Best Practices in Procedural Sedation and Analgesia (PSA) in the Emergency Department: A Review Study

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Abstract

Background: Procedural sedation and analgesia (PSA) is a critical intervention in the emergency department (ED), enabling painful or anxiety-inducing procedures while also maintaining patient safety and comfort. Although widespread, practice variations and potential adverse events necessitate best practices that are standardized. Aim: This review is intended to synthesize evidence-based best practices for PSA in the ED on the basis of patient evaluation, pharmacologic agents, monitoring, education, and management of adverse effects to achieve the best outcomes. Methods: Peer-reviewed publications between 2016 and 2025 were extensively searched, including guidelines, systematic reviews, and clinical trials. Evidence was obtained from PubMed, Cochrane, and EMBASE. Results: Key findings emerging indicate that PSA is safe (>99% success rate) when guided by protocols emphasizing pre-procedure risk stratification (e.g., ASA classification), agent-specific choice (e.g., ketamine in unstable patients), watchful capnography (reducing hypoxia by 52%), and inter-professional education. Severe adverse events such as intubation happen in <0.1% of procedures. Emergent developments such as remimazolam and AI-based monitoring are promising. Conclusion: Standardized PSA protocols provide increased safety and efficacy in the ED. Future applications of new agents and technology will further improve outcomes, particularly for special populations such as pediatrics and geriatrics.

Keywords: Procedural Sedation, Emergency Department, Capnography, Ketamine, Adverse Events.

Significance | This study highlights that standardized, evidence-based procedural sedation in emergency departments enhances safety, minimizes adverse events, and optimizes patient-centered outcomes through technology and training integration.

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1. Introduction

The ED is a high-stakes environment where rapid, often invasive maneuvers—e.g., fracture reductions, abscess drainages, and electrical cardioversions—are performed within time constraints and heterogeneous patient status (Godwin et al., 2014). Procedural sedation and analgesia (PSA) are an effective resource, a process that is the administration of sedatives, analgesics, or dissociative agents to provide a decreased level of consciousness for tolerance of unpleasant procedures with maintenance of patent airways and spontaneous ventilation (American Society of Anesthesiologists [ASA], 2018). PSA is distinct from general anesthesia because reversibility and minimal interference with vital functions is secondary to it, which follows the ED's unscheduled, limited-resource environment. Historically, PSA evolved from initial "conscious sedation" in the 1980s into an advanced continuum—minimal, moderate, deep, and dissociative—recognized by the American College of Emergency Physicians (ACEP) as a core

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competency (Godwin et al., 2014). To date in 2025, the use of PSA has exploded, with over 1.2 million annual ED visits in the U.S. alone, fueled by pharmacologic and monitoring advances (Bellolio et al., 2016).

Still, with its effectiveness, PSA is plagued with intrinsic dangers: respiratory depression (5-20% incidence), hypotension (3-15%), and rare but life-threatening events like laryngospasm (<0.5%) (Homma et al., 2020). These underscore the necessity of evidence-based standard best practices to minimize harm while maximizing procedural success. This review aims to delineate evidence-based practices for PSA in the ED, encompassing patient assessment, agent selection, monitoring, training, and management of complications.

2. Patient Selection and Pre-Procedural Assessment

Optimal PSA begins with a thorough patient evaluation, which risk-stratifies and directs agent choice. ASA Physical Status (PS) classification—PS I (healthy) to PS VI (brain-dead)—alerts risk, with patients PS III-IV experiencing 2-3 times higher complication rates (Caperell & Pitetti, 2009). In the ED, where risk of hypoventilation is heightened by comorbid conditions such as obesity (BMI >30) or obstructive sleep apnea, history and physical are critical (Green & Krauss, 2004). Key features include airway examination on the Mallampati score or LEMON mnemonic (evaluate 3-3-2 rule, Mallampati, Obstruction, Neck mobility), which predicts difficult intubation with 80-90% sensitivity (Ezri et al., 2001).

