

Managing Propofol-Induced Hypoventilation

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Editor's Note: The *Expert Clinical Management* series consists of shorter, practical review articles focused on the optimal approach to a specific sign, symptom, disease, procedure, technology, or other emergency department (ED) challenge. These articles, typically solicited from recognized experts in the subject area, will summarize the best available evidence relating to the topic while including practical recommendations when the evidence is incomplete or conflicting.

SEE EDITORIAL, P. 61.

INTRODUCTION

Propofol has rapidly become the preferred deep sedation agent in North American EDs, with ample literature validating its safety and efficacy¹⁻⁵ and a level A endorsement from the American College of Emergency Physicians.¹

We discuss propofol-induced hypoventilation in terms of pre-sedation preventive measures, intra-sedation preventive measures, and acute management. We will assume proficiency with standard ED deep sedation care and an understanding of propofol pharmacology, items now routinely part of the curricula of emergency medicine residencies and pediatric emergency medicine fellowships.

PRESEDATION PREVENTIVE MEASURES

Patient Selection

Anticipate that patients who are at extremes of age, are debilitated, are obese, or have substantial underlying illness will be more prone to hypoventilation and that their time to desaturation will be shorter.³ The elderly require lower propofol doses to achieve a given sedation depth and desaturate more frequently despite lower doses.⁶ Examine the neck, mouth, and airway of each patient to assess the difficulty of bag-valve-mask-assisted ventilation, should it become necessary.

Patients with substantial risk factors can be referred to the operating room, when possible. Others can be managed with greater reliance on local or regional anesthesia and a lighter target sedation level. Another cautionary measure would be having a

separate procedural physician, such that the emergency physician can focus on monitoring and ventilatory management.

Avoid Opioid Coadministration

The concurrent administration of propofol and opioids should be avoided because they potently synergize their respiratory depressant effects.⁷ One common strategy is to attend to analgesia during the preprocedure phase, titrating opioids early to attain complete or substantial pain relief. One can then set up for the procedure and administer propofol as a single agent 15 or more minutes later once peak opioid levels have passed.³

A second strategy is to substitute dissociative ketamine as the analgesic, thus avoiding concomitant opioids. Adding ketamine to propofol ("ketofol") decreases the amount of propofol required for effective sedation, but has not been shown to decrease the frequency of respiratory depression relative to propofol alone.⁸ Pretreatment with midazolam is not routinely recommended because recovery agitation, a known adverse effect of ketamine, is uncommon with ketofol, warranting treatment in just 4% of adults.⁸ Ketamine can be dosed independently (commonly 0.3 to 0.5 mg/kg intravenously) in advance of titrated propofol, or as a single-syringe mixture of ketamine and propofol.⁸

Regardless of strategy, propofol is a potent amnestic^{7,9} and the coadministration of opioids with propofol does not decrease recall or catecholamine response.¹⁰ Currently, the clinical importance of incomplete analgesia at sedation is unknown.

Preoxygenation

Whenever possible, patients should receive oxygenation with a high-flow mask for 3 or more minutes before propofol administration.¹¹ Such hyperoxygenation provides a reserve that would delay oxygen desaturation should hypoventilation ensue.^{12,13}

INTRASEDATION PREVENTIVE MEASURES

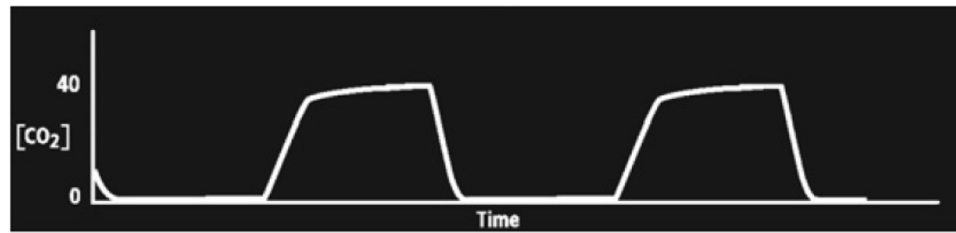
Supplemental Oxygen

Maintenance of high-flow oxygen throughout sedation has been shown to decrease the frequency of hypoxia.¹³

Titration

Titrate propofol carefully with the intent to minimize rapid swings in consciousness. Recognize the stair-stepping phenomenon, ie, that additional doses will provide progressively more potent effect because of accumulating propofol in the brain.¹⁴

Normal ventilation, showing the characteristic wave form for each exhalation.



Onset of propofol-induced hypopneic hypoventilation – respiratory depression during which the exhaled CO₂ concentration decreases due to shallow, low tidal volume breathing.



Periodic breathing, in which propofol-induced respiratory depression is accompanied by brief apneic pauses, which may progress to central apnea (flat line pattern).



Figure. Capnographic changes with propofol-induced hypoventilation. Images reproduced from Krauss and Hess,²³ to which readers are referred for a detailed review of capnography interpretation for procedural sedation. [Figure used with permission.]

Dosing

Hypoventilation is more frequent with higher propofol dosing and more rapid administration.^{3,15} The strategy of administering smaller doses slowly should reduce the risk of hypoventilation and is preferred for patients at higher risk.

