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In Reply:—We thank Green and Beger for their observations on the Combitude. We concur with their assessment that the possibility of excessive insertion may result in the inability to ventilate a patient's lungs. As with all airway devices, vigilance is the operative word. Sheridan Catheter will review the package insert for clarification of the depth of insertion and auscultation of breath sounds.

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A Simple Spreadsheet Tool for Cost Accounting Anesthesia Care

To the Editor:—Health-care providers, including anesthesiologists, are under increasing pressure to review the importance that cost factors play in their practices.¹ As an initial step, an accurate accounting of the cost of anesthetic agents is needed. We developed a cost accounting tool, using computer spreadsheets, that simply and rapidly quantitates nonpersonnel costs of anesthesia care.

Methods. A list of intravenous and inhalational anesthetic agents and several disposable anesthesia equipment items was compiled and entered into a computerized spreadsheet format using Microsoft's Excel for Windows, Version 5 program (fig. 1). The spreadsheet in-

corporated unit costs (cost paid to supplier), enabling the agents and items to be tracked and their costs totalled per anesthetic encounter. The cost estimates of volatile anesthetics were obtained from repetitive calculations of vaporizer settings and fresh gas flow rates at specific times using the formula²

$$\text{Cost} = (P \cdot F \cdot T \cdot M \cdot C) / (24.12 \cdot D \cdot 100),$$

where P = percent inspired anesthetic (volume %), F = fresh gas flow (l/min), T = time (min) anesthetic was being delivered at the

Table 1. Anesthetic Drug Waste (Drawn Up, but Unused) before and after an Educational Intervention Using the Spreadsheet Tool

Drug	mg/ml	Cost per ml	Waste in ml per Week		Waste Cost per Week (\$)	
			9/92	5/93	9/92	5/93
Midazolam	1.0	1.59	85	72	135.00	114.48
Fentanyl	0.05	0.12	114	144	13.68	17.28
Sufentanil*	0.01	8.65	59	14	102.07	24.22
Succinylcholine	20	0.04	443	43.5	17.72	1.74
Atracurium	10	4.21	117	6.5	492.57	27.37
Vecuronium	1	1.73	244	39.5	422.12	68.33
Propofol	10	0.525	418	257	219.45	134.93
Thiopental	20	0.10	844	1039	84.40	103.90
Ephedrine*	5	0.325	519	108	16.87	3.51
Phenylephrine*	0.1	1.78	327	45	5.82	0.80
Atropine	0.5	0.615	91	7.5	55.97	4.61
Glycopyrrolate	0.2	0.28	65	8.5	18.20	2.38
Total waste per week					1,583.87	503.55

* Diluted concentrations: sufentanil 10 µg/ml, ephedrine 5 mg/ml, phenylephrine 100 µg/ml.

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FIG-1.XLS

Case No.	019				Enflurane																	
Procedure	Right leg I&D	application of ext. fixator			Ent	Ent	Ent	Ent	Ent	Ent	Ent	Ent	Ent	Ent	Ent	Ent	Ent	Ent	Ent			
Date:					Mol weight	Mol weight	Mol weight	Mol weight	Mol weight	Mol weight	Mol weight	Mol weight	Mol weight	Mol weight	Mol weight	Mol weight	Mol weight	Mol weight	Mol weight			
DRUG	\$ Cost/mg	MG drawn up	MG given to patient	\$ Cost drawn up	\$ Cost used	\$ Cost of gases																
Alfentanil	\$3.5900	10	0.3	\$35.90	\$33.39		Enflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Atrecurium	\$0.4210			\$0.00	\$0.00		Enflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Atropine	\$1.2300			\$0.00	\$0.00		Enflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Bupivacaine .5%	\$0.0090			\$0.00	\$0.00		Enflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Desflurane %cc	0.29					\$0.00	Enflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Doxacurium	\$2.8000			\$0.00	\$0.00		Enflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Droperidol	\$0.0980			\$0.00	\$0.00		Enflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Edrophonium	\$0.0000			\$0.00	\$0.00		Enflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Enflurane %cc	0.5240					\$0.00	Enflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Ephedrine	\$0.0085			\$0.00	\$0.00		Enflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Eamolol	\$0.0980			\$0.00	\$0.00		Enflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Etomidate	\$0.7450			\$0.00	\$0.00		Enflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Fentanyl	\$2.3000			\$0.00	\$0.00		Enflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Glycopyrrolate	\$1.4000	0.3	0.3	\$0.42	\$0.42		Enflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Halothane %cc	0.0890					\$0.00	Halothane	197	197	197	197	197	197	197	197	197	197	197	197			
Isoflurane %cc	0.9000					\$8.73	Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Ketamine	\$0.0260			\$0.00	\$0.00		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Ketorolac	\$0.2020			\$0.00	\$0.00		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Lidocaine, Cardiac	\$0.0225			\$0.00	\$0.00		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Lidocaine, Epidural	\$0.0125			\$0.00	\$0.00		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Midazolam	\$1.5900	2	1	\$3.18	\$1.59		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Mivacurium	\$0.6270			\$0.00	\$0.00		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Morphine	\$0.0400			\$0.00	\$0.00		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
N2O (fl.)	0.0020	Liters used =	202	N2O =	\$0.40		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Neostigmine	\$1.4820	2.5	2.5	\$3.68	\$3.68		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Pancuronium	\$0.2000			\$0.00	\$0.00		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Phenylephrine	\$0.1780			\$0.00	\$0.00		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Propofol	\$0.0525			\$0.00	\$0.00		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Pyridostigmine	\$0.1100			\$0.00	\$0.00		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Scopolamine	\$2.0500			\$0.00	\$0.00		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Sod. Thiopental	\$0.0050	500	100	\$2.50	\$0.50		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Succinylcholine	\$0.0020	200	75	\$0.40	\$0.15		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Sufentanil	\$180.8800			\$0.00	\$0.00		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
Vecuronium	\$1.7300	20	18	\$34.60	\$31.14		Isoflurane	184	184	184	184	184	184	184	184	184	184	184	184			
EQUIPMENT	Unit Price	# Kits opened	# Kits used				Total cost of non-gas pharmacy drugs given to patient =													\$70.94		
Anes. Circuit	\$2.95	1	1	\$2.95	\$2.95		Nitrous Oxide plus potent inhalational agents =													\$9.14		
Epidural Tray	\$17.40			\$0.00	\$0.00		Equipment cost total =													\$10.28		
ETT (Adult)	\$1.80	1	1	\$1.80	\$1.80		Total cost of drugs administered to patient, plus gases and equipment used =													\$90.26		
Esoph. Temp.	\$2.95	1	1	\$2.95	\$2.95		Total opened															
Mask (disposable)	\$2.78	1	1	\$2.78	\$2.78		Total non-gas to patient															
Nasal Cannula	\$1.50			\$0.00	\$0.00		Total gases															
Needle (block)	\$11.50			\$0.00	\$0.00																	
Spinal Tray	\$11.50			\$0.00	\$0.00																	
				\$90.94	\$81.12	\$9.14																

