

Intravenous Anaesthetic Drug Wastage and Its Financial Burden on A Tertiary Care Hospital in Sri Lanka

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With recent advancements in anaesthetic management where newer drugs and innovative treatment modalities are being introduced, the healthcare cost has increased and it is prudent to reduce the healthcare expenditure in a developing country such as Sri Lanka without compromising on patient care. Reducing drug wastage, can reduce the impact on hospitals pharmaceutical budget. The present study was conducted to assess the wastage of intravenous anaesthetic drugs and to assess its economic impact at a tertiary hospital in Sri Lanka. Following ethical clearance and institutional approval, a prospective study was conducted at all operations rooms at a tertiary care hospital for four consecutive weeks. Intravenous anaesthetic drugs left in syringes, vials and opened ampules not used were documented at the end of each day. The total and daily cost of drug wastage was calculated using the unit price list issued by the Ministry Of Health, Sri Lanka. The largest volume of drug wastage was from Propofol 1489.28 mg. per day followed by Ephedrine (145.35 mg per day). The total financial loss during the study period was Rupees. 164477.95, and the average daily loss was Rupees. 5874.21. The maximum daily cost of drug wastage was due to Metaraminol (Rupees. 3537.9) followed by Propofol (Rupees. 616.35). The financial impact from anaesthetic drug wastage was considerable with Metaraminol and Propofol being the main contributors. Educating the staff on drug costs, employing practical methods to reduce wastage and frequent audits can be used as a wastage cost reduction strategy.

Keywords: Intravenous, Anaesthetic, Wastage

Introduction

With the recent advancements in anaesthetic management where new drugs and innovative treatment modalities are being introduced, the healthcare cost has increased. In this context, it is imperative to reduce the healthcare expenditure in a developing country such as Sri Lanka without compromising on patient care.

Reducing drug wastage is one such option. Cost of drug wastage takes up a substantial portion of a hospitals budget.^{1,2} Prior studies have found anaesthetic drugs take up 5% or less of a

hospitals pharmacy expenditure³, this does not mean anaesthetic drug costs can be ignored, rather prioritize our efforts for cost-saving interventions. Anaesthetic drugs such as Propofol has greater implications on being discarded as it does not degrade in nature and has possible harmful ecological effects.⁴

Waste from drug administration could be due to difficulties in anticipating variations in patient response. Waste reduction strategies reduce cost without substantial effects on patient outcomes.² It was noted that 20-50% of drugs drawn up are never used but discarded and it may be possible to estimate rational amounts of drugs needed prior to a procedure while preserving unused drugs under optimal and sterile conditions.^{5,6}

Previous studies on anaesthetic wastage were conducted by recording unused drugs that were discarded at the end of the day and through nurses drug records.² Prior studies found that Propofol, Thiopental, Vecuronium, Ephedrine and Atropine accounted for a higher percentage of financial impact in drug wastage.^{7,8,9}

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Received: 06/03/2022

Accepted: 03/02/2023

DOI: <https://doi.org/10.4038/slja.v31i1.9027>



Cost-cutting strategies such as educating the staff on drug costs, rational use of expensive drugs and reducing wastage can be implemented.¹⁰ It must be kept in mind the anaesthetic management and drug prescription varies in various countries, for different patient populations and according to the surgery. It has been demonstrated that reduction of drug wastage happens with feedback.¹¹

Objective

This study was conducted to assess the wastage of intravenous anaesthetic drugs used intraoperatively in the Teaching Hospital Anuradhapura and to assess its economic impact, and based on the findings, suggest actions to lessen it.

Method

Following institutional approval and ethical clearance this prospective clinical study was conducted over a period of four consecutive weeks at surgical operating rooms (OR) of Teaching Hospital Anuradhapura (THA), a tertiary care hospital in Sri Lanka from the 1st of December 2021 to the 29th December 2021. Data collected in the study was the amount (mg/mcg) of discarded intravenous anaesthetic drugs at the end of the operation day and excluded from the study were all discarded non-intravenous anaesthetic medication (epidural, subcutaneous, intra-neural, topical, sub arachnoid) during the study period.

