Procedural sedation with propofol for emergency DC cardioversion

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ABSTRACT

Many emergency patients present with cardiac arrhythmias requiring emergency direct current countershock cardioversion (DCCV) as a part of their management. Almost all require sedation to facilitate the procedure. Propofol has been used for procedural sedation in Emergency Medicine since 1995. In 1996, in a review article in *Anaesthesia*, it was recommended as the drug which most closely approaches the ideal agent for DCCV. However, the existing evidence for the dosage requirements and safety of propofol in emergency DCCV is limited. We report a prospective case series of patients who underwent sedation-facilitated DCCV using propofol in the emergency department with both sedation and DCCV delivered by emergency physicians. The results indicate propofol is a safe drug for procedural sedation to facilitate emergency DCCV in patients with an atrial tachyarrhythmia without any evidence of haemodynamic compromise. A dose of 1 mg/kg appears to be safe in the majority of these patients. Using the adverse event reporting tool produced by the World SIVA International Sedation Task Force there were no moderate or sentinel adverse events in these patients. A reduced dose should be considered in older patients to prevent transient complications. Propofol at a dose of 0.5 mg/kg appears to be a safe drug for procedural sedation to facilitate emergent or urgent DCCV in patients with an atrial tachyarrhythmia with evidence of haemodynamic compromise. There were no sentinel adverse events associated with its use. Evidence to support the use of propofol to facilitate emergency DCCV for ventricular tachycardia is limited.

INTRODUCTION

Many emergency patients present with cardiac arrhythmias requiring emergent or urgent direct current countershock cardioversion (DCCV) as a part of their emergency management. Almost all require sedation to facilitate the procedure. Intravenous midazolam or propofol are both commonly used as sedative agents. Propofol is an alkylphenol derivative with some advantages over midazolam as a sedating agent. It has a short onset and recovery time with time to onset 20–40 s (longer in haemodynamically compromised patients) and a 5–10 min duration. This compares with midazolam with a time to onset of 2–3 min and a duration of 45–60 min. Propofol has good amnesic potential and good motion control, and provides good or excellent sedation in nearly 100% of cases. This is comparable with midazolam but the latter risks inducing paradoxical hyperagitation leading to procedure failure. Propofol also has the advantage of increasing emergency physician familiarity with its use.

Propofol does, however, have certain potential disadvantages. Although sedation is a continuum and all sedating drugs are capable of producing the entire spectrum, propofol does have a narrow therapeutic range compared with midazolam. This increases the risk of respiratory depression and induction of anaesthesia. This effect is offset by the significantly shorter duration of action, providing the operator has the appropriate anaesthetic skills and training. More significantly in the specific case of sedation for DCCV, propofol affects haemodynamic parameters with a reduction in mean arterial pressure, peripheral vascular resistance and stroke volume. Propofol-associated hypotension can be significantly more marked than that induced by benzodiazepines especially in haemodynamically compromised patients and/or the elderly. Fortunately, its duration is similar to the duration of the sedating effect.[1]

The existing evidence for dosage and safety of propofol in emergent or urgent cardioversion is limited. In previous studies, patient numbers are small, dosage is poorly reported, and hemodynamic status and premorbid state are either unclear or highly restricted. We report a prospective case series of patients who underwent sedation with propofol to facilitate DCCV in the emergency department (ED) with both sedation and DCCV delivered by emergency physicians from August 2010 to January 2013.

METHODS

The ED at the Royal United Hospital, Bath, sees 70 000 emergency patients per year. Over the last 7 years, a procedural sedation process largely based on the use of propofol has been developed within the ED. More recently, a protocol for early cardioversion of new atrial tachyarrhythmias, similar to the Ottawa Aggressive Protocol,[2] using flecainide and/or DCCV has been developed. Over a period of 30 months between 2010 and 2013, 111 patients required emergency DCCV for new onset atrial tachyarrhythmia or ventricular tachycardia. Patients who presented with no haemodynamic compromise were initially treated with antiarrhythmic drugs at the attending physician's discretion. Haemodynamic compromise was defined by associated shock, myocardial ischaemia, syncope or heart failure as per Advanced Life Support guidelines on peri-arrest arrhythmias.[3]

A standardised procedural sedation protocol (see supplementary appendix) was used with physician choice of propofol dose, although the protocol included advice concerning reduction of dose in the older or haemodynamically compromised patient. As part of this protocol, all patients were

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preoxygenated with high-flow oxygen via a non-rebreathing mask for a minimum of 3 min prior to the procedure and high-flow oxygen was continued until full recovery. Continuous exhaled capnography via a nasal monitor was in place throughout the sedation process. Complications were recorded prospectively and retrospective case note review double checked this record. Absolute numbers were recorded and these were then reviewed using the Quebec Guidelines, consensus-based recommendations for standardising terminology and reporting adverse events for ED procedural sedation. These guidelines use clinician rescue as a means to define clinically relevant complications.[4] Additionally, following the introduction of the World SIVA adverse sedation event reporting tool in 2012, complications were retrospectively and prospectively reviewed using the new terminology and definitions.[5]

The governance arrangements for Research and Ethics Committees in the UK deem that this study did not require patient consent or formal ethical approval.

