

Propofol Disposal in the Anesthesia Setting: Overcoming Barriers

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Propofol accounts for 41% of reported substance abuse cases among anesthesia providers. No guidelines outline appropriate propofol disposal in the healthcare setting. The lack of controlled disposal presents concerns for environmental harm, economic waste, and diversion. An evidence-based practice project was conducted in a large, Midwestern teaching institution to address propofol disposal.

Data collected regarding propofol waste and from a survey indicated that Certified Registered Nurse Anesthetists (CRNAs) have limited access to sinks in the operating rooms for disposal, have environmental concerns regarding pouring propofol into the sink, and find propofol vials difficult to open. Interventions tailored to address these barriers included implementing a specially designed bottle opener and activated carbon

pouch in each operating room to be used for propofol disposal. A χ^2 analysis showed that changing CRNA practice from sink disposal to carbon pouch disposal significantly decreased the percentage of unemptied propofol vials remaining in unsecured bins from 25.8% before the intervention to 3.4% after the intervention ($P < .0001$). Decreasing access for diversion is critical for anesthesia practices, and removing barriers to disposal can help reduce access. This evidence-based practice project demonstrated how tailoring interventions to address identified barriers produced an effective practice change for propofol disposal.

Keywords: Barrier assessment, Deterra drug deactivation system, propofol disposal, propofol diversion, tailored interventions.

Propofol is a short-acting intravenous anesthetic used primarily by anesthesia providers for sedation and induction of anesthesia. It is also used for long-term sedation in intensive care units. The United States Drug Enforcement Administration does not classify propofol as a controlled substance, and therefore no restrictions are nationally mandated for the disposal of propofol. The lack of controlled disposal of this drug poses 3 major concerns: environmental harm, economic waste, and diversion.

The purpose of this evidence-based practice (EBP) project was to address propofol disposal to reduce the potential for diversion. The project included (1) reviewing the literature, (2) assessing current propofol disposal practice at a large Midwestern teaching institution, (3) analyzing barriers to current propofol disposal practice, (4) implementing a new tailored approach to propofol disposal practice, and (5) reassessing propofol disposal practice after implementation.

Review of Literature

A literature review was conducted pertaining to environmental, economic, and diversion concerns surrounding unused propofol, as well as changing propofol disposal practice. Medical, nursing, and guideline databases were searched for the years 2000 and 2015, and the search was limited to English-language articles published in peer-

reviewed journals. The search resulted in 257 articles, of which 35 were used in the preparation of this article that pertained to environmental, economic, and diversion concerns and interventions. The level of evidence of research articles was assessed using a tool developed by Ackley et al.¹

• **Environmental Concerns.** No official guidelines for propofol disposal have been published by the US Food and Drug Administration or the Environmental Protection Agency (EPA), according to Christian G. Daughton, PhD, supervisory physical scientist in the EPA's National Exposure Research Laboratory (unpublished communication). The relationship between drug disposal and active pharmacologic ingredients found in the environment is largely unknown; however, the impact that drug disposal has on the ecosystem is an emerging concern.²⁻⁷ The lack of guidance regarding medication disposal raises concerns surrounding the potential environmental impact.²⁻⁶ Pharmaceutical waste products, in general, have the potential to pollute the environment and detrimentally affect human and animal health.⁵ Many healthcare providers do not dispose of drugs into the sink because of environmental concerns.³ Health professionals have a responsibility to meet the needs of patients as well as promote environmentally sustainable practices to protect human health.^{8,9} Considering the current lack of scientific knowledge, this

