

# Current practices in organization of anesthesia drug tray



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## ABSTRACT

**Background:** The risk of medication error is high in the operating room, since the anesthesiologist prepares, stores, and administers the medication. Poor labeling practices and cluttered drug trays increase the risk of syringe swap and medication error. Well-organized drug tray can reduce the incidence of erroneous drug administration and decrease the response time during intraoperative emergencies. **Aims and Objectives:** The aim of the study was to determine the attitude and practices of anesthesiologists in organizing drug trays. **Materials and Methods:** In the first part of the study, 30 drug trays with 209 syringes were observed before and after the procedure for 14 parameters. At the end of the procedure, a questionnaire was given to the anesthesiologists involved about their knowledge of labeling and organizing drug tray. **Results:** All the labels were handwritten with 139 (74.7%) syringes labeled circumferentially, and 47 (25.2%) syringes labeled vertically. Unlabeled syringes found were 23 (11.0%). Labels were legible in 168 (90.3%) syringes. Syringes were not found to be replaced in their designated place according to the template at the end of surgery in 7 (23.3%) trays. About 66.7% of anesthesiologists had experienced incorrect pickup of the syringe and 40.0% of anesthesiologists reported that they rely on other pointers apart from the label to identify the drug. **Conclusion:** This study identifies the variation of practices in labeling, organizing, and maintaining drug tray among anesthesiologists. Adherence to institutional protocol, eternal vigilance, and improvement in error reporting practice would minimize the incidence of medication error.

**Key words:** Anesthesiology; Drug preparation; Medication safety

## INTRODUCTION

In anesthesia practice, unlike other specialties, drugs are checked, prepared, stored, and administered in a time-critical, at times distracting environment. Medication error is a preventable event in the operating room that is potentially harmful to the patient.<sup>1,2</sup> Multiple factors such as high-risk look alike/sound alike (LASA) drugs, the urgency of the procedure, work overload, requirement of quick reflexes, fast response time, and fatigue of the anesthesiologist are associated with errors.<sup>3,4</sup> Few studies done to estimate the frequency and cause of medication error found that human errors contribute significantly.<sup>5-8</sup> A study performed at two hospitals involving 7794 anesthetic

procedures found that one drug administration error occurs every 133 anesthetic procedures, with the two largest individual categories of error involving incorrect doses (20%) and substitutions (20%).<sup>8</sup> A much higher rate of one in 20 perioperative medication errors was observed in another study, of which 79.3% were found to be preventable.<sup>6</sup> A survey from 687 anesthesiologists revealed that 85% had experienced at least one drug error or “near miss.” “Syringe swaps” (70.4%) and the misidentification of the label (46.8%) were found to be common contributing factors.<sup>7</sup>

Several medication safety strategies have been implemented to decrease medication error in the operating room

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including color coding of syringe labels, barcoding of syringes, using pre-labeled, and pre-filled syringes and also using rainbow drug trays.<sup>9-12</sup> Another economical strategy to reduce the scope of medication error is by organization and standardization of anesthesia drug trays which require minimal capital expenditure.<sup>10</sup> Anesthesia machine has space to accommodate drug tray where the syringes are organized as per departmental protocol. Nonetheless, there is considerable variation in the method syringes are loaded, labeled, placed, and organized given that the anesthesiologists come from different places with their individual preferences and experience. Despite institutional training on the strictly enforced routine of loading, labeling, and arrangement of syringes in a designated template, people deviate due to stress, haste, fatigue, casual attitude, or during critical times of surgery. There are limited studies in the literature to describe the knowledge and practices of organizing drug tray in the Asian continent. This observational study was planned to observe the practices and to measure the knowledge of anesthesia drug tray arrangement amongst anesthesiologists.

### Aims and objectives

The aim of the study was to observe the practices and to measure the knowledge of anaesthesia drug tray among anaesthesiologist in a Medical College Hospital.

## MATERIALS AND METHODS

This observational study was conducted at the operation theater in a tertiary care Medical College and Hospital, Karnataka, India, between June 8, 2022, and July 18, 2022, after taking Institutional Ethical Committee approval. The registration number of the Clinical Trial Registry of India for this study is CTRI/2022/06/043077. Written informed consent was obtained after explaining confidentiality, from 30 anesthesiologists including anesthesia trainees with more than 2 years-experience about to complete the apprenticeship, who were providing general anesthesia for various elective surgical procedures. In the first part of the study, the management of the anesthesia drug tray was observed, one case each for each anesthesiologist by the principal investigator. To ascertain the accuracy of labeling and organizing drug tray, anesthesiologists were informed that a random surprise check of the anesthesia medication tray would be conducted at the beginning and the end of the selected case during the designated time period. Fourteen parameters were observed before induction and after extubating the patient. Parameters that were observed were the loading of syringes, size of syringes, medication labeling, legibility, dosage, date, placement of any other objects in the tray, unlabeled syringes, and LASA group of drugs, and syringes separate from the needle. It was

also noted whether the broken ampoules were stored until the end of the case or discarded. Arrangement of drug tray before the procedure, any alteration from predefined, and pre-validated departmental protocol in the anesthesia medication tray and cluttering were also noted. Adherence to drug tray arrangement and maintenance were based on the parameters observed. Standard practice in the hospital is to keep prepared syringes on the tray, as shown in Figure 1.

In the second part of the study, a questionnaire was given to the anesthesiologist at the end of the surgical procedure to assess their knowledge of drug errors. The questionnaire was designed after reviewing relevant literature regarding medication errors.<sup>13-15</sup> It was ensured that the questionnaire addressed the research question. The questionnaire was validated by two senior anesthesiologists with more than 10 years of experience. Their feedback was incorporated, and the questionnaire was piloted among a sample of ten anesthesiologists, who were not involved in the study before use.

The questionnaire consisted of 20 questions with a mix of open-ended and closed-ended questions. Questions were directed towards demographics, knowledge of medication error, and error reporting practice. In the open-ended questions, anesthesiologists were asked to indicate whether a drug administration error or near-miss had occurred. If so, further details were asked to be provided. Table 1 provides the questionnaire used for this study. Collected data were entered in excel software and analyzed using R software version 4.0.1. Continuous data were presented as median and range. Categorical data were presented as count and percent. The Chi-square test was used for categorical variables. Mann-Whitney U-test was used to compare the median of the two groups.  $P < 0.05$  were considered statistically significant.



**Figure 1:** Arrangement of drug tray

## RESULTS

About 30 anesthesiologists participated in the study, in which there were 13 males (43.3%) and 17 females (56.7%) with 3.0 years of median experience ranging from 2 to 8 years, as shown in Table 2. Anesthesiologists who participated in the study prepared the drugs before the patient was wheeled inside the operating room. All 30 anesthesiologists read aloud the name of the ampoule before drawing up the drug. The syringes were labeled immediately after loading the drug. No color-coded labels were used. All the labels were handwritten with ballpoint pen, where 139 (74.7%) syringes were labeled circumferentially, and 47 (25.2%) syringes were labeled vertically. Twenty-three (11.0%) syringes were unlabeled. Labels were legible in 168 (90.3%) syringes. Drug dosages with concentration in units/mL were written in

172 (82.2%) syringes. Dates were written only in 9.6% (20) syringes. Details of the observations are given in Table 3.

Prepared syringes were arranged in the drug tray on the anesthesia machine workspace. The emergency drugs, induction agents, and neuromuscular blocking agents were found to be placed on the same tray. At the end of the procedure, 23 (76.6%) trays were found to be according to the protocol. Syringes were not found to be replaced in the designated place according to the template at the end of surgery in 7 (23.3%) trays. Alterations found were the addition of syringes, change of position of syringes, and changes in the orientation of syringes. The anesthesia drug tray was found to be cluttered in 9 (30.0%) trays (Figure 2). Cluttered tray had objects such as electrocardiogram electrodes, endotracheal tube plaster, saline bottle, empty vials, broken ampoules, and gauze pieces. In 90.0% of cases, ampoules were discarded after drawing of medication, whereas, in 10.0% of cases, they were stored till the end of the case. Syringes were found to be separate from the needle in 15.3% of cases. There was no physical separation between the LASA group of drugs in 20.0% of trays.

Tables 4-6 depicts the answers to the questionnaire. It was found that 23.4% of anesthesiologists had experienced drug error in their practice, whereas 43.3% of anesthesiologists had near miss incidents of drug error. About 66.7% of anesthesiologists had experienced incorrect pickup of the syringe. All the anesthesiologists stated that they read the name of the drug on the label before administration. About 26.7% of anesthesiologists relied on the position of the syringe on the drug tray to identify the drug and 40.0% of anesthesiologists reported that they rely on the pointers such as color, size of the syringe, position on the tray, and others to identify the drug. A majority (80%) of

**Table 1: Questionnaire**

1. Occupation (a) Anesthesia resident and (b) Practicing anesthesiologist
2. Experience of anesthesiologist in years.
3. Gender: Male/Female
4. Have you experienced medication errors in your practice? Yes/ Never/Near miss
5. If yes, what was the incident?
6. If near miss, what was the incident?
7. Have you experienced picking up an incorrect drug? yes/No
8. Have you misidentified an ampoule or vial? Yes/No
9. Have you mislabeled a syringe? Yes/No
10. How often do you read the label before drug administration? Always/Sometimes/Never
11. Do you rely on the position of the syringe in the anesthesia drug tray while picking the drug? Yes/No/Sometimes
12. Is your anesthesia drug tray always organised? Yes/No
13. In critical situations, does your anesthesia drug tray get cluttered? Yes/No
14. Do you think a cluttered anesthesia drug tray increases "search time"? Yes/No
15. Do you think cluttered drug tray increases the risk of syringe swap? Yes/No
16. How do you identify the syringe before administration?
  - Color
  - Label
  - Drug location on the anesthesia tray
  - Size of the syringe
17. Do you think pre-filled syringes prevent drug error? Yes/No
18. Do you think a standard anesthesia drug template prevents drug swap or wrong drug errors? Yes/No
19. Are you usually an organized person? Yes/No
20. Do you report errors in drug administration? Always/ Sometimes/Rarely

**Table 2: Demographics of anesthesiologists**

Anesthesiologist	Number	Percentage
Years of experience*	3.0 (2–8)	
Gender		
Male	13	43.3
Female	17	56.7

\*Median (range)

**Table 3: Details of observation of drug tray**

Parameters	Adherence		P-value
	Yes (n=22)	No (n=8)	
Type of surgery			0.218
Super specialty	11 (50.0)	3 (37.5)	
Orthopedics	2 (9.1)	2 (25.0)	
ENT	3 (13.6)	1 (12.5)	
General surgery	6 (27.3)	2 (25.0)	
Duration of surgery (h)	2.0 (1.5–3.0)	2.5 (2.0–3.0)	0.192
Total number of syringes	7.0 (5–8)	7.5 (5–9)	0.211
Number of 5 mL syringes	2 (1–3)	2 (2–3)	0.476
Number of 10 mL syringes	2 (1–3)	2 (1–3)	0.851
Number of 2 mL syringes	2 (2–3)	3 (2–3)	0.291
Label orientation			
Circumferential	17 (77.3)	6 (75.0)	
Vertical	5 (22.7)	2 (25.0)	0.792
Broken ampoules	0 (0.0)	4 (50.0)	0.109

anesthesiologists reported that they keep their anesthesia drug tray organized throughout the procedure, whereas 93.3% responded that their trays get cluttered during critical times of the procedure. Common drugs involved in drug swaps as experienced by anesthesiologists involved in the study are given in Table 7.

## DISCUSSION

Human error is the most common cause of anesthesia medication error that can cause significant mortality and morbidity to the patient.<sup>10</sup> Injectable medications are identified, drawn up in syringes, labeled, organized, and administered by the anesthesia provider just before administration. As a result, anesthesiologists experience a higher incidence of drug error than any other specialties. In this study, 66.7% of anesthesiologists experienced drug error or “near miss” at some point of time in their anesthesia practice. This is consistent with a study conducted in Turkey which determined that 52.9% of anesthesia workers including anesthesiologists and



**Figure 2:** Cluttered drug tray at the end of the procedure in one of the trays

technicians experienced at least one drug error during anesthesia administrations.<sup>13</sup>

**Table 5: Labeling practices**

Questions	Number	Percentage (%)
Do you read label before loading?		
No	0	0
Yes	30	100.0
Do you rely on the Position of the syringe?		
No	16	53.3
Sometimes	6	20.0
Yes	8	26.7
Identify by label	30	100.0
Identify by color	4	13.3
Identify by drug location	9	30.0
Identify by the size of the syringe	8	26.7

**Table 6: Organizing drug tray**

Questions on organizing drug tray	Number	Percentage (%)
Is your tray always organized?		
No	6	20.0
Yes	24	80.0
Does your tray get cluttered in critical situations?		
No	2	6.7
Yes	28	93.3
Does a cluttered tray increase search time?		
No	1	3.3
Yes	29	96.7
Do cluttered trays lead to Syringe Swaps?		
No		
Yes	30	100.0
Do prefilled syringes prevent error?		
No	12	40.0
Yes	18	60.0
Does the standard anesthesia template prevent drug swap?		
No	5	16.7
Yes	25	83.3
Organized person		
No	4	13.3
Yes	26	86.7
Report Errors		
Rarely	7	23.3
Sometimes	6	20.0
Always	17	56.7

**Table 4: Experience of drug error**

Questions regarding drug error	Number	Percentage (%)
Experience of drug error		
No	10	33.3
Near miss	13	43.3
Yes	7	23.4
Incorrect pickup of the syringe but not administered		
No	10	33.3
Yes	20	66.7
Misidentified syringe		
No	14	46.7
Yes	16	53.3
Mislabeled syringe		
No	27	90.0
Yes	3	10.0

**Table 7: Drug swap**

Succinylcholine	Flush
Succinylcholine	Midazolam
Atropine	Glycopyrrolate
Succinylcholine	Mephentermine
Fentanyl	Ondansetron
midazolam	Mephentermine
Fentanyl 10 mcg/cc	Fentanyl 50 mcg/cc
Salbutamol respules	Sterile water

Improving the labeling standards can decrease the risk of medication error. The American Society of Anesthesiologists in the Statement on Labeling of Pharmaceuticals support consistency and clarity in labeling practices. The label should color coded and display the generic name of the drug, concentration in units per mL, date, and time.<sup>14</sup> This recommendation is consistent with ASTM International (formerly American Society of Testing and Materials) and International Organization for Standards recommendations.<sup>15,16</sup> In this study, labels were legible in 80.3% of syringes with dosage written in 82.2% of syringes and date written in only 9.6% of syringes. Unlabeled syringes constituted 11.0%. Ten propofol syringes were unlabeled that the reason stated by the anesthesiologist for not labeling was the milky white color. ASA recommendations support color-coded labels with drug concentration and date written with a ball-point pen or felt-tip marker without blurring or smudging. Non-availability of color-coded labels leads to the use of handwritten labels which can potentially lead to mistakes during writing and reading. Discrepancies are due to the size of handwriting and clarity of words on the reduced size of the label. Non-availability of prefilled and prelabeled syringes is a challenge in resource-constrained settings. However, 60.0% of anesthesiologists opined that prefilled syringes could prevent drug error.

Although the single most important factor to reduce medication error is to identify the drug and its concentration by reading labels, anesthesiologists may subconsciously rely on other visual pointers and guides such as color, size of syringe, and location in the “bucket of drugs” to identify the syringe, especially in a time-pressured critical environment.<sup>17</sup> In this study, 40.0% of anesthesiologists reported that they rely on other pointers apart from the label to identify the drug. Therefore, maintaining the anesthesia drugs in a carefully orchestrated drug tray during the entire surgery can minimize the chances of drug swap and reduce the search time of the syringes.<sup>18</sup> Merali et al., recommended standardizing anesthetic cart trays and considering usage patterns to improve medication safety.<sup>19</sup> About 83.3% of anesthesiologists in this study stated that organizing drug tray according to a standard template reduces the incidence of syringe swap. In this regard, Smith et al., devised low-cost standardized strategies of anesthesia tray revision project to reduce human error.<sup>10</sup>

Recommendations by Jensen et al., included the formal organization of the drug workspace with attention to tidiness, the position of ampoules and syringes, separation of dangerous or similar drugs, and removal of dangerous

drugs from the drug tray.<sup>20</sup> In this study, 20% of trays had the LASA group of drugs which are an established factor for drug error. About 10% reported that they had mislabeled syringes. This could have been due to LASA drugs.

Among the drugs used during anesthesia, intravenous induction agents, neuromuscular blocking agents, opioids, sedatives, anticholinergic drugs, and local anesthetics have all been reported in medication errors.<sup>21</sup> Succinylcholine and mephentermine were the common drugs involved as reported by anesthesiologists in this study. A critical incident analysis done in a developing country showed that the highest number of incidents was associated with neuromuscular blocking agents.<sup>22</sup>

The study of medication error can be done by reviewing the critical incident report. The review identifies serious adverse errors as they are more likely to be notified.<sup>6,23</sup> Many practitioners may not report errors for the fear of being pointed out or errors had minor consequences. In this study, 23.3% of anesthesiologists stated that they rarely report the medication error, and 20% of them reported error “sometimes”.

In today’s complex and rapidly changing environment of surgical methods, anesthesia practices, and operating room practices, one may identify a syringe by virtue of position in haste which makes adherence to the organization of the drug tray more vital. Drug tray assorted haphazardly increases the “search-time” of syringes. As high as, 96.7% of our anesthesiologists stated that the haphazardly arranged cluttered drug tray increases search time. All of them were aware that cluttered trays increase the risk of syringe swap. Non-adherence to the protocol was due to addition, replacement, change of orientation of syringes, cluttering, additional objects found on tray, and illegibility of labels. Variation may also be due to the longer duration of surgery, higher ASA grading, and greater number of syringes used. Non-adherence did not vary according to the surgical specialty.

In our study, 36.6% were trainees. Understandably, medication handling is learnt by trainees by observation and practice rather than through didactic lectures. Scheduled training augments the learning regarding medication handling amongst residents. Training programs for the preparation and arrangement of drugs should be included in the trainee curriculum to improve practices. It is also imperative to emphasize the importance of organizing drug storage tray among anesthesia trainees to bridge the knowledge gap and to establish safe anesthesia practice.

## Limitations of the study

There are certain limitations of our study. The size of the study population was small which makes the generalization of results limited. Drug tray management was observed at a particular time during the entire duration of surgery. A multicentric study could have been done to observe practices in different study populations. Further, prospective studies can be done to analyze the effect of organizing drug tray to reduce medication error.

## CONCLUSION

This study highlights the importance of organizing drug storage tray in minimizing the incidence of medication error. Despite sound knowledge about organizing drug tray, there is variation in the way syringes are labeled and arranged among anesthesiologists. Replacing the syringe in its designated place after the use is as important as its initial arrangement. Most of the anesthesiologists had experienced medication error or near miss during their practice. Adequate training schedules and strict enforcement to adhere to the institutional protocol improve medication safety. Encouraging the anesthesiologists in error reporting practices identifies the cause of medication error and help to formulate strategies to prevent them. Further studies involving pre-training and post-training surveys may show changes in attitudes and practices which might improve patient safety.

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**SJ**- Design of the study, data collection, preparation of manuscript; **SMJI**- Concept, design, preparation of manuscript; **MC**- Preparation of manuscript; **RS**- Design of the study, preparation of manuscript; **AN**- Statistical analysis, interpretation of results, preparation of manuscript.

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