Original Article

Anesthetic drug wastage in the operation room: A cause for concern

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Abstract

Context: The cost of anesthetic technique has three main components, i.e., disposable supplies, equipments, and anesthetic drugs. Drug budgets are an easily identifiable area for short-term savings.
Aim: To assess and estimate the amount of anesthetic drug wastage in the general surgical operation room. Also, to analyze the financial implications to the hospital due to drug wastage and suggest appropriate steps to prevent or minimize this wastage.
Settings and Design: A prospective observational study conducted in the general surgical operation room of a tertiary care hospital.
Materials and Methods: Drug wastage was considered as the amount of drug left unutilized in the syringes/vials after completion of a case and any ampoule or vial broken while loading. An estimation of the cost of wasted drug was made.
Results: Maximal wastage was associated with adrenaline and lignocaine (100% and 93.63%, respectively). The drugs which accounted for maximum wastage due to not being used after loading into a syringe were adrenaline (95.24%), succinylcholine (92.63%), lignocaine (92.51%), mephentermine (83.80%), and atropine (81.82%). The cost of wasted drugs for the study duration was 46.57% (Rs. 16,044.01) of the total cost of drugs issued/loaded (Rs. 34,449.44). Of this, the cost of wastage of propofol was maximum being 56.27% (Rs. 9028.16) of the total wastage cost, followed by rocuronium 17.80% (Rs. 2856), vecuronium 5.23% (Rs. 840), and neostigmine 4.12% (Rs. 661.50).
Conclusions: Drug wastage and the ensuing financial loss can be significant during the anesthetic management of surgical cases. Propofol, rocuronium, vecuronium, and neostigmine are the drugs which contribute maximally to the total wastage cost. Judicious use of these and other drugs and appropriate prudent measures as suggested can effectively decrease this cost.

Key words: anesthetic drug, wastage,cost , operation room

Introduction

Anesthesiology as a medical specialty has shown a major technical and scientific evolution in the last two decades. The development of newer anesthetic drugs, devices, materials, and techniques has increased the direct anesthetic costs for which cost contention programs are advocated.[1] The cost of anesthesia drugs and equipment has increased considerably and this may have important implications especially in poor countries. A major area of decreasing the cost of anesthesia is through a decrease in drug wastage, which may decrease the cost of anesthesia without compromising on the quality of care being given. We conducted a prospective observational study to assess and estimate the amount of anesthetic drug wastage in the operation room (OR) and to analyze the financial implications to the hospital due to this wastage of drugs and suggest appropriate steps to prevent it.

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Materials and Methods

This prospective observational study was conducted in the general surgical OR of a tertiary-care hospital. Ninety-eight cases were included in the study. Surgeries conducted under both regional and general anesthesia on patients belonging to ASA physical status I and II and age greater than 12

years were included in the study, while surgeries conducted under local anesthesia were excluded from the study. Ethical committee clearance and consent of study patients were not needed, as the study did not involve any alteration or intervention in the patient anesthesia management plan and involved collection of data after the case was conducted.

The drug preparation and the doses administered were as decided by the anesthesiologist conducting the case, who was unaware of the study. The data for drug wastage were collected after the case was over, by an independent anesthesiologist who was not involved in the case management. The amount of drugs issued for the case by the nursing staff was noted and the amount left unutilized after the case was over was noted from the remaining ampoules/vials and the drugs left in syringes/vials. The amount of drugs actually administered to the patient was noted at the end of surgery from the anesthesia chart. The amount of drug loaded in the syringes in each case before giving any drug to the patient and any ampoule or vial broken while loading was noted from the drug inventory being maintained as per the institutional protocols. Drug wastage was considered as the amount of drug left unutilized in the syringes after the completion of case. A note was made of the drugs which were loaded but not used at all during the surgery. The drugs that were leftover in the syringe after use were discarded after each case as waste. The drugs which were not used even once were retained for use in the next case. The vial of propofol was discarded after 6 h of opening it and any residual drug left in the vial was included in waste. If needed, another new vial was opened. Morphine was made in the concentration of 1.5 mg/ml and loaded in two 5 ml syringes, containing 7.5 mg morphine each. The cost of inhalation agent was not included in the study as any drug left in vaporizer could be used for another case and was not considered wasted.

