Financial Implications of Intravenous Anesthetic Drug Wastage in Operation Room

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Abstract

Background and Objectives: Anesthetic drugs and material wastage are common in operation rooms (ORs). In this era of escalating health-care expenditure, cost reduction strategies are highly relevant. The aim of this study was to assess the amount of daily intravenous anesthetic drug wastage from major ORs and to estimate its financial burden. Any preventive measures to minimize drug wastage are also looked for.

Methods: It was a prospective study conducted at the major ORs of a tertiary care hospital after getting the Institutional Research Committee approval. The total amount of all drugs wasted at the end of a surgical day from each major OR was audited for five nonconsecutive weeks. Drug wasted includes the drugs leftover in the syringes unutilized and opened vials/ampoules. The total cost of the wasted drugs and average daily loss were estimated.

Results: The drugs wasted in large quantities included propofol, thiopentone sodium, vecuronium, mephentermine, lignocaine, midazolam, atropine, succinylcholine, and atracurium in that order. The total cost of the wasted drugs during the study period was Rs. 59,631.49, and the average daily loss was Rs. 1987.67. The average daily cost of wasted drug was maximum for vecuronium (Rs. 699.93) followed by propofol (Rs. 662.26).

Interpretation and Conclusions: Financial implications of anesthetic drug wastage can be significant. Propofol and vecuronium contributed maximum to the financial burden. Suggestions for preventive measures to minimize the wastage include education of staff and residents about the cost of drugs, emphasizing on the judicious use of costly drugs.

Keywords: Anesthetic drugs, cost-minimization, wastage
have anesthesia workstation with facilities to conduct low flow anesthesia. Drugs directly voided into waste bin rarely by some anesthesiologists also could not be studied. The decisions on drug preparation and dose administered were entirely taken by the anesthesia provider who was blinded to the study. In our institution, all anesthetics are available in each OR itself. Only opioids were issued by the recovery room nurse on per patient basis after entering patient details in an opioid register. The day-to-day preparation of anesthetic drugs varies with OR depending on the choice of the consultant anesthesiologist in charge of that OR and patient characteristics.

The total no of anesthetics done were also noted. The study was conducted at our MOT complex which has 10 ORs for general surgery, neurosurgery, urology, gastrosurgery, plastic and reconstructive surgery, oral and maxillofacial surgery, and orthopedics surgery. The ORs outside the MOT complex such as pediatric surgery, obstetrics and gynecology, cardiothoracic surgery, ophthalmology, otorhinolaryngology, and emergency ORs were not included in the study due to practical reasons.

Data collected were tabulated and analyzed. The total amount of drugs wasted during the study period was calculated. Average drug wasted per day and their costs were estimated. Cost estimation was done by multiplying the amount of drug wasted by the unit price of the drug. Unit price was derived from the average of maximum retail prices of the locally available brands of each drug during the study period. Any preventive measures to minimize the drug wastage were looked for and included as suggestions.

## Results

During the study period, a total of 644 cases were done reflecting the high volume of cases in our institution. The observation revealed that 2 ampoules of atropine, 30 mg mephentermine or ephedrine, 250 mg thiopentone sodium or 10 ml propofol, 100 mg succinylcholine, 100 mg lignocaine, and 2 mg midazolam were routinely loaded for all cases. Of the several drugs wasted, drugs wasted maximum was propofol (77.76 ml/day) followed by thiopentone sodium (38.6 mg/day), mephentermine (32.23 mg/day), vecuronium (23.56 mg/day), midazolam (17.03 mg/day), atropine (15.66 mg/day), and dexmedetomidine (15 µg/day). Some drugs such as atropine drawn into the syringe were never utilized at all. The total amount of wasted drugs and average daily wastage for each drug is shown in Table 1.

Cost estimation of wasted drug was done by multiplying the amount of drug wasted by the unit price of drugs [Table 2] available in market during the study period. The average daily financial loss was also calculated.

