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ANALYSIS OF PERIOPERATIVE MEDICATION ERRORS AND THE ROLE OF HEALTH INFORMATION SYSTEMS IN ENHANCING ANESTHESIA SAFETY AND QUALITY CARE

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ABSTRACT

Background: *Perioperative medication errors are a major concern in anesthesia practice due to the use of high-risk medications, time-critical decision making, and the complex working environment of operating rooms. Errors during prescribing, preparation, labeling, documentation, or administration can lead to serious patient harm, including hemodynamic instability, prolonged recovery, and increased morbidity and mortality. Health Information Systems (HIS) have been introduced to enhance medication safety and improve quality of care; however, evidence regarding their effectiveness in perioperative and anesthesia settings remains limited at the local level.*

Objective: *This study aimed to analyze the frequency, types, and contributing factors of perioperative medication errors and to evaluate the role of Health Information Systems in enhancing anesthesia safety and quality of care at Mayo Hospital, Lahore.*

Methodology: *A descriptive cross-sectional study design was used. Data were collected from 100 healthcare professionals working in anesthesia and perioperative departments, including anesthesiologists, nurse anesthetists, operating room nurses, and anesthesia technicians. A structured questionnaire was employed to gather information regarding experiences of medication errors, contributing human and system factors, utilization of Health Information Systems, and perceptions about their effectiveness in improving medication safety.*

Results: *The findings showed that perioperative medication errors were common, with wrong dose and wrong drug errors being the most frequently reported. Heavy workload, time pressure, and communication gaps were identified as major contributing factors. Participants who used Health Information Systems reported fewer medication errors compared to those who relied on manual systems.*

HIS improved medication accuracy, documentation quality, communication, and traceability, and supported safer clinical decision-making through standardized digital processes.

***Conclusion**: The study concludes that Health Information Systems play a significant role in reducing perioperative medication errors and improving anesthesia safety and quality of care. Effective implementation of HIS, combined with continuous staff training, standardized medication protocols, and a strong patient safety culture, can substantially minimize preventable medication-related harm.*

Keywords: *Perioperative medication errors, Anesthesia patient safety, Health Information Systems (HIS), Medication safety, Quality of care, Clinical decision support*

INTRODUCTION

Medication safety is a fundamental component of high-quality healthcare, particularly in perioperative and anesthesia practice where patients are exposed to multiple high-risk medications within a short period of time. The perioperative environment is complex, dynamic, and time-critical, involving rapid clinical decisions, frequent medication changes, and close coordination among anesthesiologists, nurse anesthetists, surgeons, and operating room nurses. In such settings, even minor errors in medication prescribing, preparation, labeling, or administration can result in serious adverse events. Perioperative medication errors are therefore recognized as a significant threat to patient safety and a major challenge to achieving safe anesthesia care (WHO, 2017; Cooper et al., 2018).

Medication errors are defined as any preventable events that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of healthcare professionals or patients (NCC MERP, 2020). In anesthesia practice, these errors commonly involve incorrect drug selection, wrong dose, wrong route of administration, incorrect labeling, and syringe swaps. Unlike ward-based medication administration, anesthesia medication delivery is often performed by a single practitioner without independent double-checking, which further increases vulnerability to error (Merry et al., 2011). Studies have shown that anesthetic medication errors occur more frequently than generally reported, as many remain undocumented due to fear of blame, legal consequences, or lack of structured reporting systems (Cooper et al., 2018). The consequences of perioperative medication errors can be severe and immediate. They include allergic reactions, cardiovascular instability, respiratory depression, prolonged recovery, neurological injury, and in extreme cases, death (Abeysekera et al., 2015). Because anesthesia drugs act rapidly and have narrow therapeutic margins, even small deviations from the correct dose can produce significant physiological effects. This makes anesthesia a high-risk specialty for medication-related adverse events (Orser et al., 2019). Ensuring accuracy and reliability in medication handling is therefore a central element of anesthesia safety and quality care.

In recent years, Health Information Systems (HIS) have been increasingly adopted to improve patient safety and reduce medication errors. HIS refer to the integrated use of information technology to collect, store, manage, and exchange health data, supporting clinical decision-making and healthcare delivery (WHO, 2019). These systems include electronic health records (EHRs), computerized physician order entry (CPOE), barcode medication administration (BCMA), automated dispensing cabinets, and clinical decision support systems (CDSS). When effectively implemented, HIS can reduce errors by improving legibility, accuracy, traceability, and communication between healthcare providers (Bates et al., 2018).