Data collection was done by a research assistant (Relief House Officer attached to the Department of Anaesthesiology, THA) who was not involved in the case management and the drug preparation in the operation theatre. The drug preparation and administration of anaesthetic drugs were decided by the anaesthetist in-charge looking after the patient and he/she was kept blinded during the audit. The drug preparation varied depending on the patient and the surgery. The data was collected from the nurse's medication notes and the anaesthetic notes and drugs left to be discarded at the end of the day at the operations

theatre. The wasted drugs were defined as drugs loaded for a case but not utilized during the case and which cannot be re-used (such as drugs left in syringes, opened vials, and ampules). Inhalational anaesthetics were not included in the study as they can be re-used and the majority of anaesthetic machines that operate under low flow anaesthesia and wastage was deemed minimal. Anaesthetic drugs that were discarded in trash was not accounted.

The operation theatres included in the study performed cases with regard to general surgery, orthopaedic surgery, urology, ENT, neurosurgery, plastic and reconstructive surgery, vascular surgery, obstetrics and gynaecology, onco surgery, gastro surgery, paediatric surgery, ophthalmic surgery, Vitreo-retinal surgery and oral & maxillofacial surgery. Patients received general, regional and local anaesthesia for the surgical procedures which ranged from emergency to elective surgeries.

The number of surgical operations conducted under general anaesthesia was collected for the respective day from the case registry at the operation theatre.

Using the unit price of the drug in Sri Lankan Rupees, from the price list from the Medical Supplies Division (MSD), the Ministry of Health, Nutrition & indigenous Medicine of Sri Lanka for the year 2020, cost estimation of wasted drugs were calculated.

Results

During the study period of four consecutive weeks a total of 1433 surgical procedures were performed and of those 596 (41.6%) cases were performed under general anaesthesia.

Volume wise, the maximally wasted drug was propofol (1489.28 mg/day) followed by ephedrine (145.35 mg/day), ketamine (130 mg/day), thiopental (89.28mg/day), atracurium (43.92 mg/day), morphine (35.39 mg/day) and succinylcholine (25.71 mg/day). (Table 1.)

Table 1: Amount of drug wasted during the study period.

Drug	Total volume of drug wasted (ml)	Total wasted drug (mg)	Average daily wasted drug (mg)
Propofol	4170	41700	1489.28
Ephedrine	135.67	4070	145.35
Ketamine	19.30	3640	130
Thiopental	2.5	2500	89.28
Atracurium	123	1230	43.92
Morphine	66.06	991	35.39
Succinylcholine	7.2	720	25.71
Atropine	368.83	221.3	7.90
Midazolam	43.9	219.5	7.83
Adrenaline	197	197	7.03
Metaraminol	12.3	123	4.39
Ondansetron	3	12	0.43
Etomidate	7	7	0.25
Neostigmine	1.8	4.5	0.16
Fentanyl	46.5	2.325	0.08
Remifentanyl	1.5	1.5	0.05
Naloxone	1.5	0.6	0.02
Dexmedetomidine	1.43	0.28	0.01

The total cost of wasted intravenous anaesthetic drugs during the study period accounted for Rs. 164477.95 with an average daily loss of Rs. 5874.21. Further analysis found that

metaraminol accounted for the maximum financial loss of Rs 3537.9 daily (60.23%) followed by propofol Rs 616.35/ day (10.49%) and ephedrine Rs 308.35 /day (5.25%). (Table 2.