RESULTS

Atrial tachyarrhythmia

A total of 100 patients with atrial tachyarrhythmia underwent sedation-facilitated DDCV using propofol as the sedating agent (see table 1), and 81% had atrial fibrillation (AF) with a rapid ventricular response (RVR); 77% were haemodynamically stable with 23% compromised by the tachyarrhythmia. The median propofol dose was 1 mg/kg for stable patients and 0.5 mg/kg for compromised patients. This dose was used in all age ranges apart from stable patients over 80 years old where the median dose was reduced to 0.4 mg/kg. DCCV was successful in 98% of patients, though in 5%, there was a rapid reversion to the original tachyarrhythmia. Eighty-seven per cent of the initially haemodynamically stable patients were discharged from the ED with 1% discharged after a short period of observation in the Clinical Decision Unit (CDU); 17% of the initially haemodynamically compromised patients were discharged from the ED, with an additional 22% discharged after a short period of observation in the CDU.

Five per cent of procedures had reported complications. In the initially stable group, 2 patients had transient apnoeas lasting less than 20 s while 1 patient developed transient hypotension. No intervention was required. In the initially compromised group, 2 patients developed hypotension which responded rapidly to a bolus of crystalloid. No patient complained of inadequate sedation. Using the Quebec Guidelines for reporting adverse events for ED procedural sedation, this equates to a 2% complication rate with all complications occurring in the initially haemodynamically compromised group. Using the adverse event reporting tool produced by the World SIVA International Sedation Task Force (ISTF), the three complications in patients in the initially haemodynamically normal group are all classified as minor, while the two complications in the initially haemodynamically compromised group are classified as moderate due to the required interventions.

Cases with a moderate risk adverse event:

A. An 85-year-old man with a history of hypertension, IHD and paroxysmal AF presented with AF with RVR associated with hypotension (SBP 84) and angina. He was assessed as American Society of Anaesthesiologists (ASA) class IV. He was given 0.8 mg/kg propofol and his blood pressure fell to SBP 70, but this responded rapidly to a 500 ml bolus of 0.9% saline. Cardioversion was successful.

Table 1 Atrial tachyarrhythmia

	Stable	Unstable	Total
Patients	77 AF with rapid VR—63 AF with normal VR—3 A flutter with 2 : 1 block—10 A flutter with 3 : 1 block—1	23 AF with rapid VR—18 A flutter with 2 : 1 block—4 Focal atrial tachycardia—1	100
ASA class	Median 1 (Range 1–3)	Mean 2 (Range 1–4)	
Total propofol dose	Median 1.0 mg/kg (Range 0.3–1.5 mg/kg)	Median 0.5 mg/kg (Range 0.3–1.0 mg/kg)	
Age	▶ ≤70 y—48 ▶ 70–79 y—25 ▶ ≥80 y—4	▶ ≤70 y—9 ▶ 70–79 y—7 ▶ ≥80 y—7	
Age versus total propofol dose	▶ ≤70 y—median 1.0 mg/kg (range 0.3–1.0) ▶ 70–79 y—median 1.0 mg/kg (range 0.5–1.0) ▶ ≥80 y—median 0.4 mg/kg (range 0.3–0.8)	▶ ≤70 y—median 0.5 mg/kg (range 0.5–1.0) ▶ 70–79 y—median 0.5 mg/kg (range 0.3–0.8) ▶ ≥80 y—median 0.5 mg/kg (range 0.3–0.8)	
Successful DCCV (%)	73 (95) Total excludes 3 patients with cardioversion followed by rapid reversion to AF	20 (87) Total excludes 2 patient with cardioversion followed by rapid reversion to AF	93 (93)
Outcome (%)	Admission—9 (12)	Admission—14 (61)	23%
	CDU <12 h—1 (1)	CDU <12 h—5 (22)	6%
	Discharged—67 (87)	Discharged—4 (17)	71%
Complications (%)	3 (4) ▶ 15 s apnoea ▶ Transient hypotension (SBP 80 for <60 s) ▶ 20 s apnoea	2 (8) ▶ 2×Hypotension (SBP <70)—responded to 500 mL bolus of 0.9% saline	5 (5)
Quebec criteria complications (%)	0 (0)	2 (8)	2 (2)
World SIVA ISTF adverse events	Minor—3	Moderate—2	

ASA, American Society of Anaesthesiologists; DCCV, direct current ountershock cardioversion; ISTF, International Sedation Task Force.