Fig. 1. Spreadsheet tool to quantitate costs in an adult patient undergoing a 3.75-h orthopedic procedure using isoflurane, nitrous oxide, alfentanil, and vecuronium. Drug and equipment costs are entered in the left half, whereas inhalational agents (fresh gas flow, vaporizer setting) are entered in the right half of the sheet.

above P and F parameters, M = molecular weight of the anesthetic, C = cost of the liquid anesthetic in dollars/ml, D = density of the anesthetic, and 24.12 = liter volume of 1 mole of gas at 21°C. The formula was entered into the spreadsheet and then replicated to account for incremental time periods of different length, each with possibly differing fresh gas flows and vaporizer settings. The spreadsheet summated costs of the incremental time periods and transferred the subtotal to appropriate locations as shown in the example in figure 1.

The spreadsheet tool was used for two separate 1-week periods to determine the cost of drug waste (defined as opened but unused drugs left on the anesthesia carts at the close of the day). Educational efforts emphasizing awareness of waste were made during the interim separating the two periods.

The spreadsheet was also used to compare the costs of various anesthetic agents including muscle relaxants, propofol, opioids, and volatile anesthetics.

Results. The use of the spreadsheet tool allowed accurate and rapid determinations of the costs of the volatile agents as well as the intravenous drugs given to each patient during anesthesia. The use of the tool in concert with educational efforts reduced drug waste by \$1,000 per week, which was about 10% of our total weekly drug costs (table 1).

Discussion. The spreadsheet format was readily adaptable to additional changes encountered in anesthesiology. New agents or equipment could be added to the sheet, others could be deleted, and the prices could be modified with a few strokes on the keyboard. In addition, drug or equipment substitutions could be made to sim-

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ulate "what-if" scenarios for different conceived anesthetic plans. The spreadsheet tool was useful in identifying relative costs of groups of anesthetics and techniques (e.g., regional *vs.* general).

Conclusions. Accounting of anesthesia pharmaceutical and disposable equipment costs can be simplified with the use of a computer spreadsheet program. The use of a computer spreadsheet allows non-computer programmers to quickly set up a customized tool to identify anesthesia costs at their individual hospital institutions. Application of the spreadsheet tool permits accurate cost accounting for drugs given to the patient, as well as drugs that are drawn up but not used (*i.e.*, wasted at the close of each case). The tool allows comparative cost analysis between anesthetic techniques and agents and between individual anesthesia care providers. The tool also can be used to identify costly practices and monitor savings that result from educational efforts, as well as uncover or enhance the value of published clinical trials involving different anesthetic regimens.

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Insensitivity of Implicit Memory to Anesthesia Methods

To the Editor:—Schwender *et al.*¹ are to be commended for their pioneering exploration of relationships among midlatency auditory evoked potentials, implicit memory, and methods of general anesthesia. A note of caution concerning their results seems warranted, however. They state that "implicit recall was statistically significant more often in group 1 than in the control group (group 4) or group 2 or group 3 ($P < 0.01$)."¹ Readers should not interpret this statement to mean that flunitrazepam/fentanyl anesthesia (group 1) significantly increased the incidence of implicit memory relative to isoflurane/fentanyl (group 2) or propofol/fentanyl (group 3) anesthesia. The significance level of $P < 0.01$ in the statement apparently refers to a test comparing all four treatments and indicating that they were not all equivalent. Schwender *et al.* did not report additional analyses indicating whether groups 2, 3, and 4 individually differed from group 1. Such analyses, either with the chi-squared tests used by Schwender *et al.* or Fisher's exact tests, which are more appropriate because 50% of the cells have expected counts fewer than 5, indicate that group 1 differed significantly from group 4, but not groups 2 or 3 ($P = 0.051$ by chi-squared test and $P = 0.14$ by Fisher's exact test). Although the trend toward a greater incidence of implicit memory with the combination of the benzodiazepine and the opioid

than with the combinations of isoflurane or propofol with the opioid warrants further investigation, anesthesiologists' judgments about the choice of anesthetic regimens should not be influenced by these equivocal differences.

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