Mini Review Article

A mini-review of procedural sedation and analgesia in the emergency department

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Procedural sedation and analgesia (PSA) is performed for a variety of indications in emergency departments (EDs). Although the practice of PSA in the ED is somewhat unique from other clinical areas, there is currently no guideline for this practice in Japan. Policy statements and guidelines for PSA have been published in Europe and North America. These guidelines suggest first evaluating patients carefully before performing PSA, and then deciding on target sedative level and choice of medications. Patient evaluation requires a combination of continuous visual observation by trained medical staff to assess the depth of sedation and respiration with noninvasive measurements of blood pressure, continuous electrocardiography monitoring, and pulse oximetry. Sedative selection should be based on its characteristics, peak time, effectiveness, and risks. It is important to administer sedatives and analgesics in small, incremental doses while keeping a close eye on the patient's reaction to avoid adverse events (AEs) until the planned sedation level is reached. Further, additional attention is needed for special populations such as pediatric and elderly patients. PSA is a key element for patient-centered care in emergency medicine. In this manuscript, we review the available evidence for PSA in the EDs, including guidelines for evaluation, monitoring, pharmacology, AEs, and special populations such as pediatric and elderly patients.

Key words: Anesthesia, conscious sedation, education, safety, simulation training

INTRODUCTION

PROCEDURAL SEDATION AND analgesia (PSA) is a "common emergency department (ED) clinical practice that alleviates pain, anxiety, and suffering for patients medical procedures".[1] These procedures are usually short and include reduction of joint dislocation, cardioversion, and imaging studies, but do not include sedation for tracheal intubation. Over the past decade, a number of studies have shown PSA to be safely performed in the ED.[1–5] The availability of ultra-short-acting sedatives and analgesics as well as noninvasive monitoring devices such as capnography have made PSA practice even safer. The availability and common use of sedative and analgesic agents differ depending on region or country.[2,6] As a result, emergency medicine societies in some countries have published different policy statements and guidelines specific to the ED practices in their respective countries.[1,7,8] The European Society of Anesthesiology and European Board of Anesthesiology also published PSA guidelines for adults.[9]

In Japan, the context for PSA differs from that in North America and Europe in three primary ways. First, the patient population is older and more patients have the American Society of Anesthesiologists (ASA) physical status classification of 3 or 4.[2,10] Second, indications for PSA in the ED are different (Table 1).[2,4,5] Third, emergency physician (EP) training opportunities for PSA in Japan are somewhat limited.[11] The Japanese Procedural Sedation and Analgesia Registry (JPSTAR), a multicenter prospective observational study, showed slightly higher incidence of adverse events (AEs) during PSA in participating EDs in Japan than previous studies in other countries.[2] These differences suggest

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Table 1. The major indications of PSA in North America, Europe, and Japan

Frequency ranking	Study/country		
	Smits *et al.* 2017[4]/Netherlands	Sacchetti *et al.* 2007[5]/United States	Norii *et al.* 2019[2]/Japan
1	Fracture or dislocation reduction	Fracture or dislocation reduction	Cardioversion
2	Abscess drainage	Lumbar puncture	EGD
3	Cardioversion	CT	Fracture or dislocation reduction
4	Tube thoracostomy	Foreign body removal	Laceration repair
5	Lumbar puncture	Tube thoracostomy	MRI

CT, computed tomography; EGD, esophagogastroduodenoscopy; MRI, magnetic resonance imaging; PSA, procedural sedation and analgesia.

that PSA guidelines from other countries may not cover the Japanese patient population. A PSA guideline specific to Japanese EDs might be needed. Although some of medical societies in Japan have developed guidelines on PSA,[12] there are no PSA guidelines specific to ED practice. In the ED, EPs usually practice "unscheduled" PSA, which has unique aspects. EPs must manage not just the procedure and PSA, but also the acute pain, anxiety, unstable physiological state, undefined diagnosis, insufficient patient information, and associated troubles.[8] The Japan Society of Procedural Sedation and Analgesia (JSPSA) developed a PSA training course in order to meet the need for training in Japan and other countries in Asia. The course evaluation results showed that health care professionals who participated in the training had a somewhat limited baseline knowledge of pharmacology, elderly patients, timing of AEs, and fasting time on PSA, and that the knowledge was significantly improved after the training.[11]