A cost estimation of the amount of drugs wasted was done. The amount of drug wasted was multiplied by the maximum retail price of the drug per unit available in market at the time of study (Appendix 1). An estimate of the cost of wasted drug per case was made by dividing the cost of drug wasted in study by the number of cases in which the drug was loaded. Also, an estimate of the percentage of cost of waste due to a particular drug with respect to the total wastage during the study period was done.

The possible areas for reduction in drug wastage were identified and possible measures are suggested.

Results

Ninety-eight cases were included in the study of which 74 were conducted under general anesthesia and 24 under regional anesthesia. The study revealed that the wastage of various drugs varied from 7.4% to 100% [Table 1]. The maximum percentage waste of loaded drugs was seen with adrenaline and lignocaine which showed wastage of about 100% and 93.6%, respectively. The drugs which accounted for maximum wastage due to not being used after loading into syringe were adrenaline, succinylcholine, lignocaine, mephentermine, and atropine [Table 1]. It was observed that 5 ml of lignocaine, 2 ml of succinylcholine, and three ampoules of atropine were loaded in each case. It was also found that a total of 350 ml of propofol was loaded in cases performed under regional anesthesia, which was not used at all. In 44 cases, succinylcholine was loaded and not used, which accounted for 92.63 % of the total wastage of the drug. In 16 cases, it was found that the rocuronium wasted was more than or equal to 5 ml (one vial of rocuronium), thus indicating that the wastage could have been much less had these vials not been loaded and could have been used in other patients. The study revealed wastage of one ampoule of adrenaline and morphine each being wasted due to breakage while trying to cut the ampoule for loading.

The cost analysis revealed that the total cost of the drugs loaded/issued during the study period was Rs. 34,449.44. Of this, only drugs amounting to Rs. 18,405.43 were used while drugs amounting to Rs. 16,044.01 were wasted [Table 2]. Further analysis of the cost of total wastage (Rs.16,044.01) for the study duration [Table 2] revealed that the cost of wastage of propofol was maximum being 56.27% (Rs. 9028.16) of the total wastage cost, followed by rocuronium 17.80% (Rs. 2856), vecuronium 5.23% (Rs. 840) and neostigmine 4.12% (Rs. 661.50). In a patient undergoing an anesthetic procedure utilizing morphine, propofol, rocuronium, neostigmine, and glycopyrrolate, the cost of drug wastage would amount to Rs 215.50, apart from the regular preparations of atropine, succinylcholine, and lignocaine in each case amounting to Rs. 19.04.

Discussion

We observed that the maximum percentage wastage of loaded drugs was seen with adrenaline and lignocaine, which showed wastage of about 100% and 93.6 %, respectively. Although adrenaline was loaded in only 20 cases in our study, it was hardly ever required in routine cases and resulted in waste. It is possible that the anesthesiologist was anticipating some anesthetic/surgery related complications intraoperatively in such cases as it was not found to be a routine practice in every case. The practice of loading adrenaline may appear to be relevant in anticipated cases (like hydatid cyst, anticipated airway edema, etc.) in centers where the anesthesiologist is

