

Audit on Wastage of Commonly Used Anaesthetic and Analgesic Agents in Developing Country: The Case of Ethiopian University Teaching Hospital

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Abstract

Background: Anaesthetic drug wastage is a common challenge encountered in current anaesthetic care. Drug wastage is a potential area that significantly contribute for unnecessary health care budget allocation and financial lose. The aim of this study was to assess the amount of anaesthetic drug wastage and to analyze the cost of wasted drug in four operation room.

Methods: A prospective observational study was conducted from January 10 to January 26, 2017 in the three-major surgical and one obstetric operation room of university of Gondar teaching hospital. During consecutive period, data on amount of drug used or discarded were collected on patients undergoing surgical procedures under general or spinal anaesthesia. The total cost of used and wasted drug was estimated.

Result: Of 86 patients included in the study, 54.6% were operated under general anaesthesia and 31.4% were under spinal anaesthesia. From 18 commonly used anaesthetic drugs, 16 of drugs were included into the final analysis. Of 16 different anaesthetic drugs, the maximum amount of wastage after loaded in syringes but not used, partially unused in ampoules or vials per case basis were seen in propofol, tramadol, and diclofenac (23.72 mg, 18 mg, and 10.6 mg, respectively). A total of 1967.8 Ethiopian birr (89.44 USD) were the cost of wasted drugs, of these the cost of wasted bupivacaine was maximum (33.8%).

Conclusion: There was a significant amount of anaesthetic drugs and financial wastage during perioperative anaesthetic management for different surgical procedure. The use of drugs like neostigmine, metoclopramide, cimetidine and acetaminophen was best practice of usage during the study period no wastage was seen in those drugs. The use of fentanyl was also good which is 3.7% compared to other drugs.

Keywords: Drug wastage; Anaesthetic drug and wastage; Cost and drug wastage

Background

Despite limited resources and skilled professionals, anaesthetic service shows a major progress in in terms of anaesthetic techniques and best evidence-based practice in developing countries. Spending on anaesthesia drugs, anaesthesia machine and monitoring may represent majority of allocated hospital budget. In a time of increasing price of anaesthetic drugs, minimization of wastage of drugs is crucial and this may have a positive implication particularly for underdeveloped countries [1,2].

Several evidences suggest that wastage of anaesthesia drugs may be occurred during perioperative period at any time and most importantly during emergency situation. Prevalence of drug wastage might be high during use of IV anaesthetic, unexperienced anaesthetist, working alone, and trainees. It is also prevalent when working in new setup, handling for emergency and pediatric patients [2,3,4]. Current evidence shows that discarding of unused intravenous anaesthetic agents are common due to different reasons, when

compared to inhalational anaesthetic agents, are packed in subtle volume [5,6].

It is clear that for prevention of contaminations from infection, partially used ampoules and syringes are discarded at the end of the procedure; even unused syringes are discarded specially during shift work time of anaesthetist [6].

Waste reductions strategies of anaesthetic agents are one of increasing efficient use of resources in anaesthesia department. It enables to decrease run out of drugs for effective patient management with the most likely drug indication in according to the cause. Generally, it preserves proper utilization of hospital budget and unnecessary cost expenditure. Avoiding total wastage of IV anaesthetic drugs are not possible but focusing on reducing the amount of unused drug wastage without affecting optimal patient outcome [2,3,7].

In this study drug wastage was defined as removing or discarded drugs which might be partially used or totally unused in the syringes, ampoules and vials due to different reasons in to safety-box.

The University of Gondar hospital is an academic medical center and provides health services for more than five million people and approximately 6,000 patients are operated under anesthesia annually,

according to the annual report of the department of surgery and anaesthesia.

As a tertiary hospital, it is better to have a clear understanding of how much IV anaesthetic agents, analgesics and pre anaesthetic drugs are wasted in GUH. This helps to analyses efficient utilization of resources. On the other hand, it helps to know how much resources are wasted which needs to be reduced or how we are be able to avoid such unnecessary wastage of IV anaesthetic and other drugs while considering optimal perioperative patient management. The most important thing is avoiding unwanted negligence of anaesthetist especially during emergency situation while trying to have best patient monitoring.