In the sections which follow, we describe concrete procedures for safe PSA in the ED. These procedures include, an evaluation of the patient by an EP, who will also plan for sedative levels and medications. The EP will also need to explain the procedure to the patient and prepare for monitoring and rescue. During PSA, they need both knowledge of pharmacology and monitoring skills to avoid AEs. After finishing the procedure, patients should be observed until awaking. Special populations such as pediatric and elderly patients need to be considered. In this manuscript, we aim to summarize the existing guidelines for PSA, review the available evidence, and highlight unique challenges for PSA practice in the ED in Japan.

EVALUATION AND ASSESSMENT

MOST GUIDELINES RECOMMEND evaluating and assessing patients carefully before performing PSA to improve patient comfort and reduce AEs.[6,8,9,13] First, they recommend that EPs assess the patients' needs for analgesia, anxiolysis, immobility, or some combination of the three.

Second, they recommend performing a patient history review that includes allergies, medications, past medical and sedative history, underlying illnesses, and the time of last meal. The ASA's physical status scale is useful for evaluating baseline physical status, comorbidities, and related characteristics.[8,9,13] If the patient is in an unstable physiological state, treatment to stabilization should be prioritized. After taking the history, they recommended a physical examination. Careful assessment before PSA is important, especially evaluation of the airway.[8,9,13,14] If EPs identify that the patient has a difficult airway or an unstable physiological state, they may consider alternatives to the usual PSA, such as local anesthesia, a nerve block, or consultation with the anesthesiologist.[13]

Third, based on patient's indication and risk factors, it is recommended that EPs assess target sedative level, the need for combining analgesics, and choose medications based on the likelihood of AEs.[8,14,15] Table 2 shows the level of PSA based on examination findings.

Monitoring

The goals of monitoring are to confirm and continue to document the patient's well-being, and early detection of any AEs during and after PSA. The improvement of monitoring is the most effective way to decrease AEs.[16]

PSA are safer with a minimum of two trained providers at the bedside,[8] one provider to administer sedation and provide uninterrupted monitoring and another to perform the procedure.[14] Monitoring guidelines include a recommendation to assess the depth of sedation by using responsiveness to tactile stimulation or response to verbal commands during and after PSA.[8,9,13,14] Intermittent noninvasive

Table 2. The level of PSA based on examination findings

Examination findings	The level of PSA			
	Minimal	Moderate	Deep	General anesthesia
Responsiveness	Normal response to verbal stimulation	Purposeful response to verbal or tactile stimulation	Purposeful response following repeated or painful stimulation	Un-rousable 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
Indication examples of PSA	Imaging, lumbar puncture, wound care, EGD	Colonoscopy, bronchoscopy, pediatric wound care, fracture, or dislocation reduction	Cardioversion	Open surgery

EGD, esophagogastroduodenoscopy; PSA, procedural sedation and analgesia.

measurements of blood pressure and continuous electrocardiography monitoring are typically performed in all patients undergoing PSA.[8,13] Patients undergoing PSA should always be monitored using pulse oximetry, which can minimize the risk of, and help rapidly manage, hypoxemia during PSA by emitting a continuous variable pitch pulse tone and alarm when oxygen saturation (SpO_2) is low.[9] Although pulse oximetry can measure oxygenation, it cannot detect ventilator insufficiency due to airway obstruction, hypoventilation, or apnea. Capnography measures exhaled carbon dioxide continually, so it can detect ventilator insufficiency before hypo-oxygenation occurs. A previous meta-analysis found support for the use of capnography during PSA to detect respiratory depression and reduce hypoxia.[17] By contrast, a recent Cochrane review showed that there is a lack of convincing evidence for the effectiveness of using capnography in addition to standard monitoring to reduce the rate of clinically severe AEs in ED PSA.[18] Further studies are needed to investigate the indications for the effective use of capnography.