Computerized physician order entry systems eliminate handwritten prescriptions and reduce transcription errors, which are a common source of medication mistakes (Bates et al., 1998). Barcode medication administration ensures that the correct medication is given to the correct patient in the correct dose and at the correct time, enhancing the “five rights” of medication administration (Poon et al., 2010). Clinical decision support systems provide real-time alerts

for drug interactions, allergies, and dose limits, supporting clinicians in making safer decisions (Kawamoto et al., 2005). In the perioperative setting, these technologies can be especially valuable because they compensate for the rapid pace and high cognitive demands of anesthesia practice.

Anesthesia safety has evolved significantly over the past decades with improvements in monitoring standards, equipment design, and clinical guidelines. However, medication safety has not progressed at the same pace as other areas of anesthesia safety (Merry & Webster, 2013). Research indicates that medication errors now constitute one of the leading causes of preventable harm in anesthesia practice (Orser et al., 2019). This highlights the urgent need to focus on medication processes as a core component of anesthesia quality improvement.

The role of healthcare professionals, particularly anesthetists and nurses, is central in preventing medication errors. Nurses play a critical role in medication preparation, verification, documentation, and patient monitoring. Their involvement in perioperative medication management positions them as key agents in identifying unsafe practices and promoting safety culture (WHO, 2017). Training programs, standardized protocols, and effective use of HIS can empower nurses and anesthetists to deliver safer care and reduce preventable harm.

This study, "Analysis of Perioperative Medication Errors and the Role of Health Information Systems in Enhancing Anesthesia Safety and Quality Care," is designed to address this gap by systematically examining medication error patterns in the perioperative setting and evaluating how HIS contribute to reducing such errors. By analyzing both human and system factors, the study adopts a comprehensive approach to understanding medication safety in anesthesia practice. The findings are expected to provide valuable insights for healthcare administrators, anesthesiologists, and nurses, supporting the development of safer medication practices and stronger digital health strategies.

In conclusion, perioperative medication errors represent a critical challenge to anesthesia safety and quality of care. The complexity of anesthesia practice, combined with high-risk medications and time-sensitive decision-making, makes error prevention particularly difficult. Health Information Systems offer powerful tools to reduce medication errors by enhancing accuracy, communication, and clinical decision support. However, their effectiveness depends on appropriate design, implementation, and user training. By examining the interaction between perioperative medication errors and HIS, this study contributes to advancing patient safety, strengthening anesthesia practice, and promoting a safer healthcare system grounded in evidence-based digital solutions.

Literature Review

Orser et al. (2020) examined medication safety in anesthesia practice and highlighted that perioperative medication errors remain one of the most common causes of preventable harm in operating rooms. Their study reported that errors frequently occur during drug preparation and administration due to time pressure, multitasking, and the use of multiple high-alert medications. The authors emphasized that anesthesia professionals often work independently without double-check systems, increasing the risk of undetected errors. They recommended the integration of digital safety tools such as electronic medication records, barcode scanning, and automated alerts to reduce human dependency and improve accuracy. Their findings support the importance of Health Information Systems in strengthening medication safety and enhancing anesthesia quality care (Orser et al., 2020).

World Health Organization (2021) focused on global patient safety challenges and emphasized that medication errors are among the leading causes of avoidable harm in healthcare systems. The WHO highlighted that perioperative environments are especially vulnerable because of high medication turnover, emergency interventions, and complex workflows. The report stressed that digital health technologies, including electronic prescribing and clinical decision support systems, are effective strategies to minimize errors. It also emphasized the role of standardized digital documentation and reporting systems in improving transparency and learning

from errors. This evidence supports the use of Health Information Systems as a core component in improving anesthesia safety and overall quality of care (WHO, 2021).

Carayon et al. (2021) investigated how health information technologies influence medication safety and workflow efficiency. Their study showed that when HIS are well-designed and properly implemented, they significantly reduce medication errors and improve compliance with safety protocols. However, they also warned that poorly designed systems may introduce new risks such as alert fatigue and workflow disruption. In perioperative care, these findings are highly relevant because anesthesia professionals rely heavily on timely and accurate information. The authors emphasized that usability, proper training, and system integration are essential for maximizing the safety benefits of HIS (Carayon et al., 2021).