The cost analysis revealed that the cost of total wasted drug for the study period was Rs. 59,631.49, and average daily financial loss was Rs. 1987.67. Further analysis showed that vecuronium contributed maximum to the financial loss being 35.21% of total loss (Rs. 699.93/day) followed closely by propofol 33.46% (Rs. 662.26/day). Although the total volume of drug wasted for thiopentone sodium and mephentermine was higher than vecuronium, being cheaper drugs, they accounted for lesser financial loss (Rs. 54.23/day and Rs. 121.06/day, respectively) only. But unlike this dexmedetomidine having a high unit price caused a higher percentage to financial loss (4.63%) even though the wastage was minimal (30 µg/day). Due to strict regulations in use of opioid, wastage was negligible.

Our study underestimated the actual total wastage from our institution as only 10 ORs in the MOT complex were included in the study. Wastage from the other ORs outside the MOT complex, which were not included in the study, could have added more than the measured amount to total wastage. The total no of cases done under anesthesia from our institution in the year 2015 was 18,675 (11,027 elective and 7648 emergency cases). Extrapolating the results the approximate total institutional financial loss could be as high as Rs. 17 lakhs annually ($25,757.58).

## Discussion

In our study, we observed that the maximum amount of drug wasted by volume was propofol, followed by thiopentone sodium, mephentermine, and vecuronium. Cost estimation revealed that total financial loss during the study period was Rs. 59,631.49, and average daily loss was Rs. 1987.67. The average daily cost of wasted drug was maximum for vecuronium (Rs. 699.93) followed by propofol (Rs. 662.26).

Propofol, being a major contributor to drug wastage (33.46%), should be handled carefully. A previous report from India found that cost of wasted propofol contributed maximum to total loss (56.27%).[3] Western reports also highlighted that most

### Table 1: Amount of wasted drugs during the study period

| Drug            | Total volume of wasted drug (ml) | Total wasted drug (mg) | Average wastage/day (mg) |
|-----------------|---------------------------------|------------------------|--------------------------|
| Atracurium      | 235                             | 587.5                  | 7.83                     |
| Atropine        | 470                             | 282                    | 15.66                    |
| Dexmedetomidine | 90                              | 900                    | 30                       |
| Ephedrine       | 38                              | 228                    | 1.6                      |
| Glycopyrrolate  | 30                              | 6                      | 1                        |
| Ketamine        | 111                             | 1110                   | 3.96                     |
| Lignocaine      | 585                             | 11,700                 | 19.5                     |
| Mephenetermine  | 967                             | 5802                   | 32.23                    |
| Midazolam       | 511                             | 255.5                  | 17.03                    |
| Ondansetron     | 56                              | 112                    | 1.86                     |
| Propofol        | 2333                            | 23,330                 | 77.76                    |
| Succinylcholine | 375                             | 18,750                 | 12.5                     |
| Thiopentone sodium | 1158                         | 28,950                 | 38.6                     |
| Vecuronium      | 707                             | 707                    | 23.56                    |
Table 2: Cost estimation of wasted drugs

| Drug               | Unit price (Rs. *) | Total cost on wasted drug (Rs.) | Average cost/day (Rs.) | Percentage of total loss (%) |
|--------------------|-------------------|---------------------------------|------------------------|----------------------------|
| Atracurium         | 5.2/mg            | 3055                            | 101.83                 | 5.12                       |
| Atropine           | 7.66/mg           | 2161.8                          | 121.068                | 3.63                       |
| Dexametomidine     | 3.073/µg          | 2765.97                         | 92.19                  | 4.638                      |
| Ephedrine          | 0.78/mg           | 177.84                          | 5.92                   | 0.29                       |
| Glycopyrrolate     | 80/µg             | 480                             | 16                     | 0.84                       |
| Ketamine           | 0.233/µg          | 258.63                          | 8.62                   | 0.433                      |
| Lignocaine         | 0.0516/µg         | 603.72                          | 20.124                 | 1.01                       |
| Mephenetermine     | 0.626/µg          | 3632.05                         | 121.068                | 6.09                       |
| Midazolam          | 6.172/µg          | 1576.94                         | 52.56                  | 2.64                       |
| Ondansetron        | 4.09/µg           | 458.08                          | 15.26                  | 0.768                      |
| Propofol           | 8.516/ml          | 19,867.82                       | 662.26                 | 33.46                      |
| Succinylcholine    | 0.105/µg          | 1968.75                         | 65.62                  | 3.30                       |
| Thiotepone sodium  | 0.0562/µg         | 1626.99                         | 54.23                  | 2.72                       |
| Vecuronium         | 29.76/µg          | 20,997.9                        | 699.93                 | 35.21                      |
| Total              |                   | 59,631.49                       | 1987.67                | 100                        |

