



Propofol for adult procedural sedation in a UK emergency department: safety profile in 1008 cases

B. Newstead¹, S. Bradburn, A. Appelboom, A. Reuben, A. Harris, A. Hudson, L. Jones, C. McLauchlan, P. Riou, M. Jadav² and G. Lloyd*

Emergency Department, Royal Devon & Exeter NHS Foundation Trust, Barrack Road, Exeter EX2 5DW, UK

¹ Present address: Emergency Department, Plymouth Hospitals NHS Trust, Derriford Road, Crownhill, Plymouth, Devon PL6 8DH, UK

² Present address: Emergency Department, Royal Cornwall Hospital, Truro Cornwall, TR1 3LJ, UK

* Corresponding author. E-mail: gavin.lloyd@nhs.net

Editor's key points

- Propofol administration by non-anaesthetists remains controversial because of safety fears.
- The World SIVA International Sedation Task Force recently developed an adverse event diagnosis and reporting tool.
- This tool was used to evaluate safety among 1008 consecutive emergency department patients sedated with propofol.

Background. Concerns exist regarding the safe use of propofol by Emergency Physicians for procedural sedation. The World SIVA International Sedation Task Force has recently created an adverse event tool, in an effort to standardize reporting. We present a safety analysis of our use of propofol using this tool.

Method. Propofol was given according to a previously published guideline. We analysed our dedicated departmental sedation database between December 2006 and March 2012 and cross-examined the original sedation chart for each case recorded. We stratified the identified adverse events according to consensus agreement.

Results. Of the 1008 consecutive cases, we identified 11 sentinel (5 cases of hypoxia, 6 of hypotension), 34 moderate, 25 minor, and 3 minimal risk adverse events. There were no adverse outcomes.

Conclusions. Our large series of propofol sedations performed by emergency physicians supports the safety of this practice. The sentinel adverse event rate of 1% that we identify prompts review: we will in future emphasize adherence to the reduced 0.5 mg kg⁻¹ propofol dose in the elderly, and reconsider our use of metaraminol. We believe that our application of the World SIVA adverse event tool sets a benchmark for further studies.

Keywords: anaesthetics i.v.; governance; propofol; sedation

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The use of propofol for procedural sedation in emergency medicine was first reported in 1995.¹ Studies have since demonstrated a safety profile equivalent to benzodiazepine/opiate combinations²; and its safe use by emergency physicians has been established³ and promoted.⁴ A specific policy for propofol sedation was introduced by the American College of Emergency Physicians in 2007.⁵

We developed a departmental propofol guideline for the sedation of selected adults in 2005, recording its use on a dedicated electronic database from December 2006. We have demonstrated that propofol is effective for prosthetic hip relocation in the emergency department (ED) with a successful hip prosthetic relocation rate of 96%,⁶ comparing favourably with 62% in another large series using midazolam and morphine.⁷

Propofol use by emergency physicians in the UK nevertheless remains controversial.⁸ Barriers to its use in emergency medicine internationally have been eloquently and pragmatically discussed,^{9–10} and are largely focused on patient safety. Meaningful comparison of adverse event rates

between studies is however limited by variation in the defined outcome measures used. For example, hypoxia is defined as oxygen saturations <93%,¹¹ <90% for >10 s¹² and by a selection of interventional criteria¹³ in just three recent emergency medicine publications. Standardization in reporting adverse events has been recommended,^{14–15} latterly by the World SIVA International Sedation Task Force.

In this study, we report a safety analysis of our use of propofol, using the consensus-based World SIVA adverse sedation event reporting tool (Supplementary Appendix 1).

Methods

Our ED saw ~60 000 (2007) to 78 000 (2012) adult patients a year. For the purposes of procedural sedation, we initially gave propofol according to our published guideline,⁶ an amended version of which we introduced in 2008 (Supplementary Appendix 1) and a summary of which appears in Table 1. For those patients with fracture, dislocation or both, we supplement i.v. morphine given by paramedic crews with further boluses

Table 1 Summary of propofol sedation guideline

- Perform an airway assessment
- Fasting assessment
- Consider the risk/benefit for at risk patients
- Monitor oxygen saturation, electrocardiogram, respiratory rate, noninvasive blood pressure
- Equipment check
- Patient consent
- Pre-oxygenation with $F_{I_{O_2}}$ of 1.0 for 3 min
- 1 mg kg⁻¹ i.v. propofol bolus
- Incremental top ups of 0.25 mg kg⁻¹ propofol as required

according to pain score and response, before radiological investigation.

