Original Article

Impact of the United States propofol ban on emergency providers' procedural sedation agent choice and patient length of stay

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BACKGROUND: In the recent past, propofol was temporarily removed from the emergency department (ED) for use in procedural sedation. We sought to determine which agents replaced it in clinical practice and the impact this change had on turnaround times (TAT) for sedated patients.

METHODS: This study is a retrospective chart review at a level one trauma center. Patients receiving sedative agents (propofol, ketamine, midazolam, and etomidate) were identified by pharmacy codes, and their charts were then reviewed for demographics and TAT. Propofol was unavailable in the emergency department (ED) between May 2010 and February 2011. The study period extended from May 2009 until May 2011. Patients receiving sedation by non-emergency medicine physicians and those receiving sedation related to intubation were excluded.

RESULTS: In total 2466 charts were reviewed and 209 met inclusion criteria. When propofol was available, the most commonly used sedative agent was etomidate (40%), followed by propofol (28%), ketamine (20%), and midazolam (6%). When propofol was unavailable, etomidate remained the most commonly used agent (43%), followed by ketamine (41%), and midazolam (11%). When propofol was available, the median TAT for sedated patients was 163 minutes compared to 178 minutes when propofol was unavailable ($P=0.83$). When propofol was the primary sedative agent used, the median TAT was 166 minutes as compared with a median TAT of 172 minutes for all other sedative agents combined ($P=0.87$).

CONCLUSION: When propofol was unavailable, ketamine became a preferred ED sedation agent. Removal of propofol from the sedation armamentarium did not affect ED TAT.

KEY WORDS: Procedural sedation; Turnaround time; Propofol; Ketamine; Etomidate; Midazolam

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INTRODUCTION

Procedural sedation and analgesia (PSA) has been performed for painful procedures in the emergency department (ED) for decades and is one of the core skills of the emergency physician (EP). In the 1990s, the PSA armamentarium expanded rapidly with the first ED uses of ketamine, propofol, and etomidate.^[1–5] Each of these agents has unique qualities which makes it particularly well-suited for use in the ED. Ketamine, a dissociative anesthetic, is short acting and has inherent analgesic

properties. When it is used intravenously for PSA, average recovery times for patients receiving ketamine range from 14 to 55 minutes.^[2,5,6] Both etomidate and propofol act primarily through GABA-A receptor pathways, causing deep sedation without significant analgesia.^[7,8] Average recovery times for patients receiving etomidate and propofol are reported to be 5-15 minutes and 6-33 minutes, respectively.^[1,2,4,6] Since the introduction of these medications as PSA agents in the ED, multiple studies have proven their safety and

efficacy.^[1,3,4,6,9–13]

Prior to the widespread use of short-acting PSA agents, it was not uncommon for ED personnel to spend up to two hours monitoring patients after sedation until discharge.^[3] As EPs in the US have become more comfortable with performing deep sedation, propofol has emerged as a preferred agent for brief procedures, such as dislocation reductions.^[14] This is because of propofol's rapid onset and short duration of action,^[4,7,11] making it ideal for an environment in which patients are quickly evaluated, treated, and then dispositioned. Longer acting agents may adversely affect length of stay and turnaround time, impacting patient throughput and leading to increased ED overcrowding.

In spite of the benefits of propofol use and its studied safety record in the hands of trained EPs, there has been some concern that propofol is most appropriately used in the anesthesia suite exclusively. When Michael Jackson died unexpectedly and propofol was found in his home, regulatory bodies began to scrutinize the use of propofol by nonanesthesiologists. This culminated in a 2010 CMS mandate requiring that sedative agent use be governed under the umbrella of institutional anesthesia departments.^[15]

For many EPs, the immediate result of this mandate was the removal of propofol from their EDs. This was primarily a result of specific language in the propofol package insert requiring that a qualified anesthesia provider administer the medication. As a result, many EPs were forced to substitute ketamine, etomidate, fentanyl, or midazolam to perform PSA in their patients. These other PSA agents have been shown to have marginally longer durations of action compared to propofol, resulting in prolonged recovery times post-procedure. While there are multiple studies that have sought to evaluate patient recovery time from sedative agents, there are few studies which elucidate true turnaround time, from evaluation to disposition.^[16] In our study we determined if the propofol ban adversely affected ED turnaround time in patients undergoing PSA when compared with those undergoing sedation with propofol prior to the ban was initiated and after it was lifted.

