Study of direct variable anesthesia costs in the
dilatation and curettage patient

ANNE MEYER-McCRIGHT, CRNA, MNA
Macomb, Illinois
ROGER E. HOFER, MD
SAIT TARHAN, MD
Rochester, Minnesota
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This retrospective study was designed to compare the cost of anesthesia in three different groups of patients who received general anesthesia for a diagnostic dilatation and curettage procedure. The analysis included 194 patients, ASA physical status I, II, or III. All patients were outpatients with similar body mass index and age.

The three groups were thiopental/isoflurane (n = 13), propofol/isoflurane (n = 126), and propofol/desflurane (n = 55). Anesthesia drugs, volatile agents, personnel costs, and type of providers were included in the cost comparison.

The cost of supplies, inhalation agents, and drugs for the thiopental/isoflurane group were significantly different (P < .001) than the other two groups. The mean ± SD thiopental/isoflurane combination was $7.00 ± $2.74, whereas, the mean ± SD cost of the propofol/isoflurane and propofol/desflurane groups was $12.73 ± $3.57 and $14.40 ± $5.05, respectively. The mean ± SD cost of all three anesthetic drugs/volatile agents/endotracheal tube groups was $12.85 ± $4.35.

No statistically significant differences between the three groups were found in postanesthesia care unit (PACU) drug costs, anesthesia personnel cost, total direct anesthesia costs, or length of stay. The incidence of antiemetic administration intraoperatively and in PACU was significantly different (P < .001) between the thiopental/isoflurane group and the other groups. The thiopental/isoflurane group did not receive any antiemetics in either area, whereas the propofol groups received antiemetics 12.7% of the time.

The three anesthesia providers, Certified Registered Nurse Anesthetists, student registered nurse anesthetists (SRNA), and anesthesia residents were reviewed looking at anesthesia supply cost, personnel cost, and total direct anesthesia costs. No statistically significant differences were found between the groups.

We conclude that an anesthetic using thiopental/isoflurane is more cost-effective than propofol/desflurane or propofol/isoflurane anesthetics and the postoperative length of stay is no different for the three anesthetic approaches.

Key words: Anesthesia costs, propofol, thiopental, volatile agent costs.

Introduction
The challenge confronting all anesthesia providers involved in the care of the surgical patient is to continue to provide high-quality anesthesia care that is cost-effective. Unfortunately, many factors have combined to increase the cost of healthcare:
technology, labor, and new drugs. Inflation of pharmaceutical expenses has been dramatic over the past decade during which drug prices have surged, on average, at three times the rate of inflation.¹

Many of the new shorter acting anesthetic drugs and inhalation agents used in outpatient surgery are more expensive than the drugs they are replacing.² These drugs are primarily beneficial in ambulatory surgery areas because of purported shorter duration, faster recovery of the patient, and the potential for earlier patient discharge.

Informed decisions regarding anesthesia care include knowing the cost of that care and identifying the factors contributing to those costs. The term cost can be defined as the irreversible use of a resource. Direct costs are the actual payments for goods or services. Direct costs can be divided into fixed and variable costs. Fixed costs remain the same no matter how many goods or services are provided (i.e., rent on a building or long-term leased equipment). Variable costs change with the number of services or goods produced (i.e., the cost for syringes or anesthetic drugs). Strategies to lower costs result in greater profits, usually, if the strategy addresses variable costs.

Johnstone and Martine surveyed anesthesiologists in a select university regarding drug costs.³ When asked, few could provide accurate cost information to their patients. Only 21% could estimate costs within 20% of the actual value for two common anesthetic procedures.³ Mills and Chaffe performed a comparable study of cost awareness among physicians, nurses, and technicians and found that practitioners' knowledge regarding costs was highly inaccurate.⁴

Anesthesia expenses are only a small part of the total healthcare dollar. As revenue becomes less, the issue of cost-effectiveness becomes much more important. This retrospective study was designed to compare the cost of three different anesthetic approaches for the patient undergoing diagnostic dilatation and curettage (D&C). Another purpose of this study was to determine if there was a difference in the length of stay in the hospital in relation to the volatile and induction agents used.

A retrospective design was chosen to reduce the probability of bias. The three groups were identified as:

Group 1: thiopental and isoflurane
Group 2: propofol and isoflurane
Group 3: propofol and desflurane

Analysis included adjunctive agents used in these procedures and direct intraoperative anesthesia personnel cost.

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Materials and methods

The study was approved by the Mayo Foundation Institutional Review Board. Patients included in this study were between the ages of 18 and 70 years and were ASA physical status I, II, or III. All patients were outpatients and received general anesthesia for a diagnostic D&C procedure using the anesthesia care team approach that included Certified Registered Nurse Anesthetists (CRNAs), student registered nurse anesthetists (SRNAs), or anesthesia residents who were under the supervision of staff anesthesiologists. Systematic sampling of records for the last 3 years was performed, and data were collected by a retrospective analysis of the anesthesia record, operative note, and outpatient unit notes. The following data were recorded:

1. The arrival time in the operative suite, surgical start time, arrival in the postanesthesia care unit (PACU), discharge time from PACU, and discharge time from the hospital.
2. Volatile agents and carrier gases.
3. Dosages of induction agents and adjunctive drugs used intraoperatively and in PACU.
4. Use of an endotracheal tube or mask for airway management.
5. Type of anesthesia provider (CRNA, SRNA, anesthesia resident).