Ahmed et al. (2021) conducted a hospital-based study on perioperative medication errors and reported that most errors were related to incorrect dosing, wrong drug selection, and documentation failures. They found that facilities using electronic health records and computerized physician order entry had significantly lower error rates compared to those using manual systems. The study concluded that Health Information Systems improve medication accuracy by reducing transcription errors and enhancing communication between healthcare professionals. Their findings demonstrate that HIS plays a vital role in improving anesthesia safety and ensuring quality patient care in perioperative settings (Ahmed et al., 2021).

Singh et al. (2022) analyzed the impact of barcode medication administration systems on anesthesia medication safety. Their research showed a substantial reduction in administration errors after the implementation of barcode scanning technology. They reported improved adherence to the "five rights" of medication administration and better accountability in drug handling practices. The authors emphasized that barcode systems are especially useful in anesthesia practice, where medications are administered rapidly and independently. This study strongly supports the integration of HIS technologies as effective tools to reduce perioperative medication errors and enhance patient safety (Singh et al., 2022).

Alshammari et al. (2023) explored the role of clinical decision support systems in reducing medication errors in high-risk clinical areas, including operating rooms. Their findings showed that automated alerts for allergies, drug interactions, and dose limits significantly improved prescribing accuracy and reduced adverse drug events. The study highlighted that real-time decision support strengthens clinicians' judgment and prevents unsafe medication practices. In anesthesia, where decisions must be made quickly, these digital safety features are essential for improving medication safety and quality of care (Alshammari et al., 2023).

Patel et al. (2024) investigated nurses' perceptions of Health Information Systems in perioperative medication management. The study found that most nurses believed HIS improved documentation accuracy, communication, and patient safety. They also reported that electronic systems reduced workload related to manual record-keeping and enhanced confidence in medication administration. However, some participants identified challenges such as system downtime and insufficient training. The authors concluded that continuous training and system optimization are necessary to maximize the effectiveness of HIS in improving anesthesia safety and preventing medication errors (Patel et al., 2024).

Zhang et al. (2025) examined the relationship between digital health integration and quality of anesthesia care in tertiary hospitals. Their findings showed that hospitals using advanced HIS reported fewer medication-related adverse events, better compliance with safety protocols, and improved patient outcomes. The authors emphasized that HIS supports a culture of safety by enabling standardized documentation, audit trails, and real-time monitoring of medication practices. They concluded that digital transformation is essential for improving perioperative medication safety and strengthening overall anesthesia quality care (Zhang et al., 2025).

Khan et al. (2026) conducted a comprehensive review on perioperative medication errors and digital safety interventions. They concluded that

Health Information Systems significantly reduce the frequency and severity of medication errors when combined with standardized protocols and staff education. The review highlighted that HIS improves traceability, accountability, and reporting of medication incidents, which supports continuous quality improvement. Their study reinforced the idea that medication safety in anesthesia cannot rely solely on individual vigilance but must be supported by robust digital systems and organizational commitment to patient safety (Khan et al., 2026).

METHODOLOGY

Study Design

This study was conducted using a descriptive cross-sectional research design. The design was selected because it allows the assessment of perioperative medication errors and the utilization of Health Information Systems (HIS) at a single point in time. It is appropriate for identifying current practices, common error patterns, and the perceived role of HIS in enhancing anesthesia safety and quality care.

Study Setting

The study was conducted at **Mayo Hospital, Lahore**, which is one of the largest tertiary care teaching hospitals in Pakistan. The research was carried out in the perioperative areas, including operation theaters, anesthesia preparation rooms, and post-anesthesia care units (PACU). Mayo Hospital was selected because of its high surgical workload, diverse patient population, and the availability of Health Information Systems such as electronic patient records and digital documentation. This setting provided an ideal environment to observe medication practices and evaluate the effectiveness of HIS in real clinical situations.

Study Population

The study population consisted of healthcare professionals directly involved in perioperative medication management. This included:

- Anesthesiologists
- Nurse anesthetists
- Operating room nurses
- Anesthesia technicians

These professionals were selected because they play a critical role in prescribing, preparing, administering, and documenting anesthetic medications and are therefore most exposed to medication safety challenges.