B. A 56-year-old man with a history of alcohol dependence presented with a focal atrial tachycardia with a ventricular rate of 220/min. He was assessed as ASA class II. He was given 0.5 mg/kg propofol and his blood pressure fell to SBP 70, but this responded rapidly to a 500 mL bolus of 0.9% saline. Cardioversion was successful.

Ventricular tachycardia (VT)

Eleven patients with VT underwent sedation-facilitated DCCV using propofol as the sedating agent (see table 2); 55% were haemodynamically stable, with 45% compromised by the tachyarrhythmia. The median propofol dose was 0.7 mg/kg for stable patients and 0.5 mg/kg for compromised patients. This dose was used in all age ranges apart from stable patients over 80 years old where the median dose was reduced to 0.4 mg/kg. DCCV was successful in cardioverting 100% of patients. All were admitted after cardioversion.

Twenty-seven per cent of procedures had reported complications. In the initially stable group, 1 patient had an apnoea leading to desaturation to an oxygen saturation of <90% which resolved with a short period of bag-valve mask (BVM) ventilation. In the initially compromised group, 1 patient had a transient apnoea lasting less than 20 s and 1 patient developed hypotension which responded rapidly to a bolus of crystalloid. No patient complained of inadequate sedation. Using the Quebec Guidelines for reporting adverse events for ED procedural sedation this equates to an 18% complication rate. Using the adverse event reporting tool produced by the World SIVA ISTF, the 1 adverse event in the initially haemodynamically normal group is classified as moderate due to the need for Bag-Valve-Mask (BVM) ventilation. The 2 adverse events in the initially haemodynamically compromised group are classified as minor and moderate, respectively.

Cases with a moderate risk adverse event:

A. An 82-year-old woman with a history of hypertension presented with VT with no haemodynamic compromise. She was assessed as ASA class IV. She was given 0.25 mg/kg propofol followed by a 0.25 mg/kg top-up. She had an apnoea with desaturation to O_2 saturation 85%. She recovered after BVM ventilation for 60 s. She was successfully cardioverted.

B. An 80-year-old man with a history of IHD and non-Hodgkin's lymphoma presented with VT associated with angina and pulmonary oedema. He was assessed as ASA class III. He was given 0.3 mg/kg propofol and his blood pressure fell to SBP 70 but this responded rapidly to a 500 mL bolus of 0.9% saline. He was successfully cardioverted.

Limitations

Although complications were recorded prospectively it is possible that minor, transient complications which required no intervention were not recorded. However, retrospective case note review was also carried out and this should have identified any complication requiring intervention by a clinician.

DISCUSSION

The first reported use of propofol as a sedative agent for DCCV was in 1988. This was in patients with AF undergoing elective DCCV.[6] Propofol has been used for procedural sedation in Emergency Medicine since 1995.[7] In 1996, in a review article in *Anaesthesia*,[8] it was recommended as the drug which most closely approaches the ideal agent for cardioversion; however, a systematic review of the use of propofol for procedural sedation in Emergency Medicine in 2001 concluded that although there was evidence to support the use of propofol for DCCV this evidence came from stable patients in a non-ED setting, and there was as yet no evidence to support its use in emergency practice.[9] Since then, Miner *et al*[10] have shown that procedural sedation in the ED with propofol appears to be safe in ASA class III and IV patients. Heuss *et al*[11] produced similar results for patients undergoing elective endoscopy but did demonstrate that there was a significantly increased risk of short-lived oxygen desaturation with a higher ASA class—3.6% for ASA classes III and IV