Table 2: Calculated cost of wasted drugs during the study period

Drug	Price/mg (Rs)	Total drug wastage (Rs)	Average daily loss (Rs)	Percentage (%)
Metaraminol	805.37	99061.24	3537.9	60.23
Propofol	0.41	17257.96	616.35	10.49
Ephedrine	2.12	8633.82	308.35	5.25

Adrenaline	40.68	8013.96	286.21	4.87
Ketamine	1.93	7027.45	250.98	4.27
Atracurium	4.34	5338.69	190.66	3.25
Morphine	3.75	3716.25	132.72	2.26
Atropine	16.1	3562.93	127.24	2.17
Dexmedetomidine	11000	3135	111.96	1.91
Remifentanil	1.90	2859.48	102.12	1.74
Succinylcholine	3.76	2710.72	96.81	1.65
Thiopental	0.40	1006.22	35.93	0.61
Midazolam	3.79	831.9	29.71	0.51
Fentanyl	274.7	638.67	22.80	0.39
Naloxone	555.12	333.07	11.89	0.20
Etomidate	33.	231.04	8.25	0.14
Neostigmine	22.5	101.28	3.61	0.06
Ondansetron	1.51	18.19	0.64	0.01

Discussion

This study demonstrated that the maximum financial loss during the period was from Metaraminol, Propofol, Ephedrine, Adrenaline and Atracurium. This has a negative impact on the budget of the hospital and patient care, especially in a developing country like Sri Lanka. The main reasons for the higher drug wastage in our hospital might be due to lack of protocol for appropriate use of drugs and lack of awareness about wastage and cost of drug

Propofol is the most commonly used intravenous induction agent for the maintenance of anaesthesia in certain surgical cases. Propofol accounted for 10.49% of the total financial loss due to wastage of drugs during the study period which was found to be less than that of previous studies, which found it to account for 33.46% (10) to 56.27% (8) of the total financial loss. If

not for Metaraminol, Propofol would account for 26.38% of the wastage. Propofols' inexpensiveness and readily availability might have also resulted in the large volume of wastage (total of 4.17L) with a lower-than-expected financial impact. The Propofol 50ml vial was commonly used in the OR and the 20ml vial was seldom used. The opening of the 50ml vial for a short surgical operations list with a single case, preloading large volumes for induction and maintenance of anaesthesia and vials elapsing the safe period of use after breakage were the main reasons for the wastage. The United States Food and Drug Administration (US-FDA) recommends that Propofol must be handled with strict aseptic technique and each vial of Propofol is intended for single administration for an individual patient. It should be used within 6 hours of starting as an infusion. These recommendations need to be enforced and reiterated among anaesthetists to provide safe

patient care. Discussing with the authorities to procure 10ml and 20ml vials and reducing 50ml and 100ml vials has been found to reduce Propofol wastage.⁴ Discussing with the surgical team the anaesthetic requirements will also reduce wastage. Reduction in propofol wastage is important due to its environmental impact as it is poorly degraded.

Daily wastage of Metaraminol was calculated to be 60.23% (3537.9 Rs). Metaraminol was used as an emergency anaesthetic drug and our study found it to be commonly used in labour OR. Metaraminol comes in 10mg/ml vials and is diluted with Sodium Chloride 0.9% to a dilution of 0.5mg/ml. The wastage was due to the pre-drawn metaraminol being discarded after single use or at the end of the operations day. In a recent study on wastage of emergency drugs in labor theatres, a consensus was drawn to keep 5ml from 20ml of diluted Metaraminol readily drawn and rest stored at 2 to 8°C to minimize wastage.¹² Metaraminol, after dilution has been found to have in-use chemical and physical stability for 48 hours when stored between 2 to 8°C, this practice needs to be implemented in the OR to reduce the wastage.¹³

Atracurium was the most widely used neuromuscular blocking agent in our study. With atracurium, sterility needs to be maintained as it is a multidose vial. Its' wastage amounted as a percentage of total cost was nearly twice as that of Suxamethonium. Amucheazi et al, found atracurium accounted to 37.78% of drugs wasted due to not being used after loading into syringes for surgical cases.¹⁴ Judicious use with constant neuromuscular status assessment and educating anaesthetists on price of the drug has been found to reduce the wastage of Atracurium.¹⁵ Furthermore, calculating the dose according to patients' body weight prior to use and not keeping it preloaded reduces wastage.¹⁶ Succinylcholine wastage was due to the practice of pre-prepared drugs being discarded at the end of the day. Pre-preparation was rationalized by the reduction of the 'decision to delivery' time when a single anaesthetist is working where pre-

preparation and dilution is considered necessary (paediatric surgery). Pre-filled syringes have led to 'syringe swap' or 'wrong drug' errors and the costs due to these complications can be more than 20 times the cost of the drug.^{17,18} Pre-preparation of succinylcholine for adult cases is not practiced at our hospital.