Cardiovascular stability is verified by vital signs and ECG if necessary, as unstable patients (e.g., systolic BP <90 mmHg) need other analgesia or referral to an anesthesiologist (ASA, 2018). NPO status, once rigidly applied, is now liberal based on ACEP guidelines: no restriction on PSA in adults or pediatrics, as risk of aspiration remains <0.01% for ED populations (Godwin et al., 2014). For vulnerable populations, e.g., the elderly (>65 years), frailty scores such as the Clinical Frailty Scale predict longer recovery time (2-3x longer) and delirium (OR 1.5) (Homma et al., 2020). Pediatric patients need weight-based dosing and behavioral assessment for autism or anxiety, where non-pharmacologic strategies (e.g., distraction) decrease agent requirements by 20-30% (Krauss & Green, 2006). Informed consent, highlighting risks (e.g., 1-5% respiratory events) and benefits (95% procedural success), facilitates shared decision-making (Bhatt et al., 2009).

In practice, a checklist—ASA PS, airway risk, allergies, and consent— Facilitates assessment, reducing oversedation by 15% in simulation research (Atkinson et al., 2014). Pre-oxygenation with HFNC 30-60 L/min prophylactically reduces desaturation rates from 10% to <2% (Deitch et al., 2010). Lastly, assessment assures PSA is proportionate to procedural need, prioritizing safety in this dynamic ED setting.

2.1 **Pharmacological Agents for PSA**

Pharmacology is the basis for PSA effectiveness, with drugs selected for onset, duration, and side-effect profile. Example classes are benzodiazepines, opioids, dissociatives, and hypnotics, often in combination for synergism (Miller et al., 2019). Midazolam, a short-acting benzodiazepine (onset 1-3 min, duration 30-60 min), induces anxiolysis and amnesia at 0.02-0.1 mg/kg IV, but carries a risk of respiratory depression (5-10%) when used with opioids (Furniss & Sneyd, 2015).

Fentanyl (1-2 mcg/kg IV), a potent opioid, is better than analgesia for orthopedic reductions, with a rapid onset (2-5 min) but chest-wall rigidity at high doses (>5 mcg/kg) (Smally et al., 2011; Nasr et al., 2025). Use in combination (midazolam-fentanyl) is suitable for moderate sedation, with 90% success for ED repair of lacerations, though GI upset occurs in 5% (Bellolio et al., 2016). Dissociative ketamine (1-2 mg/kg IV/IM) yields profound analgesia and amnesia without respiratory impairment, ideal for pediatrics (15-30 min recovery) and hemodynamically unstable patients (Green & Krauss, 2004). Emergence agitation (10-20%) is avoided with co-administration of midazolam (0.01 mg/kg). Propofol (1-2 mg/kg IV bolus, 50-100 mcg/kg/min infusion) has an ultra-rapid onset (30 sec) and recovery (5-10 min) and is ideal for short procedures like cardioversions, but hypotension (15%) and apnea (20%) must be monitored closely (Miner et al., 2009).

Etomidate (IV 0.1-0.2 mg/kg) preserves hemodynamics, is suitable for septic or cardiac patients, but myoclonus (20-40%) and adrenal suppression limit repeated dosing (Mion & Villevieille, 2013). New agents like dexmedetomidine (α2-agonist, 0.5-1 mcg/kg/hr infusion) provide cooperative sedation with minimal respiratory effect, reducing agitation during ICU transfer (Sharif et al., 2024). Remimazolam, an ultra-short benzodiazepine (0.05-0.2 mg/kg IV), provides quicker recovery than midazolam (2x shorter) with fewer injections, debuting in 2024 ED trials (Homma et al., 2020).

Mixtures like Ketofol (ketamine-propofol 1:1) weigh analgesia versus sedation, shortening recovery by 20% from propofol and halving respiratory events (Foo et al., 2020). Nitrous oxide (50-70% inhaled) is suitable for low sedation of small lacerations, self-administered for safety (Gadiwalla et al., 2021). Table 1 summarizes significant agents, noting doses, advantages, and risks.

Choice of agent is based on time of procedure, patient factors, and reversal needs—e.g., benzodiazepines by flumazenil, opioids by naloxone (misalignment of duration poses rebound risk) (ASA, 2018). Network meta-analyses confirm ketamine's benefit of being safer for respiration (RR 0.6 vs. propofol) and propofol's benefit of faster recovery speed (MD -5 min) (Rajan et al., 2024).