Table 1: Amount of drug wastage of various drugs

Drug	No of cases in which drug loaded	Amount of drug issued/ loaded	Amount of drug used	Amount of drug wasted (%)	Amount of drug loaded and not even used once (%)	Amount of drug loaded and not used wrt. wasted drug (%)
Propofol	70	2600 ml	1176 ml	1424 ml (54.76)	350 ml (13.46)	24.57
Thiopentone	15	7500 mg	2100 mg	5400 mg (63.53)	-	-
Succinylcholine	72	144 ml	49 ml	95 ml (65.97)	88 ml (61.11)	92.63
Lignocaine	60	314 ml	20 ml	294 ml (93.63)	272 ml (86.62)	92.51
Adrenaline	20	21 ml	0 ml	21 ml (100)	20 ml (95.24)	95.24
Atropine	73	203 ml	60 ml	143 ml (70.44)	117 ml (57.64)	81.82
Morphine	57	705 mg	300 mg	405 mg (57.45)	-	-
Fentanyl	8	700 μg	420 mcg	280 μg (40)	-	-
Rocuronium	48	395 ml	259 ml	136 ml (34.43)	5 ml (1.27)	3.68
Vecuronium	16	164 mg	122 mg	42 mg (25.61)	16 mg (9.76)	38.10
Neostigmine	35	470 ml	323 ml	147 ml (31.28)	-	-
Glycopyrrolate	35	81 ml	75 ml	06 ml (7.41)	-	-
Midazolam	12	21 ml	7.5 ml	13.5 ml (64.29)	8 ml (38.10)	59.26
Mephentermine	19	570 mg	33 mg	537 mg (94.21)	450 mg (78.95)	83.80

Table 2: Cost evaluation of study drugs

Drug	Cost of drug issued/ loaded (Rs.)	Cost of drug used (Rs.)	Cost of drug wasted (Rs.)	Cost wasted of total wastage (%)	Cost of wasted drug per case (Rs.)
Propofol	16484	7455.84	9028.16	56.27	128.97
Thiopentone	487.5	136.5	351.00	2.19	23.40
Succinylcholine	763.2	259.7	503.50	3.14	6.99
Lignocaine	270.04	17.2	252.84	1.58	4.21
Adrenaline	105	0	105.00	0.65	5.25
Atropine	812	240	572.00	3.56	7.84
Morphine	705	300	405.00	2.52	7.10
Fentanyl	266	159.6	106.40	0.66	13.30
Rocuronium	8295	5439	2856.00	17.80	59.50
Vecuronium	3280	2440	840.00	5.23	52.50
Neostigmine	2115	1453.5	661.50	4.12	18.90
Glycopyrrolate	486	450	36.00	0.22	1.03
Midazolam	107.1	38.25	68.85	0.43	5.74
Mephentermine	273.6	15.84	257.76	1.61	13.57
Total cost	34449.44	18405.43	16044.01	NA	NA

working single handed and especially in the less-developed countries where anesthesia assistants are often neither well educated nor well trained. A more prudent way would be to keep adrenaline ampoules on/near the anesthetic machine with a saline filled syringe so that it can be easily accessed and prepared when needed.

The use of lignocaine in the study was limited to prevention of pain of propofol injection. Lignocaine may be mixed with propofol or 1–2 ml may be loaded in the syringe and given prior to propofol injection instead of loading 5 ml in each case. Easy accessibility of lignocaine multidose vials on/near the anesthetic machine, in case of need, would limit wastage to a large extent.

The use of atropine was primarily for reversal of neuromuscular blockade. Thus, depending on the need for atropine to reverse neuromuscular blockade in select cases, the atropine may be loaded accordingly as required. In all other cases, one ampoule may be loaded preoperatively as a prophylaxis for treatment of any intraoperative bradycardia (preventing the wasteful loading of atropine preoperatively when glycopyrrolate is to be used for reversal of neuromuscular blockade). In centers where premixed ampoules of neostigmine and glycopyrrolate are available/used for reversal, there may not be any need to draw up more than one ampoule of atropine.

It was found that no patient required more than 20 ml of propofol for induction of anesthesia (usually less than 15 ml suffices), so a prudent way would be to load up to the upper limit range for induction (2.5 mg/kg) which would be less

than 20 ml for an average 60–70 kg patient so as to prevent wastage due to drug left in the syringe. Also, the opening of 50 ml vials on the days of a short OR case list or a single major case or cases under regional anesthesia would amount to a lot of wastage due to recommendation to discard the vial after 6 h of opening. A majority of wastage of propofol were observed to be due to drug left in the vial. Thus, a better option for management would be to procure 20 ml vials. Although these vials might appear to be slightly costlier, the overall wastage when reduced could perhaps reduce the cost of wastage. Also, wastage due to loading of propofol in 20 ml syringes for regional anesthesia and then being left unused can be minimized by discussing the plan of anesthesia beforehand and keeping the vial of propofol available in OR in case of need.