Table 2 Ventricular tachycardia

	Stable	Unstable	Total
Patients	6 (2×ICD failure)	5	11
ASA grade	Median 3.0 (Range 2–4)	Median 3.0 (Range 2–4)	
Total propofol dose	Median 0.70 mg/kg (Range 0.5–1.0 mg/kg)	Median 0.50 mg/kg (Range 0.2–1.0 mg/kg)	
Age	▶ ≤70 y—3 ▶ 70–79 y—2 ▶ ≥ 80 y—1	▶ ≤ 70 y—2 ▶ 70–79 y—2 ▶ ≥ 80 y—1	
Age versus total propofol dose	▶ ≤70 y—median 0.5 mg/kg ▶ 70–79 y—median 0.55 mg/kg ▶ ≥80 y—median 0.5 mg/kg	▶ ≤70 y—median 0.6 mg/kg ▶ 70–79 y—median 1.0 mg/kg ▶ ≥80 y—median 0.4 mg/kg	
Successful DCCV (%)	6 (100)	5 (100)	
Outcome (%)	Admission—6 (100)	Admission—5 (100)	
Complications (%)	1 (17) ▶ BMV ventilation for 60 s for apnoea with desaturation to <90%	2 (40) ▶ 20 s apnoea—no intervention ▶ Hypotension (SBP <70)—responded rapidly to 500 mL bolus of 0.9% saline	3 (27)
Quebec criteria complications (%)	1 (17) ▶ BMV ventilation for 60 s for apnoea with desaturation to O_2 saturation of 85%	1 (20) ▶ Hypotension (SBP <70)—responded rapidly to 500 mL bolus of 0.9% saline	2 (18)
World SIVA ISTF adverse events	Moderate—1	Minor—1 Moderate—1	

versus 1.7% for classes I and II. They also showed that the propofol dose required for classes III and IV patients was, on average, 10–20% lower.

The first reported use of propofol to facilitate DCCV in Emergency Medicine practice was by Coll-Vinent *et al* in 2003.[12] In haemodynamically stable patients with supraventricular arrhythmias where a rhythm control strategy using DCCV was planned, propofol provided effective procedural sedation with a favourable adverse effect profile compared with etomidate, midazolam, or midazolam followed by flumazenil. However, only nine patients in the trial received propofol, and the drugs were delivered by an anaesthetist within the ED. In 2006, Burton *et al* reported a large consecutive series of patients who received procedural sedation with propofol for cardioversion in a pragmatic prospective observational study from 3 centres in the USA.[13] All sedation was provided by Emergency Physicians. Out of a total of 792 patients, 77 underwent emergent DCCV in the ED. Unfortunately, the report did not include a detailed breakdown of the type of arrhythmia cardioverted, or the haemodynamic state of the patients prior to cardioversion. The rate of oxygen desaturation events (defined as a SpO_2 <90%) was 13% compared to 7.7% for all procedures, and the rate of BVM ventilation was 5.2% compared to 3.9% for all procedures. However, all propofol-related events resolved with brief supportive interventions with no adverse sequelae. Standard dosing of propofol was 1 mg/kg with 0.5 mg/kg supplementary doses. Variance to this dosing regime was physician determined but not reported. Campbell *et al* in 2006,[14] reported a series of 38 patients who underwent DCCV in a Canadian ED facilitated by procedural sedation provided by advanced level paramedics. This group was part of a larger series of 979 patients receiving procedural sedation, and the drugs used for sedation varied considerably with only 595 having propofol. No information on propofol efficacy and safety specifically related to cardioversion was available. This report did not include a detailed breakdown of the type of arrhythmia cardioverted or the haemodynamic state of the patients prior to cardioversion. Parlak *et al* in 2006,[15] reported a randomised clinical trial comparing midazolam and propofol in two groups (patients younger than or older than 65 years) who underwent DCCV in ED or Coronary Care Unit (CCU) for AF. The dosage schedule for propofol (33 patients) was an initial dose of 20 mg followed by 20 mg every 2 min until adequate sedation was achieved. Propofol use resulted in significantly reduced recovery time and a lower risk of desaturation events with no reported difference in haemodynamic effect. Older patients needed less medication than younger patients though this result was not statistically significant. Haemodynamically compromised patients were excluded. Zed *et al* in 2007,[16] reported a series of 42 patients who underwent DCCV in the ED facilitated by procedural sedation with propofol provided by emergency physicians. This group was part of a larger prospective series of 113 patients. Overall complication rates were low with a 1% rate of oxygen desaturation (O_2 Sat <90%) while breathing air, no periods of apnoea longer than 30 s and an 8% rate of 'insignificant hypotension' which required no intervention. This report did not include a detailed breakdown of the type of arrhythmia cardioverted or the haemodynamic state of the patients prior to cardioversion.