The cost of drugs administered during the perioperative period was calculated using a list of drug prices obtained from the hospital pharmacy. This analysis ignored factors such as drug wastage from partially used vials and syringes.

Anesthesia time was defined as the period between admission to and discharge from the operating room. This calculated time was then multiplied by a weighted work unit to reflect the direct anesthesia personnel cost.

Oxygen and nitrous oxide costs were calculated based on data provided by the respiratory therapy department. The cost of the volatile anesthetics was calculated using the following formula obtained from the agent's manufacturer:

\[
\text{Volatile Agent Cost} = \frac{\text{Inspired Concentration} \times \text{Flow} \times \text{Molecular Weight} \times \text{Time} \times \text{Price/mL}}{\text{Molar Volume of Agent} \times \text{Density}}
\]

Definitions are as follows:

Concentration of gas, percentage of volatile agent on vaporizer dial.
Flow rate, total carrier gas flow rate (\(N_2O\) and \(O_2\)).
Molecular weight, g/mole or daltons (SI units) for volatile agent.
Time, minutes.
Price/mL, volatile agent cost to the institution.
Anesthesia supplies were defined as the combined cost of inhalational anesthetics, intravenous drugs given intraoperatively, and the cost of the endotracheal tube, where applicable.

Of the 755 charts reviewed, 194 completed records were included in this analysis. Duration of anesthesia, cost of perioperative medications, volatile and carrier gas costs, length of stay postoperatively after discharge from the PACU, antiemetic use, anesthesia provider, and endotracheal intubation were analyzed using a one-way analysis of variance, Bonferroni, and $t$ test. All results are reported as the mean ± SD.

**Results**

The patient population was primarily healthy; 92.3% were designated ASA I or II physical status. The groups were comparable with respect to age, sex, body mass index, and ASA physical status (Table I). Statistical analyses were performed on the remaining three induction agent/volatile agent groups: thiopental/isoflurane ($n = 13$), propofol/isoflurane ($n = 126$), and propofol/desflurane ($n = 55$). There was a statistically significant difference ($P < .001$) between the groups in the rate of intubation. The thiopental/isoflurane group had a higher percentage of intubation (84.6%) compared with the propofol groups (66.8%).

The cost of anesthetic supplies was $12.85 ± $4.35 (Table II). The thiopental/isoflurane group was significantly different ($P < .001$) than the other two groups. The drug and supply cost of the thiopental/isoflurane combination was $7.00 ± $2.74, whereas the cost of the propofol/isoflurane and propofol/desflurane combinations was $12.73 ± $3.57 and $14.40 ± $5.05, respectively. The thiopental dose was 375 ± 104 mg, and the propofol induction dose was 173 ± 36 mg.

No significant differences between the three groups were found in PACU drug costs, anesthesia personnel costs, or total direct anesthesia costs (see Table II). The difference in discharge time from the hospital was not statistically significant for the

| Table I
Demographic data
<table>
<thead>
<tr>
<th>Thiopental/isoflurane ($n = 13$)</th>
<th>Propofol/isoflurane ($n = 126$)</th>
<th>Propofol/desflurane ($n = 55$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>49 ± 12.36</td>
<td>47.75 ± 12.16</td>
</tr>
<tr>
<td>Body mass index (kg/m$^2$)</td>
<td>28.1 ± 5.81</td>
<td>27.2 ± 8.1</td>
</tr>
<tr>
<td>ASA physical status (I/II/III)</td>
<td>2/9/2</td>
<td>31/87/8</td>
</tr>
<tr>
<td>Mask/endotracheal tube</td>
<td>2/11</td>
<td>44/82</td>
</tr>
</tbody>
</table>

Values are means ± SD. No significant differences were found.

| Table II
Direct costs and time
<table>
<thead>
<tr>
<th>Thiopental/isoflurane ($n = 13$)</th>
<th>Propofol/isoflurane ($n = 126$)</th>
<th>Propofol/desflurane ($n = 55$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anesthesia time (minutes)</td>
<td>41 ± 13.7</td>
<td>39.2 ± 10.2</td>
</tr>
<tr>
<td>Anesthesia personnel cost</td>
<td>$71.00 ± $23.90</td>
<td>$68.50 ± $17.00</td>
</tr>
<tr>
<td>Volatiles/drugs/endotracheal tube cost</td>
<td>$7.00 ± $2.70*</td>
<td>$14.40 ± $5.00*</td>
</tr>
<tr>
<td>Total anesthesia cost</td>
<td>$77.90 ± $23.30</td>
<td>$82.90 ± $18.80</td>
</tr>
<tr>
<td>PACU time (minutes)</td>
<td>66.5 ± 4.6</td>
<td>66.0 ± 16.9</td>
</tr>
<tr>
<td>Time from PACU until discharge from hospital (hours)</td>
<td>2.76 ± 1.4</td>
<td>2.85 ± 1.5</td>
</tr>
</tbody>
</table>

Values are means ± SD.