The wastage of rocuronium can be prevented by appropriately loading the drug for each case (per kg body weight basis) so that the sterile drug left in the multidose vial can be used in other cases and is not wasted. Judicious decision regarding which neuromuscular blocker to be used in each case, constant assessment of the requirement of neuromuscular blocker intraoperatively, and loading the drug according to patient's requirement is essential to eliminate unnecessary drug wastage. Neuromuscular blocking drugs have been found to constitute 30 % of the total anesthetic drug budget in certain countries and being costly, need to be a major area of cost consideration.[2] Although their use cannot be supplemented by any other drug, judicious use is always a possible option to decrease the cost.

A method to decrease wastage of morphine would be to first load it in 10 ml syringe and then load in separate syringes for each case as per the body weight of the patient. This may help in utilization of one ampoule of morphine for up to 3 cases and a resulting decrease in wastage of the drug. This will require the consent of the nurse in charge of drugs as narcotics are very tightly controlled drugs and sharing of an ampoule between consecutive or non consecutive patients may be a problem.

Mephentermine wastage can be minimized by avoiding the loading of 30 mg in each case, and instead loading 15 mg in cases anticipating hypotension. Proper fluid preloading/coloading before neuraxial anesthesia, assessment of vascular status of the patient and assessment of the level of sensory block may be helpful in predicting the need for mephentermine. So restricting the loaded dose to 15 mg rather than 30 mg would likely decrease the wastage by almost half. Easy availability of the drug intraoperatively in case of need should also be ensured. Some anesthesiologists may consider the option of loading the drug only if required.

The drug doses should be calculated for each case being posted in OR based on patient's weight and the usual dose range of that drug for the procedure. The calculated dose may be displayed on the machine before the start of each case. This would help in estimating the drug needs of the patient for that procedure and ensure appropriate loading thus preventing wastage.

Formulation of an emergency kit containing two ampoules of emergency drugs, such as atropine and adrenaline, and ensuring easy availability of vials of propofol, succinylcholine, and lignocaine on/near the anesthesia machine would prevent unnecessary loading of these drugs hence minimizing wastage and would also ensure availability in case of need. Implementation of drug pharmacy providing prefilled syringes of drugs as per the need and demand of each case may help in reducing wastage as it will provide drugs based on body weight and the amount left in multidose vials may be used to provide prefilled syringes for another case and ensure judicious distribution of drugs. The use of ampoule cutters to break ampoules reduces the wastage due to breakage of ampoule before loading.

The hospital operating costs directed to anesthetic pharmaceuticals form a great proportion of variable anesthetic supply costs. Strategies are required to minimize anesthetic costs and yet maintain the quality of health care.[1] Limitation of drug expenditure by decreasing the wastage of drugs used has been suggested by Gillerman.[3] Decreasing wastage is an attractive strategy because it does not limit specific drug selection by anesthesia providers.[4] It may be very useful when patients bearing the brunt of health care expenditure are from a lower socioeconomic group.

The cost analysis revealed that of the total cost of the drugs loaded/issued (Rs. 34,449.44) during the study period, only drugs amounting to Rs. 18,405.43 were used and drugs amounting to Rs. 16,044.01 were wasted. This implies that the drugs actually used during the study period accounted for only 53.43% of the total cost of drugs issued while the wastage of drugs accounted to 46.57% of the total cost borne by the hospital on drugs. The findings reflect that the cost of drug wastage was 87.17% of the cost of drugs used, which indicates the need for awareness regarding wastage of drugs and their prudent management.