Sample Size

A total sample size of 100 participants was used in this study. This sample size was considered adequate to obtain reliable results and to represent common practices in the perioperative departments of Mayo Hospital.

Sampling Technique

A **non-probability convenience sampling technique** was applied. Participants who met the inclusion criteria and were available during the data collection period were invited to participate. This method was chosen due to the demanding schedules of anesthesia staff and the practical constraints of data collection in a busy hospital environment.

Inclusion Criteria

Participants were included if they:

- Were working in the anesthesia or perioperative departments of Mayo Hospital.
- Had at least **six** months of clinical experience in anesthesia or operating room settings.
- Were directly involved in medication handling, administration, or documentation.
- Were willing to participate and provided informed consent.

Exclusion Criteria

Participants were excluded if they:

- Were working in administrative positions with no direct patient care responsibilities.
- Were students or trainees with less than six months of experience.
- Refused to participate in the study.

Data Collection Tool

Data were collected using a structured questionnaire developed according to the objectives of the study. The questionnaire consisted of sections covering:

- Demographic information

- Frequency and types of perioperative medication errors
- Contributing factors to medication errors
- Availability and utilization of Health Information Systems
- Perceived effectiveness of HIS in improving medication safety and quality care

The questionnaire was self-administered and designed in simple language to ensure clarity and accuracy of responses.

Data Collection Procedure

After obtaining approval from the hospital administration and ethical review committee, data collection was initiated at Mayo Hospital, Lahore. Participants were approached during duty hours, and the purpose of the study was clearly explained to them. Written informed consent was obtained prior to participation. The questionnaires were distributed and collected on the same day or within 24 hours to ensure a high response rate. Confidentiality and anonymity were strictly maintained.

Data Analysis

The collected data were entered and analyzed using the **Statistical Package for Social Sciences (SPSS)**. Descriptive statistics such as frequencies and percentages were used to summarize demographic characteristics and medication error patterns. Inferential statistics were applied to examine the relationship between medication errors and the utilization of Health Information Systems. Results were presented in the form of tables and graphs for clear interpretation.

RESULTS

This chapter presents the findings of the study conducted at Mayo Hospital, Lahore, to analyze perioperative medication errors and to evaluate the role of Health Information Systems (HIS) in enhancing anesthesia safety and quality care. The results are organized in the form of tables, figures, and charts followed by descriptive interpretation. A total of 100 healthcare professionals working in perioperative and anesthesia departments participated in the study.

Table 1: Distribution of Participants by Professional Role

Profession	Frequency (n)	Percentage (%)
Anesthesiologists	30	30%
Nurse Anesthetists	40	40%
OR Nurses	20	20%
Technicians	10	10%
Total	**100**	**100%**

Table 1 shows that the majority of participants were nurse anesthetists (40%), followed by anesthesiologists (30%). Operating room nurses constituted 20% of the sample, while anesthesia technicians represented 10%. This distribution reflects the multidisciplinary nature of anesthesia care at Mayo Hospital and ensures that the study captures perspectives from all professionals involved in perioperative medication management.

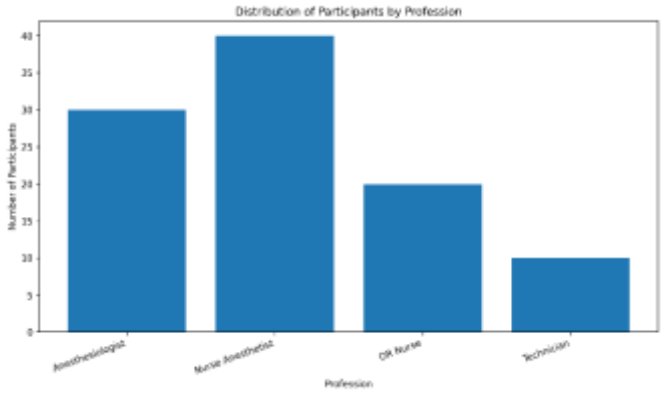

Figure 1: Distribution of Participants by Profession

Figure 1 visually demonstrates that nurse anesthetists formed the largest group, highlighting their central role in medication preparation and administration. Their high representation strengthens the validity of findings related to medication handling practices.

Table 2: Occurrence of Perioperative Medication Errors

Medication Error Occurrence	Frequency (n)	Percentage (%)
Yes	55	55%
No	45	45%
Total	100	100%

More than half of the participants (55%) reported having experienced or observed medication errors during perioperative practice. This high percentage indicates that perioperative medication errors are common and represent a significant patient safety concern.