KTA phase	Approach for innovative practice change
Phase 1: Identify a problem and find knowledge relevant to the problem	<ul style="list-style-type: none"> • Unsecured bins in ORs contain unemptied propofol vials • A knowledge-to-action gap was recognized related to disposal • A clinical question was formulated • Literature was reviewed to address the clinical question
Phase 2: Adapt the knowledge use to the local context	<ul style="list-style-type: none"> • A project implementation plan was outlined and externally reviewed • The final plan was presented to stakeholders • Project feasibility, resources, and skills were considered
Phase 3: Assess barriers to knowledge use	<ul style="list-style-type: none"> • A barriers assessment survey was designed and implemented
Phase 4: Select, tailor, and implement interventions to promote use of the knowledge	<ul style="list-style-type: none"> • Interventions were specifically tailored to identified barriers <ul style="list-style-type: none"> ◦ Propofol bottle opener placed in each OR ◦ Activated carbon pouch placed in each OR
Phase 5: Monitor knowledge use	<ul style="list-style-type: none"> • A change in the number of unemptied propofol vials left in unsecured bins was monitored before and after intervention
Phase 6: Evaluate outcomes of knowledge use	<ul style="list-style-type: none"> • Change in number of unemptied propofol vials remaining in unsecured bins demonstrates a change in behavior
Phase 7: Sustain knowledge use	<ul style="list-style-type: none"> • Practice for propofol disposal was changed • Results were disseminated throughout the institution/health system

Table. Phases of the KTA Model³⁷ With Corresponding Approaches for Innovative Evidence-Based Practice Change
Abbreviations: KTA, Knowledge to Action; OR, operating room.

EBP project did not measure the environmental impact of propofol disposal.

• **Economic Concerns.** Propofol is one of the more commonly wasted drugs in hospitals,¹⁰ which contributes to not only the risk of diversion⁵ but also unnecessary healthcare costs.^{5,10-13} It is estimated that 20% to 50% of anesthesia drugs are drawn up and wasted, or discarded as whole vials.¹² Propofol is no exception; it has been found to comprise up to 45% of the total volume of anesthesia drug waste,¹⁰ with an estimated 20% of this waste being avoidable by using appropriate sized vials.¹³ Minimizing drug waste may help reduce the source of drugs that are abused or misused, or are the targets of diversion.^{4,5} Decreasing drug waste also reduces healthcare costs^{4,8,10-13} and environmental pollution.^{4,5,8,9,14} Efforts to decrease propofol waste are ongoing at the clinical institution where the study took place and were not the focus of this EBP project.

• **Diversion Concerns.** Unregulated propofol disposal presents concerns for diversion.¹⁵ The addictive and dependency effects of propofol have been clearly demonstrated in animal studies,^{16,17} and there has been much speculation in the literature of the abuse potential of propofol in humans¹⁸⁻²¹ because most abuse case reports involve healthcare providers.^{16,18,22-28} There were 63 documented cases of propofol abuse and dependence published in the peer-reviewed literature between 1992 and 2013, with more than 40% resulting in fatalities.^{21,24}

The incidence of propofol abuse in healthcare providers is increasing,^{15,21,23,24,27} and anesthesia providers account for nearly all propofol abusers.^{23,26,29} Data from Australia and New Zealand show propofol abuse rates have increased from 20% in 2005 to 41% in 2015, making propofol the overall preferred substance of abuse among anesthesia providers.²⁴ This percentage may be much

higher, as abuse is not readily apparent because of propofol's short duration of action and lack of withdrawal symptoms,^{18,19,21} and only the most serious cases appear in the literature.²⁵

Ease of access to propofol is reported to be the most common reason among healthcare providers for abusing propofol.^{15,16,19-30} Earley and Finver²³ found that 89% of people who abused propofol have high access (ie, anesthesia providers) to the drug, whereas the remaining 9% in the study reported having easy access (ie, nonanesthesia healthcare providers). Easy access and availability to drugs are major risk factors for abuse that must be recognized by healthcare providers to prevent diversion.²⁷ Although the diversion rate of propofol at the study institution is unknown, given the importance and potential consequences, decreasing access for diversion was the focus of this EBP project.