As a general it is very important for our hospital as a community service and teaching hospital to preserve unwanted financial cost expenditure, if wastage of those drugs is significant. Because monthly stock out of medication and materials from storage for operation room is estimated around 40,000 birr (1819 USD), as information gained from the clinical anaesthesia team leader. As well there is no evidence for the presence of wastage of those drugs here in our setup.

Therefore, the output of this audit will increase the awareness of ether the presence of wastage of those drugs or not. So, this audit is delegated to increase the trend of appropriate utilization of IV anaesthetic and other drugs among anaesthesia staffs and trainees by ensuring proper usage of those resources will increase our efficiency and effectiveness of anaesthesia department and as a general for our hospital. Hence, the aim of this clinical audit was to assess the wastage of commonly used anaesthetic and analgesics drugs at University of Gondar teaching hospital.

Audit Objectives

The objectives of this clinical audit were:

- To identify where is the gap for wastage of those drugs
- To increase awareness among staffs and students about the importance of proper utilization of resources
- To determine whether anaesthetic and analgesic drugs are properly utilized by anaesthesia staffs
- To analyze the cost of wasted anaesthetic drugs

Materials and Methods

Study design and period

This prospective observational study was conducted from January 10 to January 26, 2017 in the three-major surgical and one obstetric operation room of university of Gondar teaching hospital.

Audit sample and data collection

After obtaining ethical approval from the institutional ethical review board, College of Medicine and Health Sciences, University of Gondar, this clinical audit was conducted on 86 elective or emergency patients who operated under anaesthesia and met the inclusion criteria during two consecutive weeks were included.

The sample size was calculated using single population proportion formula by assuming approximately 6% of the expected number of patients undergoing surgery in the previous year, with 95% confidence interval and 5% margin of error.

Wastage of commonly used anaesthetic drugs data were collected consecutively during the study period in all patients (elective and emergency) undergoing surgical procedure under general or spinal/epidural anaesthesia.

Pre-anaesthetic, intravenous anaesthetic drugs, analgesic and local anaesthetic agents were included. Inhalational agents, local anaesthetic for peripheral nerve block and anaesthetic drugs rarely used were not considered in this study.

The preparation of and the dose injected of each specific drug, for particular patients, were decided by the responsible senior anaesthetist who was not involving in this study and unaware. The drug loaded in a syringe for each case was recorded initially. The data for wasted drug; including the drug left in the vial, syringe, and remaining in ampoules (partially used and discarded); after each surgical patient transferred from the operation room were collected by the data collector who was not involved in anaesthetic management.

The exact amount of drug administered to the patient was collected at the anaesthetic recorded sheet. Propofol wastage was considered as opened vial discarded after 6 h, loaded in the syringe but not used, and even another new vial open. In this clinical audit anaesthetic drug waste was defined as the amount of drug left over after the required dose has administered and/or the amount of drug drawn up but not used at all during each case.

Statistical analysis

The raw data was transferred and analyzed using Microsoft excel 2016 form. Demographic and clinical parameters of study participants were presented in the form of frequency and percentage.

The mean (average) wasted anaesthetic drugs per each drug and per case basis were also calculated. Total wasted drug was considered as the ratio of the mean of each drug over the total mean wasted drug during study period.

In this study, the cost estimation of the amount of anaesthetic drugs wasted was conducted. The cost analysis method was done based on previous study [5] as follow:

- Cost of amount of drug utilized=Amount of drug utilized × cost per unit value of that drug.
- Cost of the amount of drug un-utilized=cost per unit value of that drug-cost of amount of drug utilized.
- % of cost of particular un-utilized drug=cost of particular un-utilized drug/Total cost of un-utilized drug × 100.
- Total cost of amount of drug un-utilized=the sum of each cost of the amount of drug un-utilized.
- The cost of each drug was determined based on the exact prices of the drugs obtained from our hospital pharmacy, and expressed in Ethiopian birr and USA dollar.

Results

During sixteen day of data collection period, this clinical audit observed that wastage of anaesthetic agent for both emergency and elective surgical procedures performed under various anaesthetic techniques was common.