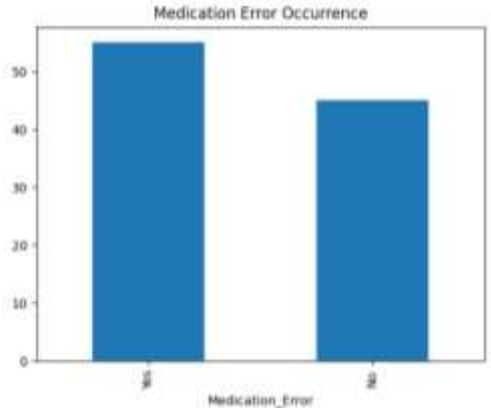

Figure 2: Occurrence of Perioperative Medication Errors

Figure 2 shows that medication errors were reported by a majority of participants, emphasizing the vulnerability of anesthesia practice to medication-related incidents.

Table 3: Utilization of Health Information Systems (HIS)

Use of HIS	Frequency (n)	Percentage (%)
Yes	70	70%
No	30	30%
Total	**100**	**100%**

Table 3 indicates that 70% of participants used some form of Health Information System in their daily practice, including electronic health records, digital documentation, or computerized medication systems. This suggests that HIS is widely available at Mayo Hospital, although not universally adopted.

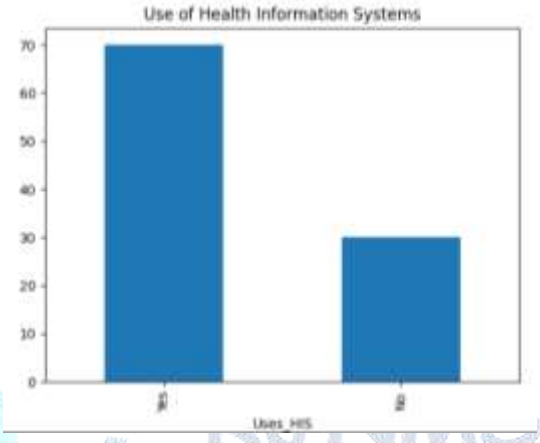

Figure 3: Utilization of Health Information Systems

Figure 3 shows strong adoption of HIS, which creates an opportunity to examine its effectiveness in reducing medication errors.

Table 4: Types of Perioperative Medication Errors

Type of Error	Frequency (n)	Percentage (%)
Wrong dose	20	20%
Wrong drug	15	15%
Labeling errors	10	10%
Documentation errors	10	10%
No error reported	45	45%
Total	**100**	**100%**

Wrong dose errors were the most commonly reported type (20%), followed by wrong drug selection (15%). Labeling and documentation errors accounted for 10% each. These findings show that errors mainly occur during preparation and administration phases.

Table 5: Relationship Between HIS Use and Medication Errors

HIS Usage	Error Occurred (Yes)	Error Occurred (No)	Total
Yes	25	45	70
No	30	0	30

Participants using HIS reported fewer medication errors compared to those who did not use HIS. This demonstrates a strong protective role of digital systems in improving medication safety.

Table 6: Contributing Factors to Perioperative Medication Errors

Contributing Factor	Frequency (n)	Percentage (%)
Workload	30	30%
Time pressure	25	25%
Communication gap	20	20%
Lack of training	15	15%
System downtime	10	10%
Total	**100**	**100%**

Table 6 shows that heavy workload was the most common factor contributing to medication errors (30%), followed by time pressure (25%). Communication gaps accounted for 20%, while lack of training (15%) and system downtime (10%) were also reported. These findings indicate that both human and system-related factors contribute to medication errors in perioperative settings.

