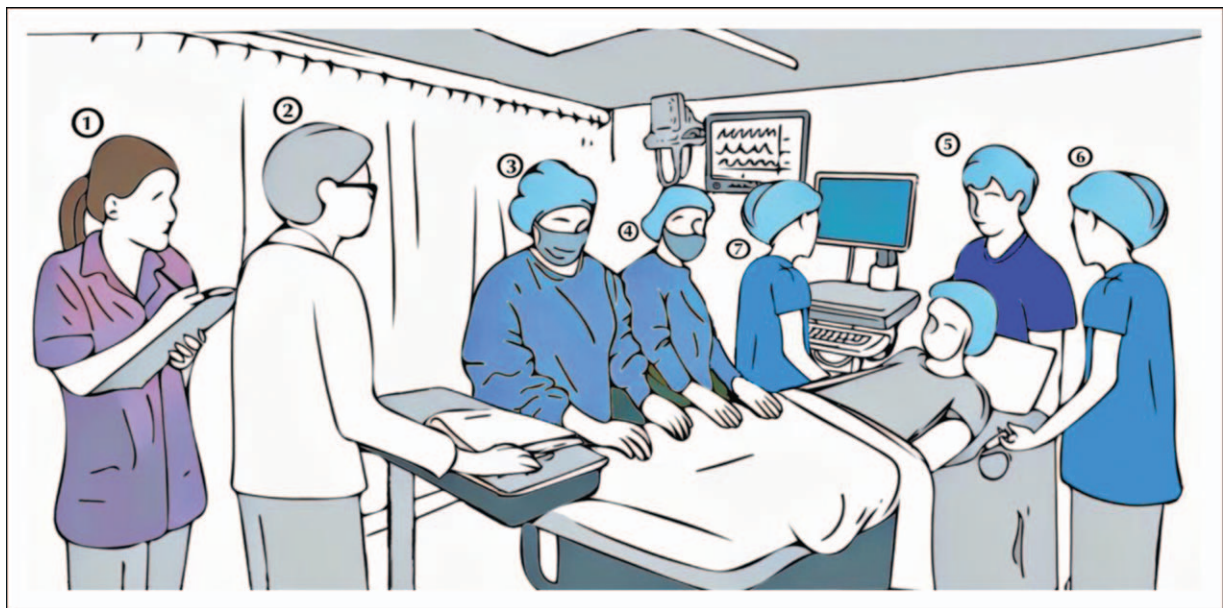
Dexmedetomidine is gaining ground over other agents used to provide procedural sedation due to its ability to provide sedation with an absence of respiratory depression. However, a loading dose poses the risk of bradycardia and hypotension. In addition, the lack of amnesia with administration can be of concern in certain situations; however, this can be easily managed with the addition of a low-dose benzodiazepines. A randomized controlled study recently showed that the use of dexmedetomidine in addition to propofol produced an overall decrease in cardiovascular, respiratory and agitation-related adverse effects while increasing patient and proceduralist satisfaction [16<sup>\*</sup>].

## SEDATION TEAM

A multidisciplinary team of healthcare providers is often employed when providing sedation to patients in the ICU or ED. A recent study has shown that the use of a curriculum including self-learning assignments, airway skills course and simulation sessions improved the expertise of physicians and nurses in the administration of moderate sedation, independent of their profession and clinical experience [17]. Having a dedicated team to provide care for sedation no matter the setting is likely to provide the best outcomes, but is often difficult to obtain due to logistical obstacles. The following personnel are recommended when providing moderate sedation:

- (1) Physician team leader (sedation and monitoring);
- (2) Proceduralist;
- (3) Physician assistant (for Proceduralist);
- (4) Registered nurses;
- (5) Respiratory therapist;
- (6) Scribe;
- (7) Ancillary staff (Radiology tech, gastrointestinal tech, etc.).

The personnel deployment will change on a case-to-case basis; Fig. 1 shows a clear delineation of roles and an organizational scheme to streamline procedures and improve efficiency without sacrificing patient safety. A preprocedural huddle or time



**FIGURE 1.** Recommended set-up of practitioners for procedural sedation cases. 1. Scribe 2. Team leader 3. Proceduralist 4. Assistant 5. Respiratory therapist 6. Nurse (Medication administration) 7. Nurse (Documentation).

out and a postprocedural debrief should be practiced in order to improve team performance. Occurrence of adverse outcomes should automatically lead to a team discussion about the specifics of the case and formulation of policies that would prevent such events in the future.

### ADVERSE EVENTS

The patient population undergoing PSA can vary from the healthy to the critically ill depending on the setting. Similarly, the complications vary widely depending on the situation, with ICU patients at a higher risk for haemodynamic compromise than their ED cohort. A 2014 systematic review and meta-analysis evaluated the incidence of adverse events in adults undergoing procedural sedation in the ED, particularly the frequency of events associated with individual drugs and/or drug combinations [5]. The study analysed 9652 procedural sedation cases, yielding hypoxia (40.2 per 1000 sedations), vomiting (16.4 per 1000 sedations) and hypotension (15.2 per 1000 sedations) as the most common adverse events. There was only one case of aspiration identified, five cases of bradycardia, five cases of laryngospasm and 19 cases of unplanned intubation. The low risk of pulmonary aspiration has been substantiated in a subsequent systematic review [18].