• **Assessing Barriers to Change.** A review of the literature confirmed that a gap exists between research recommendations, scientific evidence, and clinical practice.³¹ It is well documented that interventions designed to address this gap and change practice must be based on an accurate assessment of barriers to targeted outcomes.³²⁻³⁴ Important barriers must be identified, and those implementation strategies most likely to be effective must be selected.³⁵ Investigation of the perceived barriers facing each individual health professional can be undertaken through observation, interviews, or surveys.^{31,32,34,36} One article advocated for the use of surveys to assess barriers when leading an organizational change process.³⁶ Given the importance of an accurate assessment and the direct relationship to the future success of the intervention, an assessment of barriers to change was conducted during this EBP project.

• **Tailored Interventions.** Tailored interventions are

individual strategies or a combination of strategies that address specific characteristics of a group.^{31,33} Tailored interventions typically are identified after an individual assessment and are specific to overcoming organizational barriers.³⁴ Tailored interventions can improve professional performance and patient outcomes in healthcare settings.^{34,36}

Methods

• **Description of Evidence-Based Practice Project.** An EBP project was conducted at a large, Midwestern teaching institution after institutional review board approval. The Knowledge to Action (KTA) EBP translation framework was used to guide the design and implementation of the project. The phases of the KTA Model with corresponding specific approaches for the innovative practice change can be found in the Table.³⁷ The project included collecting baseline data on propofol disposal practice, exploring barriers to propofol disposal, implementing tailored interventions to change practice, and collecting data after the practice change.

• **Sample and Practice Setting.** The project was conducted with 280 Certified Registered Nurse Anesthetists (CRNAs) who practice in the clinical setting. Nonclinical CRNAs involved exclusively in an education role were excluded from the sample. Among all the operating rooms (ORs) at the institution, less than 10% have sinks. The outpatient procedure center (OPC) at the institution consists of 8 ORs with sinks located outside each OR. In 2014, a total of 4,205 anesthetics were administered in the OPC, with CRNAs administering propofol infusions for more than 95% of cases, according to Marlea Judd, DNP, CRNA, and codirector of nurse anesthesia at the clinical institution (unpublished communication). Because of the small number of ORs, large case volume, frequent use of propofol infusions, and absence of sinks in the ORs, the OPC was selected as the setting for the project.

• **Measurement Tools and Data Collection.** Preintervention data were collected to evaluate baseline CRNA practice for propofol disposal and to compare with postintervention data to determine whether interventions tailored to identified barriers decreased the number of unemptied propofol vials remaining in unsecured bins in ORs. Anesthesia technicians working in the OPC collected preintervention data over a 6-week period. The technicians categorized each propofol vial left in the unsecured bin at the end of each operating day as: empty with the lid off, empty with the lid on, or unemptied. An empty vial with the lid off demonstrated an effort was made to remove the lid. An empty vial with the lid on demonstrated the vial was emptied using intravenous tubing. An unemptied vial demonstrated that no effort was made to dispose of the unused propofol.

Six technicians provided input during 2 separate informational meetings regarding the data collection

process, data collection measurement tool, and data collection documentation form. Because they participated in the creation of the tools, training occurred through discussion and agreement. Interrater reliability was fostered through discussion between 2 technicians collecting the data together and agreeing on the categorization. In addition, reliability was enhanced through the simplicity of the data collection process because categorizing the vials was easy to determine. The anesthesia technicians agreed to not disclose the content of the data collection to anyone outside the anesthesia technician department or to discuss the results of the data collection. All CRNAs were blinded to the data collection because details of the data collection were disclosed only to the anesthesia technicians, further promoting the internal reliability and validity of the results.

Following baseline data collection, an informal focus group meeting was held with a subset of 15 clinical CRNAs practicing at the institution. The information gathered through this meeting provided insight into the current disposal practices of a representative sample of CRNAs and reinforced the necessity of conducting a formal needs assessment with a larger number of CRNAs at the institution. A branch-logic survey was constructed by PhD-prepared survey researchers at the institution's Survey Research Center to assess current practice for propofol disposal among CRNAs as well as barriers experienced for disposal of unused propofol in the sink. A pick list of responses was incorporated based on barriers identified by the focus group and included the following: (1) limited access to sinks in the OR, (2) environmental concerns related to sink disposal of propofol, (3) concerns of clogging the sink, (4) lack of time, (5) difficulty opening propofol vials, and (6) other.