Further analysis of the cost of total wastage (Rs. 16,044.01) for the study duration [Table 2] revealed that the cost of wastage of propofol was maximum being 56.27% (Rs. 9028.16) of the total wastage cost, followed by rocuronium 17.80% (Rs. 2856), vecuronium 5.23% (Rs. 840), and neostigmine 4.12% (Rs. 661.50). This was in contrast to Lustig A *et al.*[5] who found the wastage cost of rocuronium

(72%) to be higher than propofol (13%), though there is a similarity in rocuronium and propofol being the two major drugs amounting to wastage cost. Wastage due to discarded propofol accounted for 18%–20 % of total intraoperative costs in various studies.[6-8] We found the cost of wasted propofol to be 56.27% of total drug wastage costs. The differences in study designs and nonconsideration of cost of inhalational agents, cost of disposables, and of the anesthesiologist in our study may account for these differences. Moreover, the differences in drug practices and the availability of different sizes of vials in various institutions may vary the amount of wastage and the wastage costs. Although the volume of thiopentone wasted was higher (63.53% of loaded drug) than propofol (54.76%), the higher cost of propofol and rocuronium may account for the cost implications. Thus, due consideration must be given to the cost per unit of each drug and drugs with high cost strictly demand prudent use and should be only minimally wasted.

The analysis of our study reveals that the cost of drug wastage in a patient undergoing a surgery utilizing morphine, propofol, rocuronium, neostigmine, and glycopyrrolate for anesthesia would amount to Rs. 215.50 apart from the current regular preparations of atropine, succinylcholine, and lignocaine in each case amounting to Rs. 19.04. This amount may appear small, but when considered in context of the large number of cases done in a year with such an anesthetic practice, would amount to be a significant fraction of the total health expenditure as illustrated by Kumar *et al.*[4] and Watcha *et al.*[9]

Interventional education in the form of lectures teaching the above suggested measures, putting posters in theatres, anesthetic rooms, theatre lounges, and recovery rooms may be a very essential step in reducing drug wastage.[4,10] Displaying the prices of drugs on anesthesia machine would help as visual reminders of cost consideration apart from posters. The active involvement of senior registrars and faculty members in stressing and monitoring the above suggested modifications of current drug preparations and their usage practices would be most useful and effective. Education programs on drug-wastage reduction practices should be held repeatedly at 3–6 monthly intervals as the cost containment achieved is not sustained long after the educational measures are discontinued.[4]

Finally, the need for repeated audits to compare the success and compliance of the measures suggested in cost containment cannot be overemphasized. This helps to know what effects the steps suggested have caused and what further changes in the existing practice can cause more cost containment. A reward system for the doctor/OR team causing minimum wastage would be a good boost and ensure competitiveness for cost minimization.

The amount of waste varies from institution to institution.[11] The utilization of unused loaded drugs for the next case in our institution may have accounted for a lower estimate of drug waste costs in our study. At the same time, waste is said to be operator dependent and varies from one anesthesiologist to another.[11] Investigating costs and benefit of strategies applied by different anesthesiologists from various institutes may help in finding ways to decrease cost.[12] Constant discussions/meetings and creation of forums stressing on decreasing the costs of anesthetic drug wastage needs considerable importance. Inclusion of seminars/discussions on the cost of anesthetic techniques and reduction of drug wastage as an essential component of conferences is the need of the hour.

Conclusion

We conclude that drug wastage and the ensuing financial loss may be significant during anesthetic management. This is a cause of concern as anesthetic costs are viewed as expenditure by the hospital financial department and are constantly under the scanner, especially in corporate hospitals. Although the use of drugs should not and cannot be restricted to decrease costs and hence compromise patient care, the simple measures suggested would be helpful in decreasing drug wastage and the cost of the anesthetic without altering the quality of patient care.

Appendix 1: Market price of various drugs at the time of study

Drug	Cost per unit (Rs)
Propofol	6.34/ml
Thiopentone	0.065/mg
Succinylcholine	5.30/ml
Lignocaine	0.86 /ml
Adrenaline	5.00/ml
Atropine	4.00/ml
Morphine	1.00/mg
Fentanyl	0.38/μg
Rocuronium	21.00/ml
Vecuronium	20.00/mg
Neostigmine	4.50/ml
Glycopyrrolate	6.00/ml
Midazolam	5.10/ml
Mephentermine	0.48/mg

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