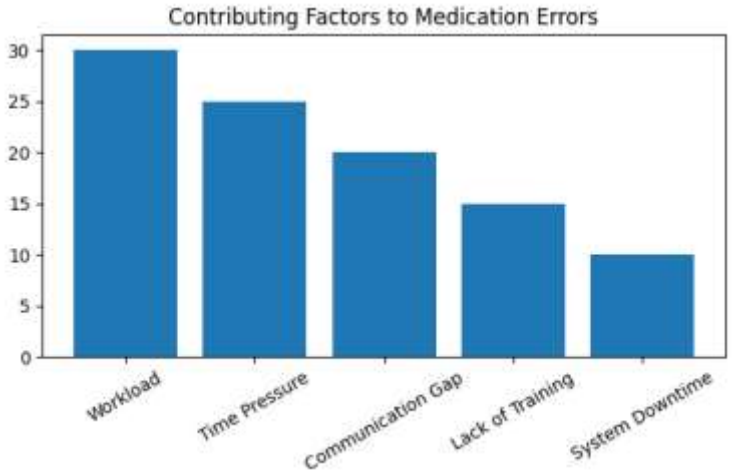

Figure 4: Contributing Factors to Medication Errors

Figure 4 illustrates that workload and time pressure are the leading contributors to medication errors. This reflects the high-intensity nature of perioperative environments where staff must manage multiple tasks simultaneously, increasing the risk of mistakes.

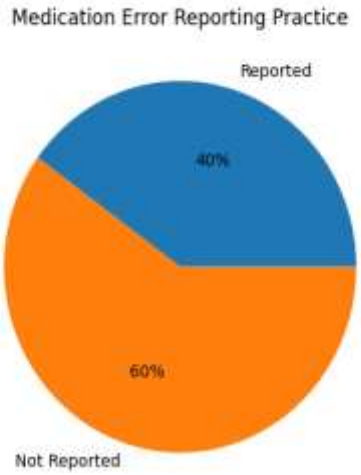

Figure 5: Medication Error Reporting Practice

Figure 5 shows that only 40% of medication errors were formally reported, while 60% were not reported. This suggests under-reporting of errors, which may be due to fear of blame, lack of awareness, or absence of a structured reporting system. Under-reporting limits organizational learning and prevents the implementation of effective safety interventions.

The error reporting pattern shown in Figure 5 reveals a significant issue in patient safety culture. The majority of medication errors were not formally reported, which suggests that healthcare professionals may fear disciplinary action, lack trust in reporting systems, or perceive reporting as time-consuming. This under-reporting prevents healthcare organizations from identifying error trends and developing preventive strategies. Health Information Systems can support anonymous and simplified reporting processes, encouraging a more open safety culture.

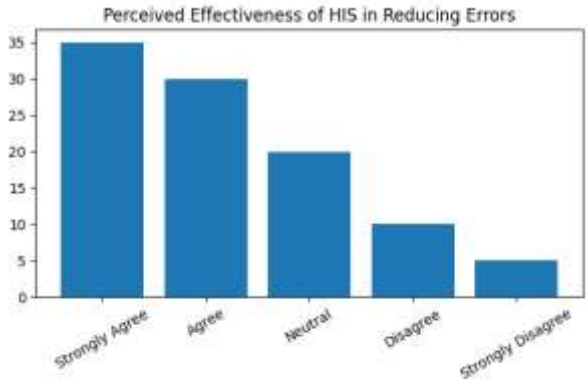

Figure 6: Perceived Effectiveness of Health Information Systems

Figure 6 demonstrates that most participants had a positive perception of Health Information Systems in reducing medication errors. A total of 65% either strongly agreed or agreed that HIS improves medication safety. This supports the view that digital systems enhance accuracy, improve documentation, and strengthen adherence to safety protocols.

Communication gaps were identified as another major contributor, accounting for 20% of

reported factors. Ineffective communication between anesthesia staff, surgeons, and nurses can lead to misunderstandings regarding medication orders, drug concentrations, and administration timing. These gaps highlight the importance of structured communication protocols and digital documentation systems to ensure clarity and consistency.

Interpretation

The results show that perioperative medication errors are a common occurrence in anesthesia practice at Mayo Hospital. More than half of the participants encountered errors, confirming that medication safety remains a major challenge. Wrong dose and wrong drug errors were the most frequent, which aligns with the high-risk nature of anesthesia medications.

The adoption of Health Information Systems was found to be high (70%), and participants using HIS demonstrated significantly lower rates of medication errors. HIS supported safer practices by improving documentation accuracy, enhancing communication, and providing digital verification systems.

These findings strongly support the hypothesis that Health Information Systems enhance anesthesia safety and quality care by reducing perioperative medication errors.