To ensure survey content validity, input from 5 CRNAs in clinical leadership was obtained during development of the survey. In addition, the survey was piloted with 4 excluded nonclinical CRNAs involved in education, to evaluate the clarity and ease of completion of the survey tool. To increase external validity of the survey, the Survey Research Center administered the web-based survey and collected the results to ensure confidentiality. A combination of questions using dichotomous responses, multiple-choice responses, and Likert-scale responses were used to elicit quantitative data. Survey data were collected over a 17-day period.

• **Tailored Interventions.** Survey results were presented to stakeholders at the institution, including the departments of waste management, pharmacy, biomedical engineering, infection control, and equipment. Discussions were held to brainstorm interventions tailored to address barriers identified in the surveys. Interventions were then tested in a 6-week trial, after an informational email was sent to all CRNAs at the institution to inform them of the implementation trial. A 10-minute educational presenta-

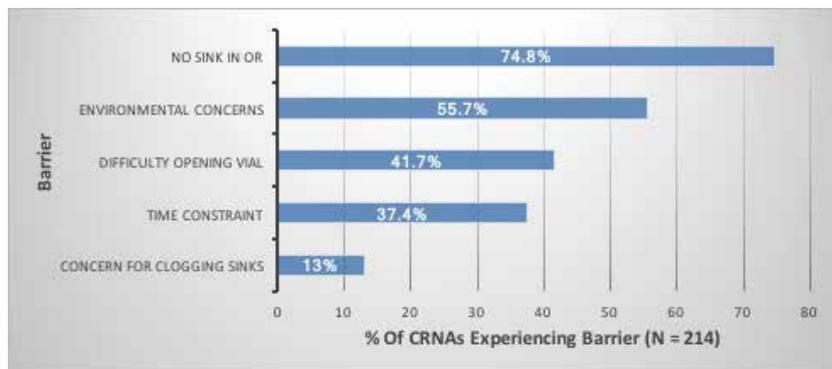


Figure 1. Barriers to Sink Disposal of Propofol Reported by CRNAs^a

Abbreviations: CRNA, Certified Registered Nurse Anesthetist; OR, operating room.

^aPercentages total to more than 100% because selection of multiple choices was allowed.

tion was provided to the CRNAs working in the OPC on how to use the interventions. The institution's anesthesia department covered costs related to development and manufacture or purchase of the interventions. One week after initial implementation, postintervention data were collected for 6 weeks using the same data collection process, tool, and documentation form as for the initial data collection.

Results

• **Survey Results.** Two-hundred eighty surveys were distributed electronically; 214 (76.4%) surveys were returned. One-hundred eighty-one CRNAs (84.6%) indicated an awareness of the recommended institutional practice to pour unused propofol into the sink; however, only 99 CRNAs (46.3%) reported sink disposal as their most frequent practice for discarding propofol. Fifty-five CRNAs (25.7%) reported most frequently disposing of propofol by leaving it in the vial and placing it in unsecured bins in the OR, 52 CRNAs (24.3%) reported disposing of the unused propofol in the garbage, and 8 CRNAs (3.7%) disposed of propofol by other methods. Twenty-two CRNAs (10.3%) were not aware of recommended practice for propofol disposal at the institution, and the remaining CRNAs thought recommended institutional practice for propofol disposal was to place the unemptied propofol vial in an unsecured bin in the OR (n = 6; 2.8%) or dispose of the unused propofol into the garbage can (n = 5; 2.3%).