METHODS

We performed a computer-based retrospective chart review at a level I academic community trauma center with an annual ED census of 70 000 patients. Electronic ED medical records were cross-referenced with pharmacy coding to create a database of ED

patients receiving sedative medications over a two-year period (May 2009–May 2011). Sedative medications administered by the pharmacy included lorazepam, diazepam, midazolam, etomidate, propofol, and ketamine. Morphine, hydromorphone, meperidine, and fentanyl were not used as sedatives for the purpose of querying the pharmacy databank since these medications are never used in isolation for the purpose of procedural sedation.

Using the database, each patient's chart was systematically reviewed for whether procedural sedation was performed in the ED. For patients in whom sedation was performed, age, indication for sedation, primary and secondary agent used, and total turnaround time in minutes (time from registration until leaving the ED) were recorded in a standardized spreadsheet by trained data abstractors. The data abstractors chose from a list of closed possibilities for indications for sedation. These possibilities included "radiographic imaging", "incision and drainage", "laceration repair", "dislocation reduction", "fracture reduction or fracture/dislocation reduction", "cardioversion", "lumbar puncture", "foreign body removal", and "other". These possibilities were chosen based on common indications for PSA mentioned in the literature.

Patients were excluded if, when their charts were reviewed, the PSA medications were found to have been given as induction agents for endotracheal intubation, or if the agents were ordered from the ED but were ultimately given in the operating room. Patients were also excluded if review of their medical records determined that they did not undergo procedural sedation, for instance, if they received medications for the purpose of control of psychomotor agitation or seizure. Patients having procedural sedation performed by a physician other than the ED physician were excluded, as were any patients with no documentation available for review. Finally, patients receiving multiple agents with multiple attempts at conscious sedation were excluded for analyses by agent, as they could not be included under a single agent. However, they were included for analysis of turnaround times in pooled analyses (for example, when we analyzed turnaround times for all agents during the propofol ban).

Propofol was unavailable for ED procedural sedation at the study institution from May 2010 until February 2011. Categorical variables for sedations performed during the propofol ban were compared with those performed when propofol was available. Turnaround times for patients undergoing procedural sedation during both time periods were recorded and compared.

Turnaround times for patients receiving propofol alone were also compared with turnaround times for patients receiving all other PSA agents combined. These comparisons were made using nonparametric statistics. Fisher's exact test was used to compare PSA agent choice for time periods before the ban began (May 2009–May 2010) and after it was lifted (February 2011–May 2011). A power calculation was performed using expected ED turnaround times based on a prior study comparing propofol with midazolam.^[17] To have 0.80 power to detect a difference of 25 minutes between groups (patients receiving propofol as compared with patients receiving other agents as well as patients receiving PSA agents while propofol was available compared with those receiving PSA agents during the propofol ban), we needed a minimum of 73 patients per group for a two-tailed test ($\alpha=0.05$).

This study was reviewed by the institutional review board and found to be exempt.

RESULTS

In total 2466 charts met initial screening requirements and were reviewed for eligibility. Of these, 209 met inclusion criteria (81 during the time period when diprivan was unavailable, 101 before the propofol ban began, and 27 after the ban ended). 43% of charts were excluded because the patients received sedation drugs for reasons such as muscle relaxation and pain control, 29% received their sedation drugs associated with being admitted to a surgical subspecialty, 12% received their medications in association with being admitted to a cardiology service, 5% received their medications associated with undergoing endoscopy by a gastroenterologist, and the remainder of patients received the agents for psychiatric agitation or for seizures. 0.25% of charts were excluded because, although the ED documentation indicated that the patient underwent procedural sedation, there was missing procedural sedation paperwork in the electronic medical record.