Given the high incidence of hypoxia associated with PSA, we promote routine use of capnography. In addition, the sedating physician should be able to manage airway issues, and comfortable with

airway manoeuvres such as patient repositioning to alleviate upper airway obstruction, application of airway adjuncts (oropharyngeal airway, nasopharyngeal airway and laryngeal mask airway) and establishing a protected airway with endotracheal intubation.

### CURRENT SAFETY GUIDELINES

Guidelines for sedation practices vary widely between different healthcare systems. In general, they follow recommendations put forward by various medical boards and accrediting bodies. In the ICU and ED, guidelines are typically based on statements from the ASA, the American College of Emergency Physicians (ACEP) and the Joint Commission.

#### American Society of Anesthesiology statement on nonoperating room anaesthesia

The ASA last amended its statement on nonoperating room anaesthetizing locations in October 2013. They noted the presence of following as essential in nonoperating room anaesthetizing locations:

- (1) A reliable source of oxygen adequate for the length of the procedure;
- (2) An adequate and reliable source of suction;
- (3) An adequate and reliable system for scavenging waste anaesthetic gases in any location where inhaled anaesthetics will be utilized.
- (4) There should be in each location:



- (a) A self-inflating hand resuscitator bag capable of administering at least 90% oxygen as a means to deliver positive pressure ventilation;
  - (b) Adequate anaesthesia drugs, supplies and equipment for the intended anaesthesia care;
  - (c) Adequate monitoring equipment to allow adherence to the 'Standards for Basic Anesthetic Monitoring' (i.e. ECG, SpO<sub>2</sub>, non-invasive blood pressure).
- (5) Sufficient electrical outlets to satisfy anaesthesia machine and monitoring equipment requirements, including clearly labelled outlets connected to an emergency power supply;
  - (6) Provision for adequate illumination of the patient, anaesthesia machine (when present) and monitoring equipment;
  - (7) Sufficient space to accommodate necessary equipment and personnel and to allow expeditious access to the patient, anaesthesia machine (when present) and monitoring equipment;
  - (8) An emergency cart with a defibrillator, emergency drugs and other equipment adequate to provide cardiopulmonary resuscitation immediately available;
  - (9) Adequate staff trained to support the anaesthesiologist;
  - (10) Compliance with applicable building and safety codes and facility standards;
  - (11) Appropriate postanaesthesia management.

### Joint Commission's policy

The Joint Commission's Policy for the care of patients sedated for procedures closely follows the ASA's recommendations. In addition, per Joint Commission standards, the physician who administers sedatives and analgesics during a procedure is responsible for the patient's global management (including sedation) as well as for supervising all involved ancillary personnel. The licensed independent practitioner (LIP) must be 'trained in professional standards and techniques' or have 'competency-based training, education, and experience' in four specific areas: pre-sedation assessment and patient selection, agent administration (selection of drug class, drug dose and route of administration) to predictably achieve the desired sedation level, intraprocedure monitoring to maintain the desired level of sedation and resuscitation expertise.

In addition, the Joint Commission recommends the appropriate consent prior to sedation, post-sedation recovery under supervision prior to discharge,

and collection and analysis of intraprocedural physiological data and outcomes of patients undergoing moderate sedation.

### American College of Emergency Physicians policy statement

The ACEP revised their statement on procedural sedation in the ED in 2011 [19]. Highlights of this revision include the delineation of light, moderate and deep sedation. They cite methods of sedation, including the use of opioids, benzodiazepines and barbiturates as well as other specific agents such as ketamine, propofol, remifentanyl, dexmedetomidine, etomidate and nitrous oxide, in addition to distraction and visual imagery. The policy statement promotes individualization of pharmacologic agents alongside credentialing and verification of the competency of providers.

We recommend that providers follow the measures outlined as follows:

- (1) Preprocedural informed discussion with the patient/clinical decision maker;
- (2) Formulation of a plan with a multidisciplinary team including nursing, respiratory therapist, proceduralist and physician in charge of providing sedation. Regular training exercises to improve inter-personnel and disaster management skills.
- (3) Administration of pharmacologic agents individualized for every case based on physician experience and clinical situation;
- (4) Intraprocedural physiological monitoring of the patient, including overall global care and management of any complications of the procedure as well as sedation;
- (5) Appropriate postprocedure recovery under supervision until achievement of preprocedure state or the closest to it as possible;
- (6) Data recording and analysis for quality assurance and improvement. Monthly discussion of cases with significant morbidity or mortality related to the procedure.

### CONCLUSION

Procedural sedation and analgesia is a growing practice outside of the OR. Universal guidelines irrespective of specialties are needed to ensure patient safety and procedural efficacy.

The Sedation Consortium recently convened a meeting of sedation experts from a variety of clinical specialties and research backgrounds with the objective of developing recommendations for procedural

sedation research. Among the goals are to facilitate comprehensive reporting across sedation trials, along with meaningful comparisons among studies and interventions in systematic reviews and meta-analyses [20]. The results of future trials designed with these objectives in mind are likely to provide further insights into the procedures and practices that optimize sedation administration in the out-of-OR setting.

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### Conflicts of interest

*There are no conflicts of interest.*

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- of special interest
- of outstanding interest

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