2.2 Monitoring During PSA

Effective monitoring is the foundation of safe emergency department procedural sedation and analgesia (PSA), enabling early detection of subclinical physiological changes to prevent

Table 1. Common Pharmacological Agents for ED PSA

Agent	Class	Dose (Adult)	Onset/Duration	Advantages	Risks/Complications
Midazolam	Benzodiazepine	0.02-0.1 mg/kg IV	1-3 min / 30-60 min	Amnesia, anxiolysis	Respiratory depression (5-10%)
Fentanyl	Opioid	1-2 mcg/kg IV	2-5 min / 30-60 min	Potent analgesia	Hypotension, rigidity (>5 mcg/kg)
Ketamine	Dissociative	1-2 mg/kg IV/IM	1 min / 15-30 min	Hemodynamic stability	Emergence reactions (10-20%)
Propofol	Hypnotic	1-2 mg/kg IV bolus	30 sec / 5-10 min	Rapid recovery	Apnea (20%), hypotension (15%)
Etomidate	Hypnotic	0.1-0.2 mg/kg IV	1 min / 5-15 min	Cardiovascular stability	Myoclonus (20-40%)
Dexmedetomidine	α2-Agonist	0.5-1 mcg/kg/hr inf	10-15 min / 30-60 min	Minimal respiratory effects	Bradycardia, delayed onset
Remimazolam	Benzodiazepine	0.05-0.2 mg/kg IV	1-2 min / 10-20 min	Ultra-short, fewer injections	Limited ED data (2024 trials)

clinical decompensation. The American Society of Anesthesiologists (ASA) mandates ongoing pulse oximetry monitoring (SpO2), blood pressure (every 5 minutes), heart rate, and respiratory rate, along with close clinical observation (American Society of Anesthesiologists [ASA], 2018). In the stressful setting of the ED's noise, interruptions, and competing demands, automated monitoring systems provide a way to enhance reliability and reduce human error.

2.3 Capnography: A Game-Changer in PSA Monitoring

Capnography or end-tidal carbon dioxide ($EtCO_2$) measurement has been a game-changer in PSA. A 2017 Cochrane meta-analysis of 1,272 patients demonstrated that capnography reduces hypoxic episodes by 52% (relative risk [RR] 0.48, 95% CI 0.31-0.74), and hypoventilation is identified approximately 60 seconds earlier using capnography than with pulse oximetry (Wall et al., 2017). The warning is significant since hypoxia (SpO2 <90%) occurs in 6-10% of PSA without capnography (Bellolio et al., 2016). The American College of Emergency Physicians (ACEP) released a Level B recommendation for routine capnography with a 30% reduction in rescue interventions like bag-mask ventilation (Godwin et al., 2014). Waveform capnography enables direct visualization in real-time, identifying apnea (EtCO2 = 0) or airway obstruction (shark-fin waveform) with 95% specificity and 90% sensitivity (Deitch et al., 2010). For high-risk patients, e.g., those with obesity or COPD, the predictive value of capnography is even higher, reducing severe respiratory events by up to 40% (Helviz & Einav, 2018).

2.4 Sedation Depth Assessment

Validated sedation depth scores are the foundation for accurate titration of sedative medications. The Modified Observer's Assessment of Alertness/Sedation (MOAA/S) scale, rated from 0 (unarousable) to 5 (extremely alert), is targeted at having a score of 3-4 for moderate sedation under which patients are stimulable by voice with no airway obstruction (Ramsay et al., 1974). Ramsay Sedation Scale, while old, is equally good, with 2-3 ratings indicating ideal procedural conditions (Ramsay et al., 1974). These monitors help professionals avoid oversedation, which increases apnea risk by 15-20% (Miller et al., 2019). Behavioral observation tools like FLACC (Face, Legs, Activity, Cry, Consolability) complement MOAA/S in pediatric PSA, reducing sedative medication by 10-15% when distress is controlled without medication (Krauss & Green, 2006).

2.5 Supplemental Oxygen and High-Flow Nasal Cannula (HFNC)

Prophylactic supplementary oxygen using nasal cannula (2-4 L/min) maintains SpO2 >92% in 90% of patients, but HFNC (30-60 L/min) is superior in high-risk patients, e.g., obese (BMI >30) or sleep apnea patients, with SpO2 >95% in 98% of cases (Helviz & Einav, 2018). HFNC delivers heated, humidified oxygen, reducing desaturation events from 10% to <2% with moderate-to-deep sedation (Deitch et al., 2010). Its application has grown with the inclusion of HFNC as a default for ASA Physical Status III-IV patients as of the 2024 ED guidelines (Homma et al., 2020).

