Propofol Wastage in Anesthesia

Russell F. Mankes, PhD, Retired

BACKGROUND: Drug waste has been implicated as a significant contributor to environmental contamination and unnecessary health care costs.
METHODS: We collected the contents of pharmaceutical waste collection containers in each of 8 operating rooms, sorted them by hand, and tabulated the results. Propofol returned to the pharmacy was not counted as wasted drug.
RESULTS: Wasted or discarded propofol accounted for 45% of all the drug waste.
CONCLUSIONS: Propofol does not degrade in nature, accumulates in body fat, and is toxic to aquatic life. We reduced wastage by removing 50 and 100 mL vials of propofol from the pharmacy, retaining only the smallest size (20 mL). (Anesth Analg 2012;114:1091–2)

Drug waste contributes to environmental contamination with potential adverse ecologic effects.[1,2] The environmental toxicity of several anesthetic drugs is summarized in Table 1. Propofol is an environmental hazard because it does not degrade, accumulates in fat, is toxic to aquatic organisms, and requires incineration to be destroyed.[a] Drug wastage also increases health care costs.[3,4,5,6,7,8] Drug wastage can be reduced by providing feedback on wastage to clinicians.[7,9,10] We studied propofol usage and wasting at a surgical care center with 20, 50, and 100 mL vials of propofol.

METHODS

We analyzed pharmaceutical waste bins in 8 operating rooms of a small surgical suite from July 2008 through April 2009. The bins were emptied at least each week or when 3/4 full and sorted by hand by trained technical staff wearing appropriate personal protective equipment. The weight of propofol discarded in pounds (including vials and syringes) was recorded as an indicator of waste generation. We also collected self-reported data from our PYXIS® drug dispensing system on the quantity of drugs wasted at the bedside (e.g., discharged by the caregiver into the toilet, sink, or other water source). These data were combined with amounts (mL) of drug discarded into the pharmaceutical waste bins.

In August 2008, we eliminated the 50 and 100 mL propofol bottles from the formulary, replacing them with 20 mL propofol bottles. We examined the use and waste of propofol based on 153 records extracted from the PYXIS system. The accuracy of these records was assessed by comparing reported wastage to random visual checks of Sharps containers and trash receptacles, and random personal audits of staff knowledge and practice for disposing of pharmaceutical waste.

[a] USP Propofol Material Safety Data Sheet (MSDS) United States Pharmacopeial Convention, Inc. 2006.

From the Albany Medical Center/Albany Medical College, Albany, New York.

Accepted for publication February 3, 2012.

This study was supported by US EPA grant X9-97256506-0.

The author declares no conflicts of interest.

Reprints will not be available from the author.

Address correspondence to Russell F. Mankes, PhD, 141 Mohawk Drive Schenectady, NY 12303-5732. Address e-mail to rmankes@nycap.rr.com.

DOI: 10.1213/ANE.0b013e31824ea491

RESULTS

As depicted in Table 2, propofol was the most widely dispensed and wasted drug at the facility. Propofol accounted for 45% of the total drug waste by mL. Eliminating the 50 and 100 mL bottles of propofol reduced the facility's propofol waste from 29.2 mL/day/bin to 2.8 mL/day/bin.

DISCUSSION

Reduction in drug wastage occurs with feedback.[7,9] The behavior is reasonably understood for volatile anesthetics.[10] Reducing the size of propofol vials reduced the wastage of propofol at our facility. By reducing propofol wastage, the hospital reduced cost and the environmental impact of propofol, which does not degrade in nature, accumulates in body fat, and is toxic to aquatic life.

DISCLOSURES

Name: Russell F. Mankes, PhD.
Contribution: This author designed the study, conducted the study, analyzed the data, and wrote the manuscript.
Attestation: Russell F. Mankes has seen the original study data, reviewed the analysis of the data, approved the final manuscript, and is the author responsible for archiving the study files.
This manuscript was handled by: Steven L. Shafer, MD.

ACKNOWLEDGMENT

The author thanks Laurie DeWeerdt, BS for technical support.

REFERENCES

1. Alvarez D, Cranor W, Perkins S, Schroeder V, Werner S, Furlong E, Kain D, Brent R. Reconnaissance of persistent and emerging contaminants in the Shenandoah and James River Basins, VA, during Spring 2007. US Geologic Survey Open File Report 2008;1231:1–19
2. Gilbert N. Drug Waste Harms Fish. Nature 2011;476:265
3. Morgan TM. The economic impact of wasted prescription medication in an outpatient population of older adults. J Fam Prac 2001;50:779–781
4. Gillerman RG, Browning RA. Drug use inefficiency: a hidden source of wasted health care dollars. Anesth Analg 2000;91:921–924
5. Nava-Ocampo AA, Alarcon-Almanza JM, Moyao-Garcia D, Ramirez-Mora JC, Salmeron J. Undocumented drug utilization and drug waste costs of pediatric anesthesia care. Fundam Clin Pharmacol 2004;18:107–112
6. Weinger MB. Drug wastage contributes significantly to the cost of routine anesthesia. J Clin Anesthesia 2001;13:491–497