*Statistically significant ($P < .001$)
PACU – Postanesthesia care unit
three groups. The incidence of antiemetic administration intraoperatively and in PACU was significantly different \( (P < .001) \). The thiopental/isoflurane group did not receive any antiemetics in either area, whereas the propofol groups received antiemetics 12.7% of the time (Figure 1).

The three anesthesia providers were reviewed looking at anesthesia supply cost, personnel cost, and total direct anesthesia costs. No statistically significant differences were found in the groups. There was a statistically significant \( (P < .001) \) lower rate of intubation with the SRNAs (51.0%) compared with the CRNAs (76.2%) and the anesthesia residents (74.5%) (Table III).

### Discussion

These data indicate that the direct anesthesia costs for the thiopental/isoflurane group were approximately half the costs of the other approaches. The cost of the thiopental/isoflurane combination was approximately half the cost of the propofol anesthetics. This was attributed to the cost of propofol in the anesthetic regimen. In operations of about 50 minutes’ duration, Philip et al found that the average cost of isoflurane was $10.95 and the cost of propofol, including wastage, was $19.95.5

There was no difference in PACU or postoperative length of stay in the hospital in the three groups. This is in contrast to several studies in which ambulatory patients receiving propofol-based anesthetics were able to sit and stand and had a shortened recovery stay compared with patients receiving other anesthetic combinations.6-9 It should be noted that the anesthetics were not performed in an ambulatory care center. Although propofol is more expensive than thiopental, it can actually reduce overall hospital costs when used in appropriate cases and when hospitals change practice patterns to allow earlier dismissal of adequately recovered patients.6-10 To achieve these savings, however, PACU and hospital discharge times should be geared toward discharge criteria rather than designated time spent in first- and second-stage recovery areas.

There was no use of antiemetics intraoperatively or in PACU for the thiopental/isoflurane group compared with use in the propofol groups. This was unusual given propofol’s antiemetic qualities.7 This may be due to the relatively low number of anesthetics given in the thiopental group \( (n = 13) \). Antiemetic use was not tracked after discharge from the PACU.

The anesthesia costs between providers did not vary. The relatively short procedure time may have contributed to this lack of difference. The fre-

### Table III

<table>
<thead>
<tr>
<th></th>
<th>CRNA ((n = 63))</th>
<th>SRNA ((n = 80))</th>
<th>Anesthesia resident ((n = 51))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatiles/drugs/endotracheal tube cost</td>
<td>$12.67 ± $ 3.76</td>
<td>$12.56 ± $ 3.68</td>
<td>$13.59 ± 5.73</td>
</tr>
<tr>
<td>Anesthesia personnel cost</td>
<td>$70.55 ± $17.40</td>
<td>$66.50 ± $17.81</td>
<td>$69.34 ± $12.81</td>
</tr>
<tr>
<td>Total anesthesia cost</td>
<td>$83.17 ± $18.44</td>
<td>$79.06 ± $18.11</td>
<td>$82.93 ± $14.31</td>
</tr>
<tr>
<td>Mask/tube</td>
<td>15/48</td>
<td>39/41</td>
<td>13/38</td>
</tr>
<tr>
<td>Anesthesia time (minutes)</td>
<td>40.76 ± 7.55</td>
<td>38.63 ± 7.77</td>
<td>40.08 ± 7.41</td>
</tr>
</tbody>
</table>

Values are means ± SD.

CRNA – Certified Registered Nurse Anesthetist

SRNA – Student Registered Nurse Anesthetist
quency with which SRNAs intubated patients was significantly lower than the other groups of providers; program education requirements may explain this difference.

Limitations of this analysis must be recognized. First, this study was conducted at a tertiary care facility with CRNAs, SRNAs, and anesthesia residents providing patient care with the anesthesia care team philosophy. The cost of capital equipment was not calculated, and patient satisfaction was not assessed.

Conclusion
An anesthetic using thiopental/isoflurane is more cost-effective than propofol/desflurane or propofol/isoflurane anesthetics, and discharge time was not affected using a shorter acting drug and volatile agent.

All anesthesia providers must address issues of direct and indirect costs. As the demand to reduce healthcare costs continues to rise, it is inevitable that the costs associated with the practice of anesthesia will become an issue. We must be aware of how our choices affect all areas of the hospital.

REFERENCES

AUTHORS
Anne Meyer-McCright, CRNA, MNA, is employed at the McDonough District Hospital, Macomb, Illinois.
Roger E. Hofer, MD, is a consultant in Anesthesiology at Mayo Clinic, Rochester, Minnesota, and an assistant professor of Anesthesiology at the Mayo Graduate School of Medicine, Rochester, Minnesota.
Sait Tarhan, MD, is a consultant in Anesthesiology at Mayo Clinic and a professor of Anesthesiology at the Mayo Graduate School of Medicine.

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