Figure 1 shows barriers experienced by CRNAs for sink disposal of propofol. The location of sinks outside the OR was a barrier identified in the survey by 86 CRNAs (74.8%); 64 CRNAs (55.7%) reported being concerned about the environmental risks associated with sink disposal; 48 (41.7%) expressed difficulty opening propofol vials; 43 (37.4%) reported time constraints associated with sink disposal; and 15 (13%) reported they had concerns for clogging the sink (totals > 100% due to ability to select more than 1 option). The most concern-



Figure 2. Tailored Interventions Implemented^a

^aPropofol bottle opener and activated carbon pouch were mounted to the anesthesia cart and used for propofol disposal in each operating room in the outpatient procedure center.

ing barriers to CRNAs were the limited access to sinks in the OR (n = 71; 39.4%) and the environmental risks associated with sink disposal (n = 69; 38.3%).

• **Tailored Interventions: Propofol Bottle Openers and Activated Carbon Pouches.** After presentation of the survey results to stakeholders at the institution, the stakeholders searched for an efficient and environmen-

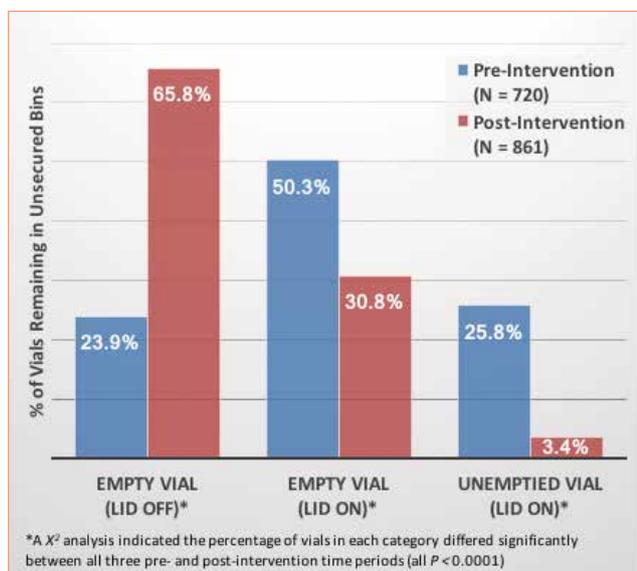


Figure 3. Data Results: Percentage of Propofol Vials Found in Unsecured Bins Before and After Tailored Interventions

tally friendly alternative to sink disposal of propofol that could be made available in the ORs. A means for safely and efficiently opening propofol vials was also considered. After evaluating costs and feasibility, a combination of interventions tailored to address identified barriers included (1) providing a bottle opener specifically engineered for propofol vials in each OR and (2) using resealable activated carbon pouches in each OR in which to pour unused propofol (Figure 2).

The biomedical engineering department at the institution designed a bottle opener to safely and conveniently open glass propofol vials. This design was sent to be manufactured and was produced for the institution (patent pending). A bottle opener was attached to the anesthesia cart in each OR with a wire cable.

Activated carbon pouches (Deterra, Verde Technologies, Minnetonka, MN) were ordered for the 6-week trial period for propofol disposal. The activated carbon in each pouch uses molecular adsorption technology to bind the propofol as it is poured into the pouch, deactivating the propofol and rendering it ineffective.³⁸ Each pouch was designed to be resealed and reused until full. The biodegradable pouch can then be sealed and disposed of in the garbage can, posing no harm to the environment.³⁸ A pouch was placed in a plastic container and attached to the anesthesia cart in each OR. Both the bottle opener and carbon pouch were also installed in each OR next to sinks previously used for propofol disposal, to facilitate use of these products. A representative for the activated carbon product was available at the time the intervention was implemented to answer questions regarding the product and its use.

• **Implementation of Propofol Disposal System in the**

Operating Room. Effectiveness of the new propofol disposal process in the OR was determined by comparing the number of unemptied propofol vials remaining in unsecured bins before and after implementation.

Preintervention data were collected from March 9, 2015, to April 17, 2015. During that 6-week period, 720 propofol vials were found in unsecured bins in the OPC. Postintervention data were collected from October 19, 2015, to November 27, 2015, during which period 861 propofol vials were found in unsecured bins. Figure 3 describes the percentage of vials remaining in unsecured bins before and after the tailored intervention and a description of the vial status (ie, empty vial with the lid off, empty vial with the lid on, and unemptied vial).