We use the ASA's guideline on fasting requirements for elective surgery (adopted by the Royal College of Anaesthetists). On occasions, we allow flexibility in clinically urgent cases (e.g. unstable patient requiring cardioversion, joint dislocation with neuropraxia) as previously presented in a consensus-based clinical practice advisory.¹⁶ We routinely risk assess each patient's airway. We use the ASA's grading informally; we carefully consider the risk and benefit of procedural sedation with propofol, vs other options, including minimal/moderate sedation with other agents (including 70% nitrous oxide) and general anaesthesia in theatre. Those patients receiving propofol are continuously monitored with pulse oximetry, respiratory rate (via transthoracic impedance trace) and ECG, and non-invasive blood pressure is measured every 5 min. We introduced nasal capnography in late 2011.

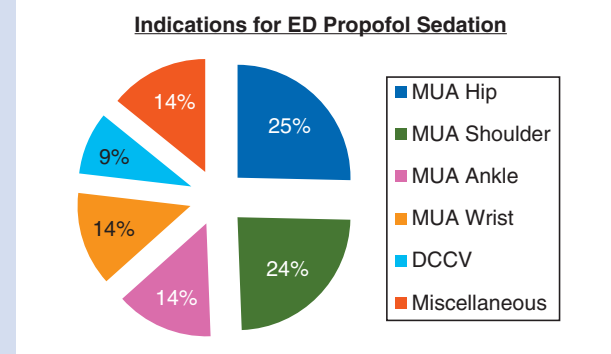
Propofol is used under the direct observation of senior emergency physicians in whom advanced airway management is part of their training. We have previously described specific training in its use for sedation,^{6,8} a combination of a paper-based tutorial and hands-on simulated scenarios, with particular attention given to the management of adverse events (hypoxia and hypotension) and inadequate sedation. Each sedation episode is recorded on the dedicated database, with emphasis on adverse events (problem, time, intervention, response and time to full recovery).

We retrospectively applied the World SIVA adverse event reporting tool to the electronic database from its inception to March 2012. In addition, one of us cross-examined the original sedation chart for each patient, in an attempt to detect adverse events not recorded electronically. Three of us scrutinized cases in which an adverse event had been identified and stratified these according to consensus agreement.

We confirm that our research and development directorate deemed that this study did not require patient consent or formal ethical review, as per the governance arrangements for Research and Ethics Committees in the UK.

Results

We identified and analysed 1008 patients. We failed to retrieve the original sedation chart in 132 cases, either because the chart had not been completed, had not been scanned, or

**Fig 1** Indications for ED propofol sedation

incorrect patient details had been recorded on the database. None of these patients had any adverse event recorded in the electronic database or in the clinical notes. Of the 1008, the patients' age ranged from 15 to 97 years (mean 58). The indication for sedation is demonstrated (Fig. 1). The mean total dose delivered was 1.47 mg (estimated) kg⁻¹.

We identified 73 adverse events and stratified 11 of these as sentinel, 34 as moderate, 25 as minor, and 3 as a minimal risk adverse event. Of the sentinel cases, five related to hypoxia and six to hypotension requiring the need for pressor treatment. We describe each sentinel case in detail.

- (1) A 30-yr-old post-ictal male with a painful shoulder; X-ray confirmed a fracture/dislocation. He was given 10 mg i.v. morphine by the paramedic crew and a further 5 mg in the ED. He had been starved from the evening before. A total dose of 2 mg kg⁻¹ of propofol was administered in the titrated aliquots of 1, 0.5 and 0.5 mg kg⁻¹ to achieve adequate sedation for reduction. After the third dose, the patient had a period of hypoxia lasting 2 min with the lowest oxygen saturation recorded as 86%. This was responsive to airway re-positioning manoeuvres and insertion of an oropharyngeal airway.
- (2) An 85-yr-old female with a dislocated shoulder. She was previously independent with a background history of arthritis and fluid retention for which she was taking furosemide. She had been given 7 mg i.v. morphine by the paramedic crew. Clinically she was in uncomplicated atrial fibrillation, confirmed by ECG. She had been starved from 7 h before hospital presentation. She was given a propofol bolus of 0.75 mg kg⁻¹ and briefly desaturated to 70%, responding in <60 s to bag mask ventilation.
- (3) A 48-yr-old alcoholic with unstable ventricular tachycardia and bilateral, evident leg ischaemia. His respiratory rate was 40 bpm, oxygen saturation 90%, systolic blood pressure 160 mm Hg, capillary refill 4 s, lactate 12 mmol l⁻¹, GCS 13 (combative). He was given 1 litre saline promptly and oxygenated as best possible. For the purposes of synchronized DC cardioversion, he