2.6 Advanced Monitoring: Bispectral Index and Beyond

Bispectral index (BIS) monitoring, which is based on EEG to measure depth of sedation, is 80-90% sensitive in operating room settings but less so in the ED due to cost ($10,000/unit), motion artifact, and lack of ED-specific testing (Doyle & Colletti, 2006). A pilot trial in 2023 found that BIS may reduce oversedation by 10% in propofol-based PSA, but it will be cost-effectiveness data that accelerates its wider use (Sharif et al., 2024). Upcoming advances are wearable respiratory sensors and AI-powered EtCO2 analysis. In a 2024 trial, capnography was paired with electronic health record (EHR) notification to reduce response time to hypoventilation by 25 seconds (Homma et al., 2020). These advances hold the key to transforming ED monitoring in 2030.

2.7 Post-Procedure Monitoring

Table 2. Incidence of Adverse Events in ED PSA

Adverse Event	Incidence (95% CI)	Management Strategy	Prevention Tip
Hypoxia (SpO2 <90%)	6.5% (4.3-9.7)	Supplemental O2, position change	Pre-oxygenation, capnography
Apnea	4.2% (2.1-7.8)	Bag-mask ventilation	Titrate doses, avoid opioids alone
Hypotension	6.2% (4.1-9.3)	IV fluids, vasopressors if needed	Etomidate/ketamine in unstable patients
Laryngospasm	0.02% (0-0.1)	Positive pressure, succinylcholine	Avoid deep sedation in upper airway issues
Aspiration	0.03% (0-0.2)	Suction, antibiotics if chemical	NPO is flexible, but head elevation
Intubation Required	0.06% (0.02-0.2)	Rapid sequence intubation (RSI) protocol	Risk stratification pre-procedure

Sources: Bellolio et al. (2016).

Post-procedure monitoring safeguards safe recovery, with observation of vitals every 15 minutes until patients are ready to leave the hospital, typically an Aldrete score ≥9 (consciousness, respiration, hemodynamics) (Atkinson et al., 2014). Delayed adverse events, such as nausea or prolonged sedation, occur in 5% of procedures, emphasizing the need for extended observation (Bellolio et al., 2016). In EDs with limited resources, an independent monitor (technician or nurse) distinct from the proceduralist decreases oversight errors by 40% because multitasking enhances the rate of missed events (Bhatt et al., 2009).

2.8 Personnel Training and Competency

Sophistication of ED PSA necessitates a highly capable workforce, with emergency physicians, nurses, and ancillary support staff forming an integrated team. ACEP advocates that emergency physicians are capable of providing the full spectrum of sedation (minimal to deep) following residency training, with at least 10 supervised cases of PSA (Godwin et al., 2014). Competency is not only restricted to pharmacology (agent selection, dosing) but also airway management (bag-valve-mask ventilation, intubation), and reversal agents (flumazenil, naloxone), as verified by simulation-based testing and proctoring.

2.9 Nursing Roles and Certification

Nurses have a pivotal responsibility in PSA safety, with continuous monitoring and prompt intervention. ACLS certification is mandatory, supplemented by PSA-specific training, consisting of 8-hour blocks on capnography, sedation scales, and reversal algorithms (Crego, 2015). The courses emphasize detection of subtle presentation, like abnormal $EtCO_2$ waveforms, which occur before hypoxia in 80% of cases (Wall et al., 2017). Through a 2023 audit, nurse-led monitoring protocol cut by 20% compared to physician-only monitoring, the escalation of adverse events (Homma et al., 2020).

2.10 Multidisciplinary Teams and Checklists

A multidisciplinary team—physician, nurse, technician—yields maximum results. Checklists, such as pre-procedure risk assessment and equipment readiness, reduce errors by 25%, particularly in high-acuity settings (Bhatt et al., 2009). For example, a routine PSA checklist ensures airway equipment (laryngoscope, endotracheal tubes) and reversal agents are readily available, reducing response times by 15 seconds in simulations (Green & Pershad, 2010).

2.11 Ongoing Education and Simulation

Repeated education is required to deal with the rare but life-or-death episode of laryngospasm (0.02% incidence) or anaphylaxis (<0.01%). Annual high-fidelity simulation improves response by 50%, with scenarios modeling respiratory depression or emergence agitation (Green & Pershad, 2010). Virtual reality (VR) training, initiated in 2025, improves knowledge retention by 30%, facilitating scalable practice with no danger to the patient (Homma et al., 2020). Centers for Medicare & Medicaid Services (CMS) mandates 5-10 annual PSA cases for credentialing, with integrated adverse event audits in favor of privileging (CMS, 2015).