There was no difference in the frequency with which procedural sedation was performed when propofol was available compared to when it was not available (8 sedations per month). During the study period, sedations

were performed for 111 dislocation reductions, 48 fracture reductions, 11 lacerations, 9 cardioversions, 9 incisions or drainages, 4 imaging studies, 4 lumbar punctures, and 12 other indications. There were no differences in indications for procedural sedation during the time period when propofol was unavailable compared to when it was available (Fisher's exact test, $P=NS$). Seventy-four percent of sedations were performed on adults and 26% were performed on children, and these proportions were similar both when propofol was available and when it was not (Fisher's exact test, $P=NS$).

Before propofol was banned from use, the most commonly used PSA agent was etomidate (primary agent in 45% of sedations), followed by propofol (34%) and ketamine (13%). During the propofol ban, etomidate remained the most commonly used agent (43%), followed by ketamine (41%) and versed (11%). When propofol was re-introduced into the sedation armamentarium, etomidate was used in 22% of sedations, ketamine was used as a solo agent in 48% of sedations, ketofol was used in 19% of sedations, and propofol was used as a solo agent in 7.4% of sedations. The increase in ketamine use and decrease in propofol use after re-introduction of propofol as compared with before the propofol ban was statistically significant (Fisher's exact test, $P<0.01$).

When propofol was available, the median turnaround time for sedated patients was 163 minutes (IQR 120 to 248) compared with 178 minutes (IQR 117 to 250) when propofol was not available ($P=0.83$, the Mann-Whitney U test). When propofol was the primary sedative agent used, the median turnaround time was 166 minutes (IQR 119 to 245) as compared with a median turnaround time of 172 minutes (IQR 120 to 252) for all other sedative agents combined ($P=0.87$, the Mann-Whitney U test). The sedation time for the various agents as well as the depth of sedation using a standard Aldrete Score is shown in Table 1.

DISCUSSION

Although actual sedation duration must play some role in length of ED stay, turnaround time for patients undergoing PSA is influenced by a number of other

Table 1. Sedation time and sedation depth by procedural sedation agents

Sedation agent	Propofol	Etomidate	Ketamine	Benzodiazepines
Median sedation time (IQR)	20 (12–35) minutes	20 (11–37) minutes	33 (20–62) minutes	43 (14.5–79) minutes
Median aldrete score (IQR)	8 (7–9)	8 (6–9)	8 (6–9)	9 (9–10)

factors. Prior studies have largely focused on time to recovery from sedation as a measure of total resource utilization, citing monitoring necessity and bedside one-on-one nursing time. These factors are clearly important to choice of PSA agents, but overall time that a patient occupies a bed in the ED is also an important measure to consider. As ED volumes continue to increase, optimizing total turnaround time in addition to appropriate resource allocation will be critical in reducing crowding and delays in patient care.

Specific conditions may lend themselves to specific PSA agent choices. Lee et al^[16] studied turnaround time in the subset of patients requiring PSA for reduction of dislocated joints and found that propofol use resulted in shorter turnaround times, in contrast to our findings. This may be because in our study, propofol was used for a variety of PSA indications, with dislocations accounting for only 69% of the total use. Our remaining propofol sedations were for cardioversions, fracture reductions, and lumbar punctures. These patients may have had longer turnaround times because they were waiting for further lab testing and other evaluations related to their underlying conditions. It is possible that propofol is particularly well suited as a PSA agent for straight-forward joint reductions, as those patients often do not require any ancillary testing beyond radiography. For this indication, it is reasonable that propofol use may reduce turnaround times. Our study was not designed to analyze subgroups based on procedural sedation indication, so this will require further inquiry.