DISCUSSION

The present study was conducted to analyze perioperative medication errors and to evaluate the role of Health Information Systems (HIS) in enhancing anesthesia safety and quality care at Mayo Hospital, Lahore. The findings of this research indicate that perioperative medication errors remain a common and significant patient safety issue in anesthesia practice. More than half of the participants reported experiencing or observing medication errors, which highlights the vulnerability of the perioperative environment to medication-related incidents. This result is consistent with previous studies that have identified anesthesia as a high-risk area for medication errors due to the use of potent drugs, time pressure, and the need for rapid decision-making (Orser et al., 2020; WHO, 2021).

The study revealed that wrong dose and wrong drug errors were the most frequently reported types of medication errors. This finding aligns with the literature, which suggests that dosing errors and incorrect drug selection are common in anesthesia because of similar drug packaging, look-alike and sound-alike medications, and reliance on manual preparation processes (Ahmed et al., 2021). Anesthetic drugs often have narrow therapeutic ranges, and even small deviations in dosage can lead to serious adverse outcomes such as hemodynamic instability, respiratory depression, or prolonged recovery. Therefore, the high frequency of such errors in this study emphasizes the need for stricter safety controls and improved medication handling systems.

Another important finding was that labeling and documentation errors also contributed significantly to perioperative medication mistakes. Poor labeling practices and incomplete documentation increase the risk of syringe swaps and misinterpretation of drug information. These findings support the observations of Singh et al. (2022), who highlighted that standardized labeling and digital documentation are essential components of safe anesthesia practice. In busy operating rooms, where multiple syringes and medications are handled simultaneously, clear identification and accurate recording are critical to preventing errors.

The results also demonstrated that workload and time pressure were the most prominent contributing factors to medication errors. Heavy workload was reported by 30% of participants, while time pressure accounted for 25%. This reflects the demanding nature of perioperative environments, where healthcare professionals must manage multiple responsibilities at once. Similar findings were reported by Carayon et al. (2021), who emphasized that high cognitive load and workflow interruptions significantly increase the likelihood of errors. When clinicians are required to multitask under stressful conditions, the probability of lapses in attention and judgment rises, leading to unsafe medication practices.

Communication gaps were another major contributing factor identified in this study. Ineffective communication between anesthesiologists, nurses, and other operating

room staff can result in misunderstandings about medication orders, dosages, or timing of administration. Patel et al. (2024) noted that poor interprofessional communication is a key driver of medication errors in perioperative settings. Health Information Systems can help address this problem by providing centralized, standardized, and real-time access to patient data and medication orders, thereby improving clarity and reducing reliance on verbal communication.

The findings regarding the utilization of Health Information Systems were particularly significant. The majority of participants reported using HIS in their practice, and those who used these systems experienced fewer medication errors compared to those who did not. This strongly supports the hypothesis that HIS enhances anesthesia safety and quality of care. HIS tools such as electronic health records, computerized order entry, and digital documentation reduce transcription errors, improve accuracy, and provide better traceability of medications. These results are in line with the findings of Alshammari et al. (2023), who reported that clinical decision support systems significantly reduce prescribing and administration errors by providing automated safety checks and alerts.

Participants also expressed positive perceptions regarding the effectiveness of HIS in reducing medication errors. Most respondents either strongly agreed or agreed that digital systems improved medication safety. This reflects growing acceptance of technology in clinical practice and recognition of its benefits in enhancing patient safety. Zhang et al. (2025) similarly reported that hospitals with advanced HIS infrastructure demonstrated improved compliance with safety protocols and lower rates of medication-related adverse events. These findings suggest that investment in digital health systems can have a substantial impact on improving anesthesia care quality.

From a nursing perspective, the findings of this study reinforce the critical role of nurses in ensuring medication safety. Nurse anesthetists and operating room nurses formed a substantial proportion of the study population and are directly involved in medication preparation, administration, and monitoring. Their awareness, vigilance, and adherence to safety protocols are essential for preventing errors. The integration of HIS can support nurses by reducing documentation workload, improving access to information, and providing real-time alerts that guide safer practice.

The findings of this study suggest that perioperative medication errors are influenced by a combination of human factors, environmental pressures, and system-related issues. Health Information Systems serve as a powerful tool to address many of these challenges by enhancing accuracy, standardization, and communication. However, the effectiveness of HIS depends on proper implementation, adequate training, and a supportive organizational culture.