*One US dollar=Rs. 66

Dollars were wasted for propofol, and 20% of this wastage was avoidable.[4] The opening of 50 ml vials just for induction and filling up of 50 ml syringe pumps for the maintenance of a short case could be the major cause for this wastage as the majority of wasted propofol was found to be in 50 ml vials and syringe pumps. The unused propofol was discarded after 6 h of opening for the fear of infection. Procuring 20 and 10 ml vials could be an option to limit this wastage. Even though smaller vials have higher unit price than 50 ml vial, by reducing overall wastage, we may be able to reduce actual financial loss. Decision to open which vial should be taken considering the purpose of drug and duration of case. Elimination of 50 and 100 ml vials has been found to produce a drastic reduction in daily propofol wastage.[5] For the purpose of induction with propofol and maintenance on inhalational agent, a 20 ml vial will suffice for most adult patients. Selecting the appropriate size vial and better communication with assistant/technician about anesthetic technique will definitely reduce its wastage. Propofol wastage has greater implications as it does not get degraded in nature and has possible harmful ecologic effects.[6,7] On the other hand propofol, anesthesia has advantages such as faster recovery, reduced postoperative nausea-vomiting, and shortened stay in postanesthesia care unit (PACU) which will definitely cause cost savings in other areas.[8,9]

Vecuronium contributed the most to the financial loss (35.21%) in our study. In some countries, 30% of annual anesthetic budget was constituted by neuromuscular blockers.[10] Judicious use of neuromuscular blockers, assessing the degree of blockade, and loading only the required amount are essential to limit the wastage. Another possible option is procuring 4 mg vials. Even though the volume of thiopentone sodium wasted was higher than any other drug, it amounted to only 2.72% of the financial loss due to low unit price. Knowledge about the inexpensive nature of thiopentone sodium and easy availability in hospital supply may explain the unexpected increased wastage of it as anesthesia providers may have never felt the need to save this drug.[11] Unlike thiopentone sodium, although wastage was minimal, dexametomidine contributed to a higher percentage to financial loss due to its high unit price. However, advantages of dexametomidine usage such as reduction in anesthetic and opioid requirement, faster recovery, and early discharge from postoperative Intensive Care Unit should be borne in mind.

Atropine and mephenetermine accounted for 3.6% and 6.1% of total financial loss in our study. Significant wastage of atropine and ephedrine has been reported in earlier studies also.[11] It is a routine practice to load 2 ampoules of atropine and 30 mg of mephenetermine or ephedrine anticipating any intraoperative complications. This may be justified only if it is a single anesthesiologist and no assistant to help is available. Otherwise loading only one ampoule of atropine or keeping it near the anesthesia workstation is sufficient as a safeguard against intraoperative bradycardia. Adequate fluid management, assessing, and limiting the level of the neuraxial blockade would be helpful to decrease the need for mephenetermine/ ephedrine. Prefilled syringes for atropine and ephedrine can reduce the wastage and allow cost-minimization.[11,12]