Atropine and Ephedrine are commonly used during anaesthesia and accounted for 2.17% and 5.25% respectively of the total financial loss due to wastage. This was comparable to previous findings of 3.6% and 6.1% respectively.¹⁰ It is common practice to load 2 ampules of 0.6mg atropine and 30mg of Ephedrine and keeping it close to the anaesthetic workstation for emergency use. The use of prefilled drugs can be justified as it reduces delay and eliminates dilution errors leading to cost reductions.^{19,20} The reduction of cost is mainly due to fewer medication errors and the consequences thereof. However, in the present study the wastage was due to pre-prepared drugs being discarded at the end of the day due to not being used. Using one vial of atropine for pre-filled syringe and keeping it where its easily accessible to all anaesthetists and maintaining adequate fluid balance and level of neuraxial block can decrease the need for ephedrine and atropine, leading to reduction in wastage.

Prior studies found 95.24% of loaded adrenaline was never used (8). The financial loss due to adrenaline in our study was 4.87% of the total and it was due to the practice of preloading adrenaline to 1:10,000 in every operations theatre room. With the study evidence, it is practical not to pre-prepare adrenaline in operation rooms as it was seldom used, and if it was prepared, to keep such preparations easily accessible to any anaesthetist who may need it.

Simple measures such as educating anaesthetists with regard to drug costs is effective in reducing drug expenditure while maintaining the standards of patient care and safety as price labelling of drugs which had increased cost lead to consciousness among anaesthesiologists,

leading to reduced expenditure.^{1,15} Education programs at regular intervals have been found to be an effective strategy and posters on drug costs put up in theatres, anaesthetic rooms and recovery rooms can reduce wastage through acting as a visual reminder.^{8,21} Active involvement of all stakeholders and regular supervision and monitoring of the modifications to practices need to be done.

Hence, education programmes should be reinforced at regular intervals not only in operation theatres but also in other areas of the hospital, if the cost reduction is to be maintained in the health care system. Anaesthetists should play an active role in providing information to the pharmacists of the needs to reduce unnecessary procurement of wasteful drugs. Refreshing knowledge on the pharmacology of anaesthetic drugs and calculating drug doses for each drug for each case prior to commencement dependent on patients' weight would lead to appropriate loading of drugs and reduce wastage. Emergency drugs, if arranged close to the anaesthetists' workstation, making it easily accessible will prevent unwanted loading of drugs. Maintaining sterility when using multiple-use-vials reduces wastage due to contamination and keeping a vial cutter to break ampules reduces wastage from ampule breakage.

Limitations

In our study we only included intravenous anaesthetic drugs, but wastage from local, regional anaesthetics and volatile agents were not included and further studies can be undertaken to include these. Our cost assessment is an under estimation of the financial loss due to loaded syringes and unused vials being discarded directly into the waste bin and not collected for study purposes. Furthermore, larger study is needed to include the wastage due to consumables (syringes, nerve conduction needles, spinal needle etc.) associated with anaesthesia.

Conclusion

The wastage from anaesthetic medication during the study period was a considerable amount and the proposed changes of educating the anaesthetists of the drug costs and employing practical methods to reduce wastage can be implemented to reduce wastage with no impact on patient care and safety. Furthermore, frequent audits need to be performed to identify issues and apply rectifying measures. Physician education on drug costs, discussions and guidelines on drug preparations for surgical procedures can be used as a wastage cost reduction strategy.

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