7. Lubarsky DA, Glass PS, Ginsberg B, Dear GL, Dentz ME, Gan TJ, Sanderson IC, Mythen MG, Dufore S, Pressley CC, Gilbert WC, White WD, Alexander ML, Coleman RL, Rogers M, Reves JG. The successful implementation of pharmaceutical practice guidelines. Analysis of associated outcomes and cost savings. SWiPE group. Systematic Withdrawal of Perioperative Expenses. Anesthesiology 1997;86:1145–1160
8. Dexter F, Lubarsky DA, Gilbert BC, Thompson C. A method to compare costs of drugs and supplies among anesthesia providers: a simple statistical method to reduce variations in cost due to variations in casemix. Anesthesiology 1998;88: 1350–1356
9. Body SC, Fanikos J, DePeiro D, Philip JH, Segal BS. Individualized feedback of volatile agent use reduces fresh gas flow rate, but fails to favorably affect agent choice. Anesthesiology 1999;90:1171–1175
10. Dexter F, Maguire D, Epstein RH. Observational study of anesthesia providers' fresh gas flow rates during anesthesia with desflurane, isoflurane, or sevoflurane. Anaesth Intensive Care 2011;39:460–464

Table 1. Properties and Amounts of Drugs Bedside Wasted at a Surgical Care Center

Generic name	PBT	Environmental risk	Ecotoxicity
Propofol	6	Low	Very toxic to aquatic organisms; may cause long-term adverse effects in the aquatic environment. LC50 Bluegill Sunfish 96 hr, 0.62 mg/L. Propofol has a high potential for bioaccumulation and high mobility in the soil. No evidence for biodegradability in water. Not biodegradable under anerobic conditions. For complete destruction of Diprivan(R), incineration >1,000°C for at least 2 sec required.
Lidocaine	3	Insignificant	Low toxicity to aquatic organisms. EC50 green algae 72 h 780 mg/L, EC50 Daphnia magna 48 h 112 mg/L, LC50 Zebra Fish 96 h 106 mg/L, EC50 (microtox test) 15 min >1,000 mg/L. Not readily biodegradable, has low potential for bioaccumulation. Disposal of waste material via high-temperature incineration is recommended.
Succinylcholine	ND	Not rated	ND
Bupivacaine	5	Cannot be excluded	Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment. EC50 (microtox test) 15 min >1,000 mg/L. EC50 Daphnia magna 48 h 39 mg/L. No observed effect concentration Daphnia magna 48 h 7.5 mg/L. Not readily biodegradable. Disposal of waste material via high-temperature incineration is recommended.
Ephedrine	3	Not rated	Readily biodegradable (according to OECD criteria). Acute and prolonged toxicity to fish: golden orfe/LC50 (96 h): approx. 460 mg/L. Acute toxicity to aquatic invertebrates: Daphnia magna/EC50 (48 h): 10–100 mg/L. Toxicity to aquatic plants: green algae/EC50 (72 h): 90.7 mg/L. Toxicity to microorganisms: activated sludge, domestic/EC20 (0.5 h): approx. 700 mg/L. Do not release untreated into natural waters.

PBT = persistance, bioaccumulation, and toxicity; ND = not determined, no data available. Y = yes, N = no. OECD = Organisation for Economic Co-operation and Development.

The column "PBT" recounts rankings (0–9, where 9 is worst) that express the inherent environmentally damaging characteristics of the substance. Persistence is the ability to resist degradation in the aquatic environment; bioaccumulation is the accumulation of pharmaceuticals in adipose tissue of aquatic organisms; and toxicity is the potential to poison aquatic organisms. Each of these characteristics is assigned a numerical value from 0 to 3. The total of these 3 values constitutes the PBT index for the substance (http://www.janusinfo.se/v/About-the-environment-and-pharmaceuticals/About-classification//?id=9933).

The data presented in the column marked "Risk" is also derived from the Stockholm County Council (http://www.janusinfo.se/v/About-the-environment-and-pharmaceuticals/About-classification//?id=9933). Environmental risk is based on the ratio between the predicted environmental concentration of a substance (PEC) and the highest concentration of the substance that does not have a harmful effect in the environment (PNEC). Risk is defined as insignificant if PEC/PNEC <0.1; low if PEC/PNEC 0.1–1; moderate if PEC/PNEC 1–10; and high if PEC/PNEC >10.

Column headed "Ecotoxicity" contains data derived from the Material Safety Data Sheets (MSDS), prepared by the manufacturer (Astra-Zeneca). Diprivan® (propofol) MSDS, Astra-Zeneca, 2006; Propofol MSDS United States Pharmacopeial Convention, 2006; West-Ward Epinephrine Injectable MSDS, West-Ward Injectables, 2011; Bupivacaine Hydrochloride Monohydrate MSDS, Astra-Zeneca, 2005; Xylocaine® Solutions with Epinephrine (lidocaine/epinephrine) MSDS, Astra-Zeneca, 2009; 2% Xylocaine® Viscous Solution (lidocaine) MSDS, Astra-Zeneca, 2010; (−)Ephedrine Sulfate Powder MSDS, BASF Canada, 2006; Epinephrine Safety data sheet according to Regulation (EC) No 1907/2006 (MSDS), Boehringer Ingelheim, 2008; Hospira Atracurium Besylate Injection MSDS, Hospira, 2011; Proparacaine HCl MSDS According to 91/155 EEC, Siegfried, 2010.

Table 2. Drug Wastage

Drug	Dispensed (mL)	Wasted (%)
Propofol	70,240	32%
Lidocaine	22,080	27%
Succinylcholine	8,630	41%
Bupivacaine	23,634	12%
Lidocaine and epinephrine	14,970	15%
Ephedrine	3,180	48%
Epinephrine	2,323	37%
Atracurium	2,130	34%
Proparacaine	1,648	39%
Atropine	1,118	37%