Most studies of ED propofol describe an initial dose of 1 mg/kg, followed by 0.5 mg/kg every 3 minutes as needed both for adults and children.^{3,13,16,17} Young children may require higher initial dosing, whereas adults may require less, with one alternative adult strategy starting with 0.25 to 0.5 mg/kg with repeated doses of 0.25 mg/kg every 1 to 2 minutes.¹⁸ For older adults, one anecdotal but easy-to-remember approach is to administer an initial test dose of 100 minus their age, eg, 40 mg in a 60-year-old, 25 mg in a 75-year-old.

Observation

Patients receiving propofol should be carefully observed to identify early signs of hypoventilation, apnea, or airway obstruction, particularly at vulnerable periods such as immediately after drug dosing and after the painful period of a procedure has ceased.³

Capnography

Continuous capnography provides objective breath-by-breath verification of the quality of ventilation, and most

propofol-induced hypoventilation begins first with capnographic abnormalities.^{13,16,17} Capnography detects respiratory depression before its evidence on clinical examination, regardless of whether the sedation provider is an emergency physician^{16,17} or an anesthesiologist.¹⁹

There have been strong arguments both for^{20,21} and against^{20,22} capnography for ED deep sedation, and this debate is beyond the scope of this article. We support this monitoring modality because its addition to standard sedation monitoring will provide the earliest possible warning of potential or impending airway and respiratory adverse events (Figure).²⁰ Deitch et al¹⁷ found that capnography significantly reduced the frequency of hypoxia with propofol, with warnings a median of a full minute before hypoxia developed.

HYPOVENTILATION MANAGEMENT

Once hypoventilation is noted—whether in the form of decreased respiratory rate, shallow chest wall motion on clinical examination, or capnographic abnormality—the emergency physician must assess its current seriousness and risk of deterioration.

When accompanied by signs of partial or complete airway obstruction, each of the strategies below should also include airway repositioning and jaw thrust. Partial airway obstruction and laryngospasm may not always be clinically obvious because

normal respiratory effort may be maintained. Should airway obstruction or laryngospasm not respond to airway maneuvers, early assisted ventilation may be warranted to prevent clinical deterioration.

Oxygen Desaturation With Apnea or Hypoventilation

Should the oxygen saturation decrease below 90% or be rapidly declining, the emergency physician should provide vigorous stimulation and be prepared to promptly initiate ventilatory assistance with a bag-valve-mask. When assisted ventilation is provided, care should be taken to use the minimum positive pressure needed to achieve sufficient tidal volume because undue insufflation of the stomach may provoke vomiting and aspiration.

The need for prolonged ventilatory assistance or intubation is unlikely, especially in the preoxygenated patient, because with typical ED deep sedation dosing, apnea is usually brief and self-resolving.¹²

Apnea With Normal Oxygenation

Should apnea or wholly ineffective respirations occur without oxygen desaturation, positive pressure ventilation should be avoided because its risks (eg, gastric insufflation) outweigh its benefits for nonfasted ED patients. Apnea, even without desaturation, signals a state in which there is a significant risk of aspiration should vomiting occur. Airway repositioning may improve ineffective respirations, and procedural or other stimulation may enhance ventilatory effort.

Studies of preoxygenation have shown that, on average, 6 minutes of apnea is required before a healthy adult or adolescent desaturates to less than 90%.¹² This duration is 1 to 2 minutes in infants and 2 to 4 minutes in healthy children.¹² Accordingly, when a hyperoxygenated patient inadvertently develops apnea with propofol, there is a strong probability that it will resolve and spontaneous effective respirations will resume before the onset of any clinically important oxygen desaturation. A period of attentive watchful waiting without airway intervention is thus preferred, lasting until either effective ventilatory effort resumes (usual) or oxygen desaturation ensues (rare).

During such watchful waiting, capnography will signal immediately the loss of ventilation and when spontaneous respirations have resumed and are strengthening, an advantage over subjective appraisal of chest wall motion.

Hypoventilation With Normal Oxygenation

Should there be clinical or capnographic evidence of depressed but not ineffective respirations (ie, disordered breathing patterns such as hypopneic hypoventilation or periodic breathing, or decreased respiratory rate or tidal volume on clinical examination) without oxygen desaturation, further doses of propofol should be withheld, with watchful waiting until the situation stabilizes. Patient stimulation may be considered.

Subclinical Respiratory Depression

When capnography shows evidence of respiratory depression despite active chest wall motion and normal oxygenation, such subclinical respiratory depression should be carefully monitored and additional propofol doses withheld or titrated carefully. Patient stimulation may be considered.

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GERIATRICS/REVIEW ARTICLE

Older Patients in the Emergency Department: A Review

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Older patients account for up to a quarter of all emergency department (ED) visits. Atypical clinical presentation of illness, a high prevalence of cognitive disorders, and the presence of multiple comorbidities complicate their evaluation and management. Increased frailty, delayed diagnosis, and greater illness severity contribute to a higher risk of adverse outcomes. This article will review the most common conditions encountered in older patients, including delirium, dementia, falls, and polypharmacy, and suggest simple and efficient strategies for their evaluation and management. It will discuss age-related changes in the signs and symptoms of acute coronary events, abdominal pain, and infection, examine the yield of different diagnostic approaches in this population, and list the underlying medical problems present in half of all "social" admission cases. Complete geriatric assessments are time consuming and beyond the scope of most EDs. We propose a strategy based on the targeting of high risk patients and provide examples of simple and efficient tools that are appropriate for ED use. [*Ann Emerg Med.* 2010;56:261-269.]

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