A total of 86 emergency and elective surgery patients who were operated on during the study period were included. Of these, males accounted for 54.7% and most patients were ASA I and II. 52 (60.5%)

of cases were emergency procedure and surgical procedures under general anaesthesia were high 54.6% (Table 1).

We were planned to assess wastage of eighteen different, but commonly used, anaesthetic drugs (preanesthetic, anaesthetic, and analgesics), however, two analgesic drugs (morphine and pethidine) were not available during study period.

Variables	Frequency (n)	Percentage (%)
Gender		
Male	47	54.7
Female	39	45.3
Age (year)		
<18	22	25.6
18-60	55	67
>60	9	10.4
ASA status		
ASA I&II	83	96.5
ASA III & IV	3	3.5
Surgical urgency		
Emergency	52	60.5
Elective	34	39.5
Types of anaesthesia		
Sedation	12	14
General anaesthesia	47	54.6
Neuraxial anaesthesia	27	31.4

Table 1: Demographic and clinical backgrounds of patients during the study period at University of Gondar teaching hospital, 2017 (N=86).

Sixteen different anaesthetic agents were contained in wasted ampoules, vials, and syringes were included in the final analysis.

From commonly used anaesthetic drugs, the cost per unit value of 0.5% of 4 ml bupivacaine is higher (95 birr, i.e. 4.32 USD) and 500 mg of 10 tablet paracetamol is lower in cost (Table 2).

This clinical audit illustrated that the wastage of different commonly used anaesthetic drugs varied, ranging from 0 to 23.72 mg per case, and 0% to 99.7% per each drug (Table 3).

The drugs most frequently prepared before the start of the case were atropine (100%), tramadol (54.7%), and adrenaline (48.8%). The drug most wasted by percentage in syringe from the average amount of loaded drug was adrenaline and it was minimum fentanyl (99.7% and 3.7%, respectively).

S. No	Drug	Price (Ethiopian birr) per unit
1.	Atropine (1 mg/1 ml)	1.50
2.	Adrenaline (1 mg/1 ml)	2.50
3.	Neostigmine	21.00
4.	Propofol	36.00
5.	Ketamine (50 mg/ml, 10 ml)	41.25
6.	Thiopental (500 mg)	17.45
7.	Succinylcholine (50 mg/ml, 10 ml)	28.00
8.	Pancuronium	12.00
9.	Vecuronium (10 mg)	76.77
10.	Bupivacaine	95.00
11.	Lidocaine	20.00
12.	Metoclopramide	6.60
13.	Cimetidine	2.20
14.	Acetaminophen (10 tabs)	1.3
15.	Diclofenac	1.69
15.	Fentanyl	26.00
16.	Tramadol (100 mg/2 ml)	14.00
17.	Morphine	-
18.	Meperidine	-

Table 2: Price per unit value of commonly used anaesthetic agents at University of Gondar teaching hospital, 2017.

From intravenous induction agent's ketamine was the maximum amount that was loaded than that of propofol, however, it was found that propofol was the most common wasted anaesthetic drug, 23.72 mg per case and comprised 27.8% of the total wasted drug. From muscle relaxants, 7.32 mg per case of suxamethonium was wasted. However, the muscle relaxant most wasted by percentage in syringe from the average amount of loaded were vecuronium (33%).

S. No	Drug	Drug was prepared n (%)	Average drug loaded per case (mg)	Average drug used per case (mg)	Average drug discarded per case (mg)	Total amount of each drug wasted (%)	Wasted drugs total wastage (%)
1.	Atropine	86 (100)	1	0.54	0.46	46	0.5
2.	Adrenaline	42 (48.8)	0.49	0.001	0.49	99.7	0.57
3.	Neostigmine	41 (47.7)	1.45	1.45	-	-	
4.	Propofol	20 (23.2)	46.51	22.8	23.72	51	27.8