The JPSTAR showed differences in monitoring practices during PSA in included EDs in Japan.[2] In the future, national guidelines that fit current practices in Japan might be helpful.

PHARMACOLOGY OF PSA

IN THE ED, EPs perform short-time procedures and most patients require a short-time PSA, especially because some are never admitted to the hospital. It is important to administer sedatives and analgesics in small, incremental doses while keeping a close eye on the patient's reaction to avoid an excessive dosage.[13] Any additional dosage should be given after peak time, which allows time for drug concentrations in the brain to reach its maximum.[13] Because these agents do not have both the hypnotic and the analgesic effects, they sometimes need to be used in combination. For example, the combination of ketamine and propofol (ketofol) has generated some interest.[19] Table 3 summarizes these characteristics, peak time, and effectiveness for major sedatives and analgesics.[15,19–22]

In Japan, thiopental, propofol, and midazolam are often used as sedatives for PSA, but thiopental is not commonly used for PSA in North America and Europe, thus it is rarely included in the guidelines for PSA in the ED.[2,4,5] Thiopental has some benefits for PSA such as rapid onset and offset when used as a single dose. However, thiopental also has disadvantages for PSA. For example, repeated administration often causes delayed recovery from sedation. Thiopental also occasionally causes respiratory and circulatory depression.[20] Additionally, some common medications frequently used for PSA in other countries, including etomidate, have not been approved in Japan.[2]

Adverse events

PSA in the ED has been found to be safe, as previous studies have shown that severe AEs affecting dispositions of patients were extremely rare.[5,23,24] Further, most AEs from

Table 3. Characteristics, peak time, and effectiveness of major sedative and analgesics

		Dosing[†], initial dose (additional dose)	Onset, min	Peak, min	Duration[‡], min	Contraindication
Propofol	Intravenous	Adult: 0.5–1.5 mg/kg (0.2–0.5 mg/kg by 0.5–1 min) Elderly: 0.5 mg/kg or less ≤3 yo: 2.0 mg/kg Pediatric: 1.5 mg/kg	0.5–1	1–1.5	5–10	
Midazolam	Intravenous	Adult: 0.02–0.04 mg/kg (same dose by 2–3 min) Pediatric: 0.05–0.1 mg/kg (same dose by 2–3 min)	0.5–1	2–3	30	
	Oral, intranasal, rectal	0.25–0.75 mg/kg, max 10 mg	10–30	30	60–90	
Thiopental	Intravenous	Adult: 3–5 mg/kg (50–100 mg) Pediatric: 5–8 mg/kg	0.2–0.5	1	5–10	Porphyria status asthmaticus
Dexmedetomidine	Intravenous	0.2–0.7 μg/kg/h	5–10	15–30	4–250[§]	
Fentanyl	Intravenous	Adult: 0.5–1 μg/kg (0.025–0.5 μg/kg) Pediatric: 1–2 μg/kg (1 μg/kg)	0.5	2–4	20	
Pentazocine	Intravenous	20–30 mg	2–30	15–30	120–180	
Ketamine	Intravenous	1–1.5 mg/kg (0.5–1 mg/kg by 2 min)	0.5–1	1	10–15	Infants <3 months of age Schizophrenia
	Intramuscular	4–5 mg/kg (2–5 mg/kg)	5	5	20–30	
Ketofol (combination of ketamine and propofol)	Intravenous	0.5 mg/kg for each ketamine and propofol (0.1–0.25 mg/kg, respectively)	0.5–1	1	10–15	Infants <3 months of age Schizophrenia

[†]Ideal body weight.
[‡]In a single dose.
[§]It depends on the duration of infusion (from 4 min after a 10-min infusion to 250 min after an 8-h infusion).