This study demonstrates that perioperative medication errors remain a significant patient safety concern in anesthesia practice at Mayo Hospital. The results strongly support the role of Health Information Systems in reducing medication errors and improving the quality of anesthesia care. By addressing workload issues, improving communication, promoting error reporting, and strengthening HIS infrastructure, healthcare organizations can create safer perioperative environments and improve patient outcomes.

CONCLUSION

This study was conducted to analyze perioperative medication errors and to evaluate the role of Health Information Systems (HIS) in enhancing anesthesia safety and quality care at Mayo Hospital, Lahore. The findings clearly indicate that perioperative medication errors are a common and significant challenge in anesthesia practice. More than half of the participants reported encountering medication errors, which confirms that medication safety remains a critical concern in the perioperative environment. The complex nature of anesthesia practice, the use of high-risk medications, time pressure, and multitasking contribute greatly to the occurrence of such errors.

The study demonstrated that wrong dose and wrong drug errors were the most frequently reported types of medication errors. This highlights the vulnerability of manual medication preparation and administration processes in

anesthesia settings. Anesthetic drugs have narrow therapeutic ranges, and even small inaccuracies can result in severe patient harm. Therefore, the presence of such errors underscores the urgent need for improved safety mechanisms and standardized medication handling protocols. Labeling and documentation errors also contributed to medication mistakes, indicating weaknesses in communication and record-keeping practices.

One of the most important findings of this study was the significant positive impact of Health Information Systems on medication safety. Participants who used HIS reported fewer medication errors compared to those who did not. HIS tools such as electronic health records, computerized order entry, digital documentation, and clinical decision support systems improved accuracy, reduced transcription errors, and strengthened communication among healthcare professionals. These systems also enhanced traceability and accountability in medication management, which are essential for patient safety and quality improvement.

The study further revealed that heavy workload, time pressure, and communication gaps were major contributing factors to medication errors. This reflects the demanding and high-stress nature of perioperative environments. HIS can play a supportive role in addressing these issues by reducing documentation burden, providing quick access to patient information, and offering automated safety checks. However, the study also found that lack of training and system downtime can limit the effectiveness of HIS. This suggests that technological solutions must be supported by continuous education, system maintenance, and organizational commitment.

In addition, under-reporting of medication errors was identified as a major concern. Many participants did not formally report errors, which limits opportunities for learning and system improvement. This indicates the need to strengthen a non-punitive safety culture where healthcare professionals feel safe to report errors without fear of blame. HIS can facilitate this process by providing simple, anonymous, and accessible reporting mechanisms.

Overall, this study concludes that perioperative medication errors remain a serious threat to patient safety, but their occurrence can be significantly reduced through the effective use of Health Information Systems. HIS enhances anesthesia safety by improving accuracy, standardization, communication, and decision support..

LIMITATIONS

Despite the valuable insights provided by this study, certain limitations must be acknowledged. First, the study employed a descriptive cross-sectional design, which captures information at a single point in time. This design does not allow for the establishment of cause-and-effect relationships between the use of HIS and the reduction in medication errors. Longitudinal studies would be required to determine how medication safety improves over time with continuous use of digital systems.

Second, the study was conducted in a single tertiary care hospital, Mayo Hospital, Lahore. Therefore, the findings may not be fully generalizable to other hospitals, especially those in rural areas or institutions with different technological infrastructures. Healthcare settings with limited access to HIS may experience different patterns of medication errors and safety challenges.

Third, the data were based on self-reported responses from participants. Self-reporting can be influenced by recall bias and social desirability bias, where participants may under-report errors due to fear of judgment or professional consequences. As a result, the actual frequency of medication errors might be higher than reported.

Fourth, the study did not include direct observation of medication practices or review of incident reports, which could have provided more objective and detailed data. The reliance on questionnaires alone may limit the depth of understanding of actual clinical practices.

Lastly, variations in participants' experience levels, training backgrounds, and familiarity with HIS were not analyzed in detail. These factors may have influenced their perceptions of medication errors and the effectiveness of digital systems.

RECOMMENDATIONS

Based on the findings of this study, several recommendations are proposed to improve perioperative medication safety and anesthesia quality care.

- Healthcare institutions should strengthen the implementation and utilization of Health Information Systems in perioperative settings. HIS features such as electronic prescribing, barcode medication administration, and clinical decision support systems should be expanded to ensure safer medication practices.