- was given 20 mg increments of propofol, receiving 100 mg over 5 min. A single 200 J shock effected sinus rhythm. He subsequently vomited and was tipped head down, turned on his side and suctioned, maintaining an oxygen saturation of ~85%. On waking the patient became increasingly restless. He tolerated the oxygen mask poorly and began removing items of monitoring. He was subsequently given a rapid sequence induction to allow further investigation and management. His computed tomography demonstrated complete occlusion of his distal aorta, most likely embolic. It also showed bilateral patchy consolidation and interstitial thickening, with the radiological differential diagnosis of infection with or without aspiration and probably a degree of pulmonary oedema. He was ventilated overnight after saddle embolectomy and bilateral fasciotomies, and subsequently discharged.
- (4) A previously well 23-yr-old woman with a unilateral fractured humerus and fracture/dislocation wrist. She had fallen from a horse and received 25 mg of morphine in titrated doses from the paramedics. She was given a further 20 mg of titrated morphine in the ED. She was subsequently given 1, 0.5 and 0.5 mg kg⁻¹ propofol boluses to achieve adequate sedation. She suffered 2 min of apnoea requiring bag valve mask ventilation, maintaining saturation of 100% throughout.
 - (5) An 86-yr-old woman with a dislocated shoulder. She had a background history of fluid retention, taking 20 mg furosemide daily. She had been given 7 mg morphine by the paramedic crew. After 1 mg kg⁻¹ of propofol, she briefly desaturated to 70% necessitating bag valve mask ventilation with prompt recovery.
 - (6) A 78-yr-old woman with a dislocated hip prosthesis. She had a background history of type II diabetes, hypertension, ischaemic heart disease, congestive cardiac failure, asthma, and a pacemaker. Her regular medication included spironolactone, furosemide, and nitrates. She received 10 mg titrated i.v. morphine 2 h before sedation. She was pre-loaded with 1 litre normal saline. After propofol at a dose of 0.75 mg kg⁻¹, her blood pressure (BP) decreased from 101/46 to 85 systolic. She received 0.25 mg metaraminol and her BP returned to baseline over 5–10 min.
 - (7) An 88-yr-old woman in atrial fibrillation with a fast ventricular response. She had a background history of type II diabetes and hypertension. She was pre-loaded with 250 ml of normal saline and then given a dose of 1 mg kg⁻¹ propofol followed by successful DC cardioversion. She remained in sinus rhythm for less than a minute, converting to atrial flutter with 2:1 block, whereupon she was given a further 0.5 mg kg⁻¹ propofol bolus and cardioverted a second time. At this point, her BP decreased to 75 systolic (baseline BP was 106/90); 0.25 mg metaraminol was given which restored her BP in 5 min.
 - (8) A 78-yr-old female with a tibial fracture requiring manipulation. She was known to have ischaemic heart disease and multiple sclerosis. It is unclear whether she was pre-loaded with fluids before the procedure. She was given 1 mg kg⁻¹ propofol. Her baseline blood pressure was 125 systolic, which decreased to 70 systolic with consequent administration of 0.5 mg metaraminol and i.v. fluids. This restored her BP to 100 systolic within 6 min.
 - (9) A 67-yr-old female with a dislocated hip prosthesis. She had a background history of metastatic breast cancer, epilepsy, hypertension, and rheumatoid arthritis. She was given 10 mg titrated i.v. morphine 90 min and again 20 min before sedation. She was pre-loaded with 1 litre saline and given 1 mg kg⁻¹ of propofol. Given a difficult reduction, a second dose of 0.5 mg kg⁻¹ propofol was administered, at which point her BP fell to 60 systolic from a baseline of 100. She was given 0.5 mg metaraminol resulting in a quick recovery. She later had a single run of non-sustained narrow complex tachycardia with no haemodynamic compromise.
 - (10) An 84-yr-old male with a dislocated hip prosthesis. He had a background history of vascular dementia and hypertension for which he was receiving atenolol and furosemide. He had been given 10 mg of titrated i.v. morphine, 2 h before sedation. He was pre-loaded with 1 litre normal saline and then given 1 mg kg⁻¹ propofol. His baseline BP was 130/70 and this decreased to 80/50 shortly after propofol was given. He remained clinically well perfused throughout. He was given 1 mg metaraminol which quickly restored the blood pressure to 140/90.
 - (11) A 61-yr-old male with hyperkalaemia. He had a background of chronic obstructive pulmonary disease, ulcerative colitis, and 'renal problems'. After 4 days of malaise, he collapsed with shortness of breath and chest pain. En route to hospital he had two respiratory arrests requiring bag valve mask ventilation. On arrival in the ED, he was tolerating a Guedel airway with good effect, had a respiratory rate 30, saturations 98%, poor perfusion with cool peripheries, BP 70/40, heart rate 150 beats min⁻¹, and a broad complex tachycardia. He was responsive to voice. His ECG was interpreted as ventricular tachycardia. He was given 25 mg propofol and 1 mg of metaraminol before receiving a 150 J biphasic shock. This effected a decrease in the heart rate to 115 beats min⁻¹ and an increase in BP to 90 systolic. Once his potassium level of 8.4 was identified on blood gas analysis, he improved with a hyperkalaemic treatment strategy.
- Of the 34 patients we categorized as moderate risk adverse events, 28 were as a result of intervening with bag valve mask ventilation. Of these, 7 patients had no decrease in oxygen saturation, 5 had a recorded saturation ≥90% throughout, and 16 had oxygen saturation recorded between 80 and