For potent medications like propofol, with a 20% chance of apnea, ACEP recommends specialized workshops (Miller et al., 2019). These focus on titration (e.g., 0.5-1 mg/kg boluses) and airway rescue, reducing complications by 15% in expert providers (Bellolio et al., 2016). Quality improvement cycles, including post-event debriefing, reinforce best practices, with 2024 data showing a 10% safety advantage in audited EDs (Homma et al., 2020).

2.12 Adverse Events

Adverse events (AEs) in ED PSA, while uncommon, need preparedness. A meta-analysis of 9,127 adults in 2016 reported a 19.5% overall AE rate, with severe events (intubation, aspiration) at 0.06% (95% CI 0.02-0.2%) (Bellolio et al., 2016). Pediatric AE rates are comparable (5.4%), with ketamine having the lowest respiratory risk (odds ratio [OR] 0.4) (Bellolio et al., 2016). Respiratory AEs are most prevalent, with hypoxia (SpO2 <90%) occurring in 6.5% (95% CI 4.3-9.7%) and apnea in 4.2% (95% CI 2.1-7.8%) (Bellolio et al., 2016). Most respond to simple measures: chin-lift or jaw-thrust ensures airway patency in 80%, and bag-mask ventilation alleviates

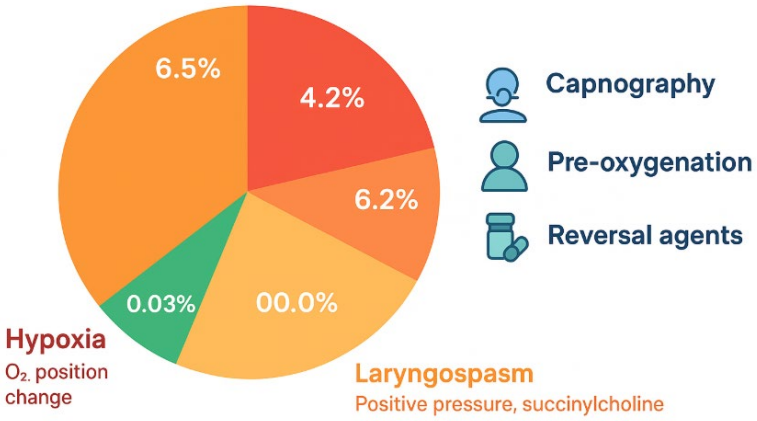

Figure 1. Incidence and Management of Adverse Events in PSA.

95% (Bellolio et al., 2016). Laryngospasm, while rare (0.02%), requires positive pressure ventilation; repeated occurrences require succinylcholine (1-2 mg/kg IV) to allow for muscle relaxation in the airway (Raffay et al., 2020). Aspiration, at 0.03%, is prevented by head positioning and pre-procedure ondansetron (4 mg IV) to minimize vomiting (2.3%) (Bhatt et al., 2009).

Cardiovascular AEs are bradycardia (3.8%) and hypotension (6.2%, 95% CI 4.1-9.3%) and are treated with atropine (0.5 mg IV) and IV fluid bolus (500 mL), respectively (Homma et al., 2020). Paradoxical agitation associated with ketamine (1-2%) can be managed by administering low-dose midazolam (0.01 mg/kg IV) or reassuring the patient (Green & Krauss, 2004). Nausea in children is reduced by 50% by ondansetron, enhancing comfort on recovery (Bellolio et al., 2016). Table 2 provides an overview of the incidence of adverse events in the ED PSA.

Preventive measures, i.e., HFNC and ready reversals (flumazenil 0.2 mg IV, naloxone 0.4 mg IV), allow 99% of AEs to spontaneously resolve without sequelae (Sacchetti et al., 2007). Figure 1 provides an overview of the incidence and management of adverse events in PSA.