PSA occur within about 30 min after the last drug administration, so closer observation is needed during this time.[25]

A recent systematic review of PSA in adult patients estimated the incidence of major severe AEs, including aspiration (1.2 per 1,000), laryngospasm (4.2 per 1,000), and intubation (1.6 per 1,000).[24]

Recent PSA studies have revealed that there is no relationship between fasting time and incidence of AEs, regardless of patient profile.[3] The US and European guidelines also contend that fasting prior to PSA is not evidence based and EPs should not delay emergent procedures based only on insufficient fasting time.[1,8,9]

No studies have clearly established which drugs are safer than others.[2–5] Each sedative and analgesic has its own specific effects and risks. For safer PSA, the type and dose of drug should be optimized according to the patient's characteristics and planned sedation level.

Guidelines recommend that EPs should be knowledgeable and skilled in these areas in order to avoid preventable AEs.[8,9,13] This is why training opportunities for ED PSA, like the off-the-job course developed by the JSPSA, are meaningful.

PROCEDURAL SEDATION AND ANALGESIA IN THE PEDIATRIC AND ELDERLY PATIENTS

FOR A LONG time, pediatric patients have been physically restrained for procedures. However, the psychological trauma from this practice may be severe enough to lead to a stress disorder.[26] Although some EPs may be concerned about the safety of PSA itself, severe AEs are rare for pediatric patients.[2]

The necessity for PSA is based on a balance of developmental status, difficulty, time duration or minuteness of the procedure, and the maturity of the physician's skill.[27] Generally, it is difficult for children to bear pain, which leads to fear or restlessness during procedures on young children. Minimal sedation helps mitigate this stress and substantially improves procedures for pediatric patients. We have several choices for effective PSA for pediatric patients that are not commonly used for adults. Ketamine, used often in pediatric procedures, has both hypnotic and analgesic effects. Intranasal, rectal, and oral sedatives are all effective for achieving minimal sedation for pediatric patients.[28]

Explanation to the child's guardian may also be a difficult part of PSA for pediatric patients. Guidelines recommend offering the guardian the opportunity to be present and giving them a role during sedation if appropriate. Offering the option of parental presence is clearly in line with the paradigm shift to family-centered care.[28]

The increasing aging of society is a considerable problem in PSA. As with pediatric patients, PSA for the elderly requires special consideration.[9,21] Elderly patients are at greater risk during PSA because of increased comorbidities, increased sensitivity to sedatives, and limited physiological reserve capacity compared to young with regard to metabolic functions, neurotransmitter activity, and their respiratory and circulatory systems.[29] There are three primary points that warrant attention in the elderly: (i) Start with a small amount of medication; (ii) Observe the effect and slowly add small amounts; and (iii) Consider potential prolonged effects and take a longer time to assess if it is possible to send the patient home.[9] A guideline on propofol use for PSA in the ED mentioned a specific dosing for elderly patients.[21] However, the suggested dose (0.5 mg/kg) might not be appropriate for very elderly patients and an even smaller dose has been suggested by previous studies.[10,30] Furthermore, most existing guidelines in other countries do not specify dosing for other sedatives in elderly patients. Because there are many other sedatives that are also used in Japanese EDs, a guideline that is consistent with the practice of PSA in Japanese EDs might be beneficial. If analgesia but not sedation is necessary, it is also important to consider whether there is a method that does not affect the patient's level of consciousness, for example, a nerve block, rather than using drugs that act on the central nerve following intravenous administration.

CONCLUSION

WE REVIEWED CURRENT guidelines and key concepts for PSA, including evaluation and assessment, monitoring, pharmacology, AEs, and special populations in ED. PSA is one of the key elements for patient-centered care in the practice of emergency medicine. To improve both understanding and safe practice of PSA in Japan, a specific ED guideline and the addition of PSA to ED curriculum are needed.

DISCLOSURE

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