90% (for <60 s). The remaining six patients with a moderate risk adverse event were as a result of hypotension, requiring the need for a crystalloid bolus. The hypotension documented in all six cases responded within 5 min.

We stratified 25 patients as minor risk adverse events. Three patients had a transient reduction in saturations that required an airway manoeuvre; another 6 had a transient reduction in saturations that spontaneously resolved without intervention. Three patients required an airway manoeuvre for partial obstruction. Three patients had partial obstruction that did not require an airway manoeuvre. Nine patients experienced hypotension (a change of >25% from baseline); all resolved spontaneously. There was one episode of bradycardia with a heart rate of 35 beats min⁻¹ that resolved without intervention. Three patients become agitated; all resolved spontaneously. These were stratified as minimal risk.

Discussion

This study adds to the evidence supporting the safe use of propofol for procedural sedation by emergency physicians. We identify a sentinel adverse event rate of 1.1% (95% CI 0.5–1.7), with no adverse outcomes. The identification of such cases has prompted us to carefully reflect on our practice. We argue that eight cases were preventable. Physiological deterioration in Case 1 could clearly have been avoided by bag valve mask ventilation. Administration of propofol doses in excess of the guideline 0.5 mg kg⁻¹ in two elderly cases (Case 2 and 7—0.75 and 1.0 mg kg⁻¹, respectively) are likely precipitants to the hypoxia encountered. Our use of metaraminol is debatable—arguably the hypotension described in Cases 6–11 may have been similarly transient, without the use of a pressor and had our titration of propofol been more gentle (as per guideline). We further note that, in Case 7, arrhythmia may have played a role in the hypotensive episode. Furthermore, Cases 3 and 11 meet the criteria for a sentinel event before sedation. We considered excluding them, but instead have aimed to transparently assess the sedative use of propofol across the full range of ED presentations. The incidence of hypoxia of 0.5% in this series appears to favourably compare with hypoxia and severe hypoxia rates during (non-cardiac) anaesthesia in adults—6.8 and 3.5%, respectively—identified with electronically recorded pulse oximetry.¹⁷

We recognize limitations to our study:

- retrospective application of an adverse event tool (albeit one created in 2012). We plan prospective use of the same tool.
- (likely) poor recording of prolonged apnoea in the database and sedation charts. It has been our expectation as a group of sedators that propofol causes apnoea, on occasions prolonged, and as a result do not routinely record this. It is why we emphasize the role of pre-oxygenation. We do note that the audit tool that we used captures, as a sentinel event, *oxygen desaturation severe (<75% at any time) or prolonged (<90% for*

>60s), the *possible* significant result of prolonged apnoea.

- the failure to find and cross-examine the original sedation sheet of 132 patients (a departmental governance issue that we will address).
- the lack of formal ASA grading of our patients.

We are pleased to find the recent joint report by the Royal College of Anaesthetists and College of Emergency Medicine supports the use of propofol by trained emergency physicians (<http://www.rcoa.ac.uk/news-and-bulletin/rcoa-news-and-statements/safe-sedation-of-adults-the-emergency-department>). We endorse the need for a robust governance framework—one that attends to physician education, the use of a guideline, patient assessment, preparation, monitoring, the presence of a skilled assistant, mandatory use of a database, and transparent audit.

In conclusion, our large series of propofol sedations performed by emergency physicians supports the safety of this practice. The sentinel adverse event rate of 1% we identify prompts review: we will in future emphasize adherence to the reduced 0.5 mg kg⁻¹ propofol dose in the elderly, and reconsider our use of metaraminol. We believe that our application of the World SIVA adverse event tool sets a benchmark for further studies.

Supplementary material

Supplementary material is available at *British Journal of Anaesthesia* online.

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Declaration of interest

G.L. is a core member of The Royal College of Anaesthetists and The College of Emergency Medicine Working Party on Sedation, Anaesthesia and Airway Management in the Emergency Department.

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