A χ^2 analysis indicated a statistically significant increase in the percentage of empty vials with the lid off from 23.9% to 65.8%; a statistically significant decrease in the percentage of empty vials with the lid on from 50.3% to 30.8%; and a statistically significant decrease in the percentage of unemptied vials from 25.8% to 3.4%. All differences were significant with a $P < .0001$.

Discussion

A confidential survey assessed CRNA knowledge of recommended institutional practice for propofol disposal, current practice for disposing of propofol, and barriers encountered to sink disposal of propofol according to recommended institutional practice. The survey results and evidence from the literature regarding the abuse potential of propofol both guided the recommendations for standardizing propofol disposal. This led to tailored interventions, including placing a bottle opener and carbon pouch in each OR. The new disposal process provided a more convenient method of propofol disposal and replaced sink disposal. After implementation, less propofol remained in vials, more propofol was inactivated, and less propofol was poured into the sink, addressing many environmental and diversion concerns. The practice change was supported for systemwide implementation.

This EBP project focused on one aspect of diversion prevention; however, a multifaceted approach may be necessary to address complex issues and considerably reduce drug diversion. The published case reports reflect the serious consequences of drug diversion, ranging from loss of license to death. Recommendations for diversion prevention published in the literature include (1) drug abuse education aimed at increasing awareness regarding the statistics and risk factors of substance abuse,^{19,22,23,27} (2) dispensing smaller vials of medication to decrease waste,^{5,10-13} and (3) regulating propofol as a controlled drug nationally^{16,21,22,27,30} or institutionally on a voluntary basis.^{15,20,21,23,24,28} Future EBP projects and research can evaluate strategies to address these issues.

Regulating propofol would require accounting for all unused drug.²⁰ Such a process has economic implications

for institutions to address the pharmacy involvement necessary to account for unused propofol, space needed for secure storage, and time and responsibility required by anesthesia providers and other staff to account for waste. In contrast, lack of regulation promotes ease of access, which is the most common reason among health-care providers for abusing propofol.^{15,16,19-30}

Barriers encountered during the implementation of this project included obtaining financial and personnel resources necessary to acquire the bottle openers and carbon pouches as well as assistance with OR installation of these products. Presenting the clinical problem and evidence regarding propofol diversion resulted in support for financial and personnel assistance from the anesthesia department in the institution. Operating room differences, particularly related to sink location throughout the institution, needed to be addressed during project implementation. The CRNAs and anesthesia technicians working in each area identified optimal locations for the bottle openers and carbon pouches to be installed. Staff education regarding use of the bottle openers and carbon pouches was provided at staff meetings, in an anesthesia department newsletter, and through email communication.

This project for propofol disposal did not address the prevention of propofol waste. Future research and EBP projects must be conducted to address economic concerns, patient variables, pharmacoeconomic issues, and variations in staff practice that may also influence propofol waste. In addition, further quality improvement projects can be conducted in various healthcare settings for disposal of drug waste using the carbon disposal system to prevent environmental harm secondary to sink disposal.

Conclusion

Propofol is known to have addictive properties consistent with being a drug of abuse. Survey research, retrospective studies, and case reports in the literature provide evidence that propofol is indeed being abused. Unique to propofol is its high incidence of fatal outcomes when abused. Ease of access is a primary reason that propofol abuse is increasing, making proper disposal of unused propofol a paramount concern. Tailored interventions to address barriers that CRNAs experience to disposal of propofol in the sink included using propofol bottle openers and carbon pouches, which significantly decreased the number of unemptied propofol vials remaining in unsecured bins in the ORs, thereby decreasing access for diversion. Future projects geared toward preventing waste would build on the results of this project and provide a comprehensive approach for addressing the environmental, economic, and diversion concerns related to propofol use.

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DISCLOSURES

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