The American College of Emergency Medicine produced a Clinical Practice Advisory on ED procedural sedation with propofol in 2007.[17] It stated that the current literature supported the safety and efficacy of propofol for a variety of ED procedures including cardioversion, though further studies were required to assess optimal dosing strategies including potential differences based on age, underlying illness and specific procedures. Since then, Bawden *et al* in 2011,[18] have reported a time in motion study of a convenience sample of patients undergoing procedural sedation with propofol in ED, where 54 of the 177 cases were for cardioversion of AF. The dosage schedule is not documented, but the median propofol dose was 100 mg. Patients with an ASA class ≥III were excluded. The haemodynamic status of the patients included is not documented. No serious adverse events were recorded. In 2012 Bellone *et al*[19] reported a clinical trial involving 121 patients who underwent DCCV in the ED facilitated by procedural sedation with propofol provided by emergency physicians. The primary outcome for this trial was the success rate of cardioversion for acute AF using DCCV versus propafenone. Excluded patients included those with haemodynamic compromise, any patients already taking antiarrhythmic drugs, and any patient with a CHADS2 cardiovascular risk score ≥2. All patients received propofol boluses of 1 mg/kg, plus additional boluses as determined by the attending physician. Overall complication rates were low with only one patient having a period of hypoxia. Need for intervention is not reported. Newstead *et al* in 2013,[20] reported the adverse event rate using the World SIVA ISTF adverse event tool in 1008 patients who underwent procedural sedation with propofol in an ED. This case series included 91 patients who underwent DCCV, of whom three had sentinel adverse events. The number of moderate or minor adverse events specifically related to DCCV is not reported. The report did not include a detailed breakdown of the type of arrhythmia cardioverted, propofol dosage or the haemodynamic state of the patients prior to cardioversion.

In summary, the existing evidence for dosage and safety of propofol in emergent or urgent cardioversion is limited. In previous studies, patient numbers are small, dosage is poorly reported, and haemodynamic status and premorbid state are either unclear or highly restricted.

It would be useful to assess the evidence for dosage and safety for midazolam-facilitated procedural sedation for DCCV. However, although midazolam is the traditional gold standard procedural sedation drug there is surprisingly little evidence regarding its safety profile especially in haemodynamically compromised patients and/or non-elective cardioversion. A systematic review in 2008 of the safety and clinical effectiveness of midazolam versus propofol for procedural sedation in the ED[21] found only two randomised controlled trials[12 15] that reported head-to-head comparisons for emergent or urgent cardioversion. There were no major adverse events. The authors noted that definition of minor adverse events was heterogeneous and these events were inconsistently reported. Due to the clinical heterogeneity, minor AEs could not be pooled in a meaningful way. Neither trial included haemodynamically compromised patients. None of the RCTs without head-to-head comparisons had any data on midazolam procedural sedation for cardioversion. Only one observational study[14] included any significant data; 38 patients out of a series of 979 who had procedural sedation underwent cardioversion. The drugs used for sedation varied considerably, and no information on midazolam efficacy and safety related to cardioversion was available.

CONCLUSIONS

Propofol appears to be a safe drug for procedural sedation to facilitate emergent or urgent DCCV in patients with an atrial tachyarrhythmia without any evidence of haemodynamic compromise. Using the adverse event reporting tool produced by

the World SIVA ISTF, there were no moderate or sentinel adverse events in these patients. Propofol at a dose of 1 mg/kg appears to be safe for procedural sedation in the majority of patients, to facilitate DCCV in patients with an atrial tachyarrhythmia without any evidence of haemodynamic compromise. However, a reduced dose should be considered in the older age group to prevent adverse events. Propofol, at a dose of 0.5 mg/kg, appears to be a safe drug for procedural sedation to facilitate emergent or urgent DCCV in patients with an atrial tachyarrhythmia with evidence of haemodynamic compromise. There were no sentinel adverse events associated with its use. It is difficult to differentiate a transient adverse drug response from postcardioversion myocardial stunning, but there is a small risk (2%) of transient hypotension even with a reduced dose, and this must be anticipated.

The evidence for propofol to facilitate emergent or urgent DCCV for ventricular tachycardia is limited by small numbers. Unsurprisingly, the adverse event rate is higher than for atrial tachyarrhythmia, despite propofol dose reduction. However, again, it is difficult to differentiate a transient adverse drug response from postcardioversion myocardial stunning or the primary cardiac cause of the ventricular arrhythmia. It would appear sensible to reduce the dose as with atrial tachyarrhythmias with evidence of haemodynamic compromise.

Contributors PK developed the idea and led the project, reviewed the existing evidence base, guided data analysis and interpretation, wrote large sections of the paper and approved the final manuscript. MG shared data collection, reviewed the existing evidence base, guided data analysis and interpretation, assisted in revisions and approved the final manuscript.

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