A previous study[11] has reported wastage of 100% of loaded adrenaline. However, in our study, we found no such wastage as routine loading of adrenaline is not practiced in our institution. In the same study, significant wastage of neostigmine (4.12%) was also reported but was not observed in our study. The use of lignocaine was to abolish the stress response of intubation and extubation and for preventing pain on propofol injection. In this case, wastage can be limited by drawing only the required amount and making it available near workstation. Even though financial loss from other drugs such as midazolam, succinylcholine, and atracurium appear smaller, considering the large volume of cases in our institution it could contribute to a significant loss annually. Similar observation
was made by previous authors also. Routine preparation of succinylcholine for all adult cases anticipating emergency intubation or airway complications such as laryngospasm is also questioned. Anesthetic cost accounted for only 5.6% of the overall perioperative expenditure of a surgical patient, but 40% of total hospital expenditure comes from ORs. Although anesthetic drug cost constituted a smaller fraction of total hospital expenditure, they are constantly under scrutiny by the hospital financial department/administrator. The limited availability of resources to meet health-care needs and significance of developing methods to decrease the health-care expenditure are stressed. Anesthetic drug wastage varies with anesthesia provider and institution.

Anesthesiologists may not be aware of the specific cost of a particular anesthetic technique or procedure. Junior residents and anesthesia technicians should be made aware of the cost of the drugs and importance of waste reduction strategies. A previous study on cost-minimization in anesthesia found that the mean cost per case decreased significantly following application of an interventional education program focused on waste reduction. They also emphasized the importance of reinforcing such educational programs at regular intervals. A recent retrospective before and after intervention study found that decreasing the accessibility of few of the cost-prohibitive agents caused a significant reduction in anesthetic cost without any effect on patient outcome.

A better understanding of pharmacokinetics and discussing anesthetic technique before starting up a case with assistant may be helpful. Placing a price list near drug tray will function as a visual reminder of importance of waste reduction. Information on price per hour or cheaper alternatives available will work better than a long list of unit price of agents. Keeping an emergency drug tray attached to workstation, systematically arranged and labeled, and making anesthetic drugs easily available will prevent unwanted loading of all drugs. Assessing the drug requirement for a particular procedure before starting, will help us to preserve the unused drugs under sterile condition. Other methods to suggest include implementation of practice guidelines for drug usage, feedback about drug wastage to provider, involvement of senior faculties in monitoring the practice of waste reduction protocols and yearly audits. Seminars/symposiums on anesthetic drug wastage and cost reduction strategies should be emphasized in conferences and continuing medical education programs.

Choice of anesthetic drugs and technique could affect 50% of intraoperative anesthetic cost. Anesthesiologist’s role in cost saving spread beyond the operation suite in decreasing postoperative complications and hospital stay by ensuring enhanced recovery and better postoperative analgesia. A previous study found that by ensuring adequate postoperative analgesia with epidurals, 30% of hospital charges could be reduced. Choosing appropriate drugs and techniques for a particular case will reduce intraoperative anesthetic requirement, extubation time, PACU stay, and discharge time. Use of low fresh gas flow rates and promoting day case surgery is some other aspects of interest when considering overall cost reduction.

Few of the limitations of our study include: (1) Drugs rarely voided into sharps bin directly could not be studied (2) volatile agents were not studied. This study underestimated the actual total drug wastage from our institution as the ORs outside the MOT complex were not included, which could have doubled the measured loss.

We hope our study will definitely raise cost awareness among the residents/assistants of our department so that we will be able to follow cost containment measures more effectively in future. Further studies on wastage of volatile agents and other materials in anesthesia are needed to assess the effectiveness of cost reduction strategies.

**CONCLUSIONS**

Intravenous anesthetic drug wastage is common, and the concerned financial loss may be significant. Propofol and vecuronium contributed maximum to the financial burden. Although some amount of drug wastage is inevitable in anesthesia, a few waste reduction strategies suggested would be helpful in decreasing the financial loss without compromising the quality of patient care. Although the financial loss per case may be negligible, considering the large number of case, it could account for a huge annual budget.

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**Conflicts of interest**

There are no conflicts of interest.

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