5.	Ketamine	26 (30.2)	93.02	77.7	6.4	7	7.5
6.	Thiopental	13 (15.1)	23.25	14.53	8.72	38	10.2
7.	Succinyl choline	14 (16.3)	81.4	71.51	7.32	9	8.6
8.	Pancuronium	31 (36)	1.44	1.03	0.4	28	0.5
9.	Vecuronium	10 (11.6)	1.2	0.8	0.4	33	0.5
10.	Bupivacaine	20 (23.3)	4.7	3.02	1.63	35	1.9
11.	Lidocaine	8 (9.3)	27.9	18.6	5.8	21	6.8
12.	Metoclopramide	20 (23.3)	2.3	2.3	-	-	-
13.	Cimetidine	20 (23.3)	93.0	93.0	-	-	-
14.	Acetaminophen	40 (46.5)	232.6	232.6	-	-	-
15.	Diclofenac	35 (40.7)	30.5	20.1	10.5	34	12.3
16.	Fentanyl*	37 (43)	43.0	41.4	1.6	3.7	1.9
17.	Tramadol	47 (54.7)	95.3	77.3	18.0	18.9	21.1
18.	Morphine	-	-	-	-	-	-
19.	Meperidine	-	-	-	-	-	-
	Total		779.1	678.7	85.44		

Table 3: Amount of anaesthetic drug wastage of various drugs from January 10 to January 26/2017 at University of Gondar teaching hospital.

S. No	Drug	Total cost of each drug loaded (Birr)	Total cost of each drug used (Birr)	Total cost of each drug wasted (Birr)	Cost wasted of total wastage (%)
1.	Atropine	129.00	69.30	59.70	3.03
2.	Adrenaline	105.00	0.28	104.73	5.32
3.	Neostigmine	903.00	180.60	0.00	-
4.	Propofol	720.00	352.80	367.20	18.66
5.	Ketamine	660.00	551.10	45.38	2.3
6.	Thiopental	69.80	43.63	26.17	1.33
7.	Succinyl choline	392.00	344.40	35.28	1.8
8.	Pancuronium	372.00	267.00	105.00	5.33
9.	Vecuronium	767.70	522.04	245.66	12.8
10.	Bupivacaine	1900.00	1235.00	665	33.8
11.	Lidocaine	120.00	80.00	40.00	2.03
12.	Metoclopramide	132.00	132.00	0.00	-
13.	Cimetidine	44.00	44.00	0.00	-
14.	Acetaminophen	5.20	5.20	0.00	-
15.	Diclofenac	59.15	38.87	20.28	1.03
15.	Fentanyl	962.00	925.60	36.40	1.85
16.	Tramadol	1148.00	931.00	217.00	11.03

17.	Morphine	-	-	-	-
18.	Merperidine	-	-	-	-
	Total cost	8488.85	5722.82	1967.8	23.2

Table 4: Cost evaluation of study drugs from January 10 to January 26/2017 at University of Gondar teaching hospital (*microgram).

This study found that, during the study period a total of 1967.8 Ethiopian birr (89.44 USD) were the cost of wasted drugs. Of these, the cost of wastage of bupivacaine was higher around 33.8% (665 Birr) (Table 4).

Discussion

This clinical audit showed that a maximum average amount of anaesthetic drugs waste per case basis were seen in propofol, tramadol, and diclofenac (23.72 mg, 18 mg, and 10.6 mg, respectively). This might have negative impact on the economy of both patient and hospital, particularly in developing countries like Ethiopia may have significant burden on the health care budget. The main reasons for the higher drug wastage in our hospital might be lack of protocol for appropriate use of drugs; a lot of students involved in patient management, anaesthetic drug store are opened for every staff and students, and lack of awareness about wastage and cost of drug.

The present study demonstrated that the most wasted drug, in milligram, was adrenaline. In average, around 100% of loaded adrenaline was wasted in our operation theater. This finding was comparable with other study [4]. This could be explained by the routine practice of drawing 1 mg/ml of adrenaline for treatment of unanticipated intraoperative incidents, by the anaesthetist or students. In our department, there is three workday shift hours, which shows that every anaesthesia providers discard the predrawn adrenaline syringe and prepare another new at the start of their working time. The use of atropine in this study was for two primary purposes, the first is for reversal of non-depolarizing muscle relaxant, and the other one is a predrawn as emergency drug. The later might be the contributing factor for the significant percentage of atropine wastage in this audit. The result of this study was in line with other studies [4,5,8]. Wastage of emergency drugs (atropine and adrenaline) is an alarming problem in our hospital and the possible strategies to reduce wastage might be development of protocol, first load 1 mg of adrenaline or atropine in 10 ml syringe with saline and then load and dilute in separate syringes for each operation room at the start of standard working day, prefilled syringe with saline prepared and then the emergency drug will be drawn when critical incident happened, preparation of an emergency kit and putting in an area near for all theater, and ensuring easy availability and familiar for all staffs.