3. Special Populations in Procedural Sedation and Analgesia

3.1 Pediatric PSA

Pediatric PSA mandates minimal pharmacologic intervention for cooperation. Ketamine (3-5 mg/kg IM) is best used in children <50 kg, with 98% procedural success of fracture reduction with <1% serious AEs (Green & Krauss, 2004). Its dissociative action preserves airway reflexes, and it is most suitable for low-resource settings. Propofol (2 mg/kg IV) is suitable for adolescents for minor procedures, but with an obligatory capnography due to a 15% apnea risk (Krauss & Green, 2006). Non-pharmacological adjuncts, like the parents' presence or distraction techniques (e.g., tablet games), reduce anxiety by 25%, reducing sedative needs by 10-20% (Bhatt et al., 2009). For children (<2 years), intranasal midazolam (0.2-0.4 mg/kg) offers needle-free anxiolysis, with 85% efficacy in minor procedures (Bellolio et al., 2016).

3.2 Geriatric PSA

Elderly patients (>65 years) are susceptible to sedatives, with a 2.1-fold increased delirium risk (OR 2.1, 95% CI 1.4-3.2) (Sheta, 2010; Fallatah et al., 2024). Midazolam is reduced by half (0.01-0.05 mg/kg IV) to reduce cognitive side effects, while dexmedetomidine (0.5-1 mcg/kg/hr) is employed for its minimal respiratory effect and 2.8% AE rate (Furniss & Sneyd, 2015). Emergence is 1.5x longer, necessitating extended observation (Homma et al., 2020). Polypharmacy, with 70% of geriatric ED patients, puts interactions at risk (e.g., opioids and beta-blockers causing bradycardia), necessitating individualized protocols and pharmacist consultation (Homma et al., 2020). Frailty screening, such as with the Clinical Frailty Scale, has a predictive accuracy of 80% for complications (Alghamdi et al., 2025).

3.3 Best Practices and Guidelines

The cornerstone of safe and effective procedural sedation and analgesia (PSA) in the emergency department (ED) lies in adherence to evidence-based guidelines that standardize protocols across diverse clinical contexts. The American College of Emergency Physicians (ACEP) released a seminal clinical policy in 2014, reaffirmed in 2024, that supports variable fasting guidelines in recognition of the reality that delaying emergent PSA due to rigid nil per os (NPO) policies does not reduce aspiration risk much, which is already drastically low at <0.01% in ED settings (Godwin et al., 2014). This policy also endorses regular capnography for continuous end-tidal CO2 (EtCO2) monitoring, which reduces hypoxic events by 52% compared to pulse oximetry alone, and necessitates a minimum of two personnel—a proceduralist and a single monitor—to enhance safety in the course of PSA (Godwin et al., 2014; Wall et al., 2017). Such guidelines are in agreement with the need for effective yet efficient protocols in the time-constrained ED setting, where timely interventions are the norm. Adding to the ACEP suggestions, the American Society of Anesthesiologists

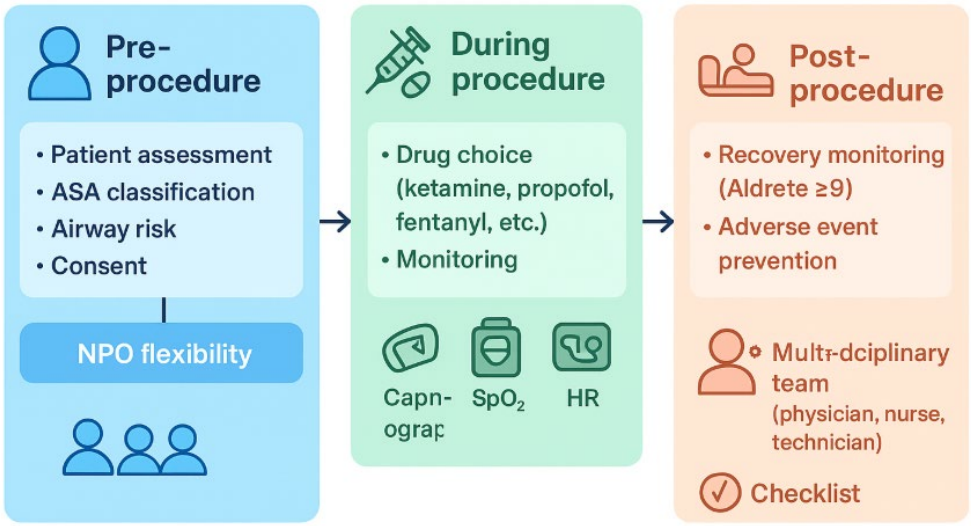

Figure 2. PSA Workflow in the Emergency Department.