Similar to the findings in our study, Dunn et al^[17] suggest that propofol has a significantly shorter duration of action as compared with midazolam (median time to recovery 3 minutes vs. 45 minutes), but patients remained in the ED for approximately the same amount of time (median time spent in the ED 200 minutes vs. 175 minutes). Delay to X-ray, waiting on inpatient beds, and midazolam oversedation were noted as factors contributing to increased time spent in the ED.^[17] Miner et al^[2] also found that propofol had a shorter duration of sedation as compared with ketamine, but the difference in time was much smaller (median time of return to baseline mental status 5 minutes as compared with 14 minutes). Etomidate was used in about 45% of our sedations overall, and it has been reported to have a duration of action comparable to propofol (5-15 minutes).^[1] In our study, benzodiazepines were the least used PSA agents, accounting for only 9% of all the sedations done. Even when propofol was unavailable, ketamine largely replaced propofol as a PSA agent of

choice during the ban, and there was no increase in benzodiazepine use. This may explain the propofol ban's lack of impact on turnaround time, as the difference in sedation time for etomidate and ketamine as compared with propofol is only about 10 minutes. It is likely that any time saved by using agents with shorter recovery times is attenuated and ultimately lost owing to a number of factors, including delay in transport to radiology for repeat imaging, physician and nurse charting, handling discharge paperwork, high or varying ED census to staffing ratio, inpatient bed turnover time, or time spent arranging safe transport of a post-procedure patient from the ED to a waiting vehicle outside. Unfortunately, the design of our study precluded identifying specific areas of delay in patient turnaround time.

Once propofol was made available again, providers continued to use ketamine with a high frequency. It is unclear why this occurred. In the United States, ketamine has generally been used for pediatric procedural sedation due to concerns regarding post-sedation agitation, which is more severe in adults. It is possible that the propofol ban created an environment in which providers were compelled to utilize PSA agents in new capacities with which they were less familiar, and the time period without propofol allowed them to develop a new comfort level with ketamine. It may also be that the providers were unaware of the reintroduction of propofol, and the increased ketamine use in the 4 months following reintroduction represented a practice lag due to ignorance of propofol availability.

In our ED as well as in many EDs in the United States, nurses are not permitted to push propofol, although they are permitted to push ketamine and etomidate. This may be part of the reason that physicians in our ED do not use propofol with a very high frequency compared to other agents. Even before the propofol ban, propofol use accounted for only about 1/3 of the procedural sedations performed in our ED, and accounts for even fewer now. This may have to do with individual practice styles and preferences, but it is also possible the additional task of pushing the medications makes physicians less likely to use the medication. Our study was not designed to determine why providers choose specific drugs, however.

Limitations

There are several limitations to this study. Since we used retrospectively collected data from a chart review, it is possible that there were procedural sedations that were performed but not documented and coded. We attempted

to control this by utilizing pharmacy codes for drugs administered to ED patients leading to a large pool of charts in our initial screening, but it is conceivable that some patients sedated were not accounted for in our study.

Our study is limited by our relatively small study size precluding subgroup analysis based on patient age or sedation indication. As some PSA agents may be better suited for certain indications than others, this information would be useful in interpreting the impact of PSA agents on ED turnaround time.

Another limitation is that we did not explore complications encountered during episodes of procedural sedation. Although turnaround time is an important consideration in PSA, time savings needs to be weighed against any undo risk from a given PSA agent. Although all the PSA agents have evidence supporting their safety, we did not explore complication rates with our PSA patients.

Finally, our data were drawn from a single institution, and may not be generalizable to other institutions.

In conclusion, removal of propofol from the sedation armamentarium has no impact on ED turnaround time in patients undergoing procedural sedation. Ketamine is a preferred sedation agent when propofol is not available and has remained a mainstay of procedural sedation even when propofol is once again available. Future studies should determine if there is a benefit in terms of cost, personnel, ED turnaround time, procedural success, or complications between use of propofol or ketamine.

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