From IV induction agents, we found that ketamine was maximally loaded and followed by propofol (8000 mg and 4000 mg, respectively). Despite this, wasted or discarded propofol accounted for 23.72 mg per case (51%) of all IV induction drugs. A study done by Russell F. Mankes [9] found that 45% of propofol was wasted. Another study [6] also suggested that propofol was more wasted compared to thiopentone (36.59% and 4.67% respectively). This slight discrepancy in figure might be the difference in number of cases operated during study period and most of anaesthetist in our hospital is more familiar with the use of ketamine. A majority of propofol wastage in our operation room might be explained by opened and partially used vials,

around the trolley and anaesthesia machine, were discarded during working hour shift. During study period, we observed that 20 ml of propofol vial were opened and loaded to syringes for short procedures, and small children and malnourished patients (which may need only small volume of propofol based on their age and weight). Thus, the best clinical practice for appropriate use of propofol would be to by 10 ml for short procedures, small children and underweight patients. Also, to handover the partially used vials for anaesthetist who is doing another case.

The total cost of wastage anaesthetic drugs within two week of data collection was 1967.8 Birr (23.2%) from the total cost of drug loaded. The most common cost of wastage of drug was seen in bupivacaine it accounted 665 Birr (33.8%). A significant percentage of cost of wastage was observed in propofol, vecuronium, and tramadol (18.66%, 12.8% and 11.03%, respectively). This shows that significant numbers of cost were wasted; particularly for underdeveloped countries like us the problem is very alarming. So anaesthesia providers should be improving their patterns of drug utilization, because it directly affects health care cost and the country's economy at large, which needs an issue of considerable interest to reduce such unnecessary significant wastage of anaesthetic drugs cost.

One of a potential area of wastage in our department is pharmaceuticals of anaesthetic agents which increases health care expenses. That needs to be reduced by different strategies which would be by management of drug wastage and avoiding wastage of expensive drugs, developing and applying drug practice institutional guideline. Limitation of use and by taking feedback about patterns of use might be another option. Also, we recommend that creating awareness among anaesthetist about the use, inappropriate wastage, and cost of the drugs, and frequent auditing.

Sonali, Ramakant and his colleagues studied [5] on a prospective observational drug audit on intravenous anaesthetic agents in a tertiary hospital shows that, out of the total cost of drug loaded Rs. 34,458.84 the total cost of drug wastage accounts Rs. 10276.25 from this the maximum amount of cost wastage was vecuronium 16.82% followed by Rocuronium 15.38% and Propofol accounts 9.93% [6]. Another audit study by Gillerman Richard and his colleagues for 1 year period on selected sex anaesthetic drugs found that the total cost of un-administered study drugs was \$165,667 and most dollars wasted were for Propofol \$80,863 and thiopental \$32, 839 [3].

Conclusion

To conclude, this clinical audit shows that there was a significant anaesthetic drugs and financial wastage during perioperative anaesthetic management. During two week, we observed that our hospital loss 1967.8 Birr (around 89.45 USD) due to wasted anaesthetic drugs. Extrapolation of this data into months or even a year might have a significant negative impact on health care cost, especially in developing countries like Ethiopia. We recommend that drug wastage

reduction and cost minimization strategies would be helpful without compromising quality of care and patient's outcome. Additionally, we recommend re-auditing with large sample and longer duration of data collection. Limitation of this study is small sample size, short data collection period and inhalational agents and other drugs are not included.

Area of Excellent Practice

The use of drugs like neostigmine, metoclopramide, cimetidine and acetaminophen was best practice of usage during the study period no wastage was seen in those drugs. The use of fentanyl was also good which is 0.4% and also use of succinylcholine was relatively good, but still it needs to improvement of usage.

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