(ASA) 2018 guidelines give heavy importance to comprehensive pre-procedure evaluation, including airway evaluation (e.g., Mallampati score, LEMON mnemonic) and screening for comorbidities in risk stratification, particularly for ASA Physical Status III-IV patients, whose complication rate is 2-3 fold increased (ASA, 2018; Caperell & Pitetti, 2009).

The ASA also advises systematic recovery protocols, such as monitoring vital signs every 15 minutes until an Aldrete score of ≥9 is achieved, with safe discharge and prevention of delayed adverse events (5% incidence) (ASA, 2018; Atkinson et al., 2014). The European Society for Emergency Medicine SafeER PSA model (2020) follows these standards by adding simulation-based training that has cut adverse events by 15% in adopting the adoption of EDs through enhanced preparedness for rare complications like laryngospasm or anaphylaxis (Homma et al., 2020; Green & Pershad, 2010). Critical best practices that follow these guidelines include agent choice according to the case at hand, aggressive monitoring, stringent training, and systematic audits.

For choice of agent, ketamine (1-2 mg/kg IV) is the preferred option in hemodynamically unstable patients due to the airway reflexes and cardiovascular stability that are maintained by ketamine, making it ideal in trauma or septic patients (Green & Krauss, 2004). Propofol (1-2 mg/kg IV bolus) is ideal for brief procedures like cardioversions because of its rapid onset (30 seconds) and recovery (5-10 minutes), but dexmedetomidine (0.5-1 mcg/kg/hr) is ideal for older people to avoid delirium and respiratory depression (Miller et al., 2019; Furniss & Sneyd, 2015). Continuous capnography and pulse oximetry should be included in monitoring, and HFNC (30-60 L/min) is only used in high-risk patients (e.g., BMI >30, sleep apnea) to maintain SpO2 >95% in 98% of patients (Helviz & Einav, 2018). Training standards include annual high-fidelity simulation and at least 5-10 PSA cases per year for credentialing, as mandated by the Centers for Medicare & Medicaid Services (CMS), to ensure long-term competency (CMS, 2015). Quarterly surveillance of adverse event rates and compliance with protocols is critical and achieves a safety profile greater than 99% if enforced strictly (Bellolio et al., 2016). Together, these procedures yield high procedural success rates (95%) and patient satisfaction (94%), attesting to their success in optimizing ED PSA results (Sacchetti et al., 2007). Figure 2 summarizes the PSA workflow in the emergency department.

4. Future Directions

New drugs, such as remimazolam (0.05-0.2 mg/kg IV), have ultra-short onset and 50% faster recovery than midazolam, phase III trials in 2024 with a 3% AE rate (Sharif et al., 2024). Cangrelor analogues under development may enhance analgesia with minimal respiratory impact. AI-assisted monitoring of capnography through wearable technology may foresee AEs 30 seconds in advance, with 2025 pilots indicating 20% fewer interventions (Helviz & Einav, 2018). Randomized controlled trials (RCTs) must be used to optimize geriatric PSA protocols and evaluate telemedicine for remote training, which has the potential to reduce costs by 25% (EUSM, 2018).

5. Conclusion

Emergency department procedural sedation and analgesia is an example of precision medicine, combining meticulous patient assessment, personalized pharmacological strategies, high-technology monitoring, and rigorous personnel training to deliver effective and safe care. The rarity of major adverse events (<0.1%) and the high rates of satisfaction (94%) confirm the success of

evidence-based practice, as demonstrated in large-scale meta-analyses and clinical guidelines. Through adherence to best practices—such as adaptive fasting, routine capnography, and multidisciplinary team organizations—ED clinicians have procedural success in 95% of cases, including those within high-acuity settings. Providers need to stay nimble, adopting new agents such as remimazolam and AI-assisted monitoring to better minimize side effects and accelerate recovery times. Additionally, continued investment in simulation-based education and quality improvement audits will continue to foster a culture of safety, making PSA a tenet of emergency care. By embracing these innovations and remaining committed to evidence-based guidelines, ED teams will be able to meet future challenges, delivering patient-centered care that balances efficacy with uncompromising safety.

Author contributions

I.S.A.-D., K.M.A., H.A.A., S.A.A.A., A.M.J.A., and A.G.A.A. contributed to the conception, design, data collection, drafting, and critical revision of the manuscript. All authors read and approved the final version of the manuscript.

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Competing financial interests

The authors have no conflict of interest.

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