



## Perioperative Medication Errors: Review on Cause, Consequences and Prevention

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**Abstract:** An anesthesiologist may inject up to half a million different drugs in his/her professional tenure. The chance of making an inadvertent error is easily fathomable. The Anesthetized patients having volatile physiological reserves would not show or express any symptoms that an awakened patient would, like hypotension, cardiac arrest, bronchospasm etc. These errors may prove fatal or cause permanent damages. When patients give permission for anaesthesia, they show trust in us related to our training, experience and judgement. Their trust makes us accountable for every action. Medication errors added a significant financial cost to human tragedy. About 2% of patients experience an adverse effect that is preventable in nature. For a 700 bed hospital, it results in a huge increase in hospital costs (about \$4700/admission). Therefore medical errors should be treated as an important, urgent and prevalent health problem. There is a need to redevelop or engineer the system so that the errors due to certain preventable approaches can be reduced. Different systems like the revision of standardisation system of labels on medication, the development of an advanced and easy to use electronic as well as digital mechanisms for “double-checking” in OR (Operation Room). There are evidence of high deaths due to medical errors than death due to medical conditions like breast cancer, cardiac arrest, or motor vehicle accidents. Despite the huge intensity of loss that medical error cause, the data related to the medical errors never figured properly in the public domain through any medium. However, some horrific incidents because of the involvement of a celebrity or because of their bad and shocking nature do find their existence in this iceberg as a tip. The main objective of this review is to discuss the safety of medication administered to the patient under anaesthesia.

**Keywords:** Hypersensitivity, Anaesthesia, Medication errors, Perioperative medications, the adverse drug reactions, Perioperative types

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**I. INTRODUCTION**

Medication administration in the perioperative settings present particularly Patient Safety challenge compared to other Hospital settings<sup>1</sup>. Preoperative medication administration nowadays repeatedly bypasses the standard safety checks and ignoring such standard safety checks can cause serious harm. For example, ignoring physician order entry with decision support electronically, approval of specific drugs by the pharmacy before administrations, nursing checks on multiple intervals of time during drug administration etc<sup>2</sup>. In the effect, the most commonly cited serious incidents in anaesthesia are errors of drug administration<sup>3</sup>. Medication errors (MEs) are mostly defined as an error in the prescribing, dispensing, and/or administration of a drug, irrespective of the fact that it may or may not lead to adverse consequences.<sup>4,5</sup> Also the high-stress, time- sensitive environment of OR may lead to both higher rates as well as a high degree of medication errors (MEs). The Perioperative syringe swaps, wrong dose calculation, ampoule swap etc can cause serious harm<sup>6</sup>. The perioperative period is the time that includes all stages through which patients will come across during surgical procedure<sup>7</sup> like admission in ward, anaesthesia, surgery and recovery from surgery. Perioperative is consists of three phases of surgeries such as preoperative (before operation), intraoperative (in between operation) and postoperative (after operation). The main concern of perioperative care is to give the patient better condition before, during and after the surgery; it is practised in hospitals, in surgical centres attached to hospitals, in freestanding surgical centres, or health care provider’s offices. This period is utilized to prepare the patient physically as well as psychologically during the surgical procedure and also after the surgery. Three different phases of perioperative care mentioned above can be defined as follows<sup>8</sup>.

**PREOPERATIVE**

In this phase, the tests are performed to limit the anxiety before operation. These tests may include fasting before the operation.

**INTRAOPERATIVE**

The intraoperative period begins when a patient is taken to the operation theatre and it ends when the patient is transferred to the post anaesthesia Care Unit (PACU). During this intraoperative period the patient is a) monitored thoroughly, b) anesthetised, c) prepped and d) draped. After these stages the operation is performed<sup>9</sup>. The duty of nursing staff during intraoperative period is to provide the safety, prevent infection and provide a sterile environment. The Intraoperative Radiation therapy and intraoperative blood salvage are also done occasionally during this phase<sup>10</sup>.

**POSTOPERATIVE**

The post operative period starts when the intraoperative period ends i.e. after the patient is transferred to the PACU and it ends with the resolution of surgical consequences. The perioperative drug administration process begins with the request/receiving of medication and it terminates with the proper monitoring of the patient after the medication has reached. The various stages of perioperative medication are shown in Table No.1. A medication error can be defined as a failure in completing a required action in the administration process of medication; can also, be defined as the usage of plan or action that is incorrect to achieve the aim of patient care. An adverse drug event can be defined as a patient harm/injury because of a medical intervention related to drug, in any case whether an error in the medication process occurs or not (Table No. 2 & 3)<sup>11,12,13</sup>.

**Table 1: Various stages of perioperative medication**

S.No	Term	Definition
1	Requesting	The medication is requested by a pharmacist from the pharmacy or it can also be requested from the medication dispensing system; the requesting step may be bypassed if a provider already received the medication directly from the anaesthesia cart
2	Dispensing	The medication is dispensed by a pharmacist straight to the provider, or the provider take the medication from dispensing system
3	Preparing	The provider prepared the medication.
4	Administration	Medication reaches the patient received the medication either through self-administration or an anaesthesia provider administrated the medication.
5	Documenting	In the anaesthesia information management system all the medications and doses of medications are documented.
6	Monitoring	Following the vital signs (such as blood glucose level, blood pressure, heartbeat etc.) or following the relevant labs for reports after the administration of medication.

**Table 2: Severity of the medication error/adverse drug event**

S.No	Term	Definition	Examples
1	Life-threatening	Untreated Symptoms can lead to the patient’s death.	Patient with > three immediate premature ventricular contractions. Patient with an anaphylactic reaction to penicillin who is administered with cefazolin or penicillin
2	Serious	Symptoms related to a serious but not life-threatening level of harm	Antibiotics are not given to the patient requiring antibiotics before incision. Patient is administered insulin without checking his blood glucose level
3	Significant	Symptoms that are harmful to the patient but causes a little or no harm the patient’s organs	Not monitoring the blood glucose level of a diabetic patient.

**Table 3: Types of Perioperative Medication Errors and Associated Potential Adverse Drug Events (ADEs) Examples**

S.No	Error Type	n (%)	Error Example	Potential ADE Example	Reference
1	Omitted Medication/Failure to Act	27(17.6%)	during all-day case no re-dosing of Cefazolin	Infection on Surgical site	4,5
2	Documentation Error	26(17.0%)	Documentation of intubation not done. Possible failure to detect difficult airway on following anaesthetic.	Airway trauma or hypoxia	14,15
3	Monitoring Error	10(6.5%)	Not checking before induction.	Blood pressure more than 200mmHg on first check just after induction.	16
4	Wrong Medication	9(5.9%)	CRNA Noticed that vial obtained from ondasterone slot was phenylephrine	Hypertension that could be life threatening.	11,17
5	Wrong Timing	5(3.3%)	Delay of 7 minutes in the administration of Ephedrine in the hypotension patient.	Organ hypoperfusion with a mean arterial pressure of less than 55 mmHg.	18,19
6	Inadvertent Bolus	2(1.3%)	Distal connecting of Phenylephrine infusion antibiotic bolus site.	Hypertension	20,21
7	Other	2(1.3%)	The Syringe of Hydromorphone left on anaesthesia machine unattended before case.	Narcotic diversion or theft.	22,23
Total		153(100.0%)			

**HISTORICAL MEDICATION ERRORS PERSPECTIVE**

The most common type of drug error (48%) is a wrong medication that occurs intraoperatively. It is followed by error due to overdose of medication (38%), an incorrect route of administration (8%), underdosing (4%) and the omission (2%) Opioids, The first three frequent causes of overdose involved are a) misunderstanding or preconception of the overdose (53%) b) pump misuse (21%) and c) dilution error (5%).<sup>6, 24</sup>In the critical care units or high dependency units, The main origin of errors takes place during the administration phase (44%), In a study by Latif et al. the most common error type ICU was omission (26%). The identified causes of harmful errors are mainly dispensing devices (14%) and mistakes in calculations (98%).<sup>22, 25</sup>.

**PERIOPERATIVE MEDICATION ERROR RATES**

In past, there were only self-reported errors that were the basic foundation of the literature available on perioperative

medication. Recently, the medication error rates are reported between 4 and 11% of all medications administered<sup>26</sup>. This data is based on prospective observational studies in the OR by efficient observers and experts.

**FACTORS CAUSING MEDICATION ERRORS**

The two main factors that are considered as the main reason behind medication error are: Human factors and Environment factors. Human Factors includes Fatigue, Disruptions during the procedures, Haste, Stress and Pressure<sup>27</sup>. Environment Factors includes the design and the environment of perioperative area, time of the day at which surgery is to be performed and workload<sup>27</sup>.

**METHODS FOR MEDICAL ERROR DETECTION**

A number of methods are present for the detection of medication errors<sup>26</sup>. Some of them are as follows (table) :

**Table 4. Method of Medical error detection**

Sr. No.	Methods for Medical error detection	Features of the method
1.	Self Reporting	Reporting of the incident by the clinicians. The Identity of the reporter is known or anonymous which makes the follow-up difficult.
2.	Mandatory incident reporting	The reporting of serious patient incidents is mandatory in the U.S.A. Underreporting is there and the Follow-up is difficult
3.	Chart review	The events are identified by reviewing patient charts. It involves a high-end training of the reviewers to review the charts. The chances of missing events may be there if charts are not well documented.
4.	Direct observation	Potential incidents are identified by monitoring the routine medication of the patient. It required trained personnel, huge money and time to conduct observations
5.	Engineering modelling techniques	It includes techniques like systems theoretic process analysis (STPA) and Failure mode and effects analysis (FMEA). STPA uses the theory of system to find an error while FMEA is an approach that proceeds gradually to find failures.

## SOLUTIONS TO PREVENT MEDICATION ERRORS

According to the recommendation of the Anaesthesia Patient Safety Foundation, the European Board of Anaesthesiology, the Australian and New Zealand College of Anaesthetists, and the World Health Organization, and medication error studies the solutions to prevent medication errors are as follows<sup>17,26</sup>: Standardization: It involves standardization of labels of all medicines/medical devices (e.g. color coding syringe labels, Tallman lettering) and standardization of medication library in the institution in case of using a Smart infusion pump.<sup>29</sup> Pharmacy: The care should be taken while dispensing Pre-filled syringes, pre-mixed solutions, and multi-used vials. For example, the concentration of Prefilled syringes and premixed solutions must be the same within an institution, use of the multi-dose vial should be limited etc. The round o'clock availability of clinical pharmacy consultants at the pharmacy is a great support to the anaesthesia clinicians in Ors<sup>33</sup>. Institutional: At an institution-level all the incidents that may relate to medication error should be reported. A confidential incident reporting system should be there which encourages reports from all anonymous providers<sup>22</sup>. Measures to Decrease Wrong Dose Errors: It could be decreased by implementing preventive measures<sup>27</sup>. By using preparations that are pharmacy or commercially available and in standardized concentrations the elimination of perioperative dilution of medications can be done which cause medication error. Other methods like using a system that supports independent double-checks and delivering infusions using an electronically controlled smart device that has a medication library can reduce chances of medication errors due to the wrong dose<sup>27</sup>.

## RECOMMENDATIONS FOR PERIOPERATIVE PERSONNEL

After a lot of research, the researchers identified several recommendations that can reduce the chances of medication errors<sup>28</sup>. These recommendations are based on the solutions to prevent Medication errors<sup>12, 26,38</sup>. Some of the recommendations are as follows:

- Proper labelling of medications.
- More usage of prefilled syringes.
- Passing of one medication at one time in the sterile room.
- Proper segregation of injectables and non-injectables.
- Less or no use of abbreviations on the label of a medication.
- After completion of medication procedures discards all containers of medicines depending on the connectivity with the patient.
- Double-checking should be done by a second person before administration of medication.
- Identify the high-risk medications.
- Using the aseptic techniques throughout the procedure.

## CONSEQUENCES OF PERIOPERATIVE MEDICATION ERRORS

The patients and their families are greatly affected by Medication errors. The medical provider, patients and their families are totally helpless once an error takes place. It results in adding of the significant amount to medical

treatment and increases morbidity as well as mortality in some cases. Preventable medical errors are “killer number Three” in U.S –and are only preceded by heart diseases and different types of cancer combined. the preventable medication error claims about 4,00,000 lives of people/year<sup>29,30</sup>.in between 1997 to 2007 there are Ninety - three claims (with the total cost of approx \$4,915,450) which are filed in the NHS Litigation Authority database under anaesthesia. The direct harm caused by an error during drug administration and due to allergic reactions were analysed Alleging<sup>31,32</sup>. The Alleged errors were categorised by using the systems that are employed by the National Coordinating Council for Medication Error Reporting and Prevention, the UK health and Safety Executive, and the American Society of Anaesthesiologists Closed Claims Project<sup>33,34</sup>. 62 claims are there that involved drug administration errors (total cost \$ 4,283,677) and 15 result in severe harm as well as death in some cases. Half of the alleged errors alleged due to the administration of the wrong drug, mainly a neuromuscular blocker. 9 of the claims that are alleging wrong dose had been given (25)alleged overdose of Opioids overdose by neuraxial routes. “Awake-paralysis” is the most frequent recorded adverse outcomes (19 claims, total cost \$182,347) and the respiratory depression that requires transfer of the patient to Intensive Care treatment (13 claims, total cost \$2,752,853). 31claims involved several allergic reactions (total cost 631,773 pounds)<sup>35,36</sup>. In 20 claims, the patient allegedly received a drug to which they were known to be allergic (total cost \$130, 794). There is evidence of the involvement of human error in all claims in which there was a possibility of categorising the error's nature involved. Less than half of the claims that appeared are preventable by an ' ideal double checking process<sup>37,38</sup>.

## 2. DISCUSSION

Main approaches to managing adverse events can be divided into two things. Firstly, by addressing the human and secondly by minimising the system factors. Human factors involve a) identifying negligence and/or b) the incompetence of operator<sup>38,39</sup>. System factors mainly focus on the circumstances in which the resultant error occurred. It can be system failure, , discrepancies occur due to interaction between the human elements, technology and social skills. Such scenarios advocate Prevention such as considerations about process restructuring and identification of problems that are hidden in the system<sup>40, 41</sup>. The need to make a truthful disclosure of the error to the patient's family remains an ethical imperative<sup>8,9,15</sup>. Surveys conducted show that only 17-30% of physicians inform their patients a medical error has occurred<sup>12,17,20</sup>. The right time to communicate with the patient's family is when the patient Safety and care has been insured and this should be done in a quiet environment and that allows the privacy of communication<sup>42,43</sup>. One should use simple words which can be understood by layperson<sup>9,41</sup>. It is important to be sympathetic and allow sufficient time for questions from family and record these details in medical record<sup>33,36</sup>. Lastly, medical errors or adverse drug reactions must be reported according to the Pharmacovigilance Programme of United States (PvPI) guidelines<sup>42,44</sup>Generally medical error do not cause life-threatening harm, Anaesthesiologist always try their best to avoid any error and provide maximum relief at a low cost to human lives. They put all efforts to report and prevent drug errors. Over the past 60 years, there is no change in Current safety protocols in intravenous Drug Delivery the incorporation of digital as

well as an electronic concept should be promoted by anaesthesia related Drug Delivery System. The review focuses on medication administration in perioperative settings. The medication errors are due to prescribing, dispensing, administration of drugs, irrespective of the fact that they cause adverse consequences or not. There are mainly three phases: Preoperative, intraoperative and postoperative in perioperative care. The various stages of perioperative medication include requesting, dispensing, preparing, administering, documenting and monitoring the drug administration.

### 3. CONCLUSION

It was concluded from types of perioperative medication errors and examples of associated potential adverse drug events that the common type of drug error is wrong medication followed by Overdose of medicine. While in ICU and Critical Care units the errors are mainly associated with the administration of anaphylactic drugs. These all

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perioperative medication errors lead to a huge effect on patients and their families. These adverse effects can be managed by either addressing the human or by minimising system factors.

### 4. AUTHORS CONTRIBUTION STATEMENT

Dr Sibghatullah M Khan gathered data, perceived the idea, carried out the research study with regard to this work. Dr. Gaurav Agarwal guided in conducting this research study and also reviewed the manuscript. Dr. Shilpi Agarwal and Mrs Jyoti Ghangas analysed the data and gave necessary inputs towards the designing of the manuscript. All authors provided critical feedback, discussed the methodology, results and contributed to the final manuscript.

### 5. CONFLICT OF INTEREST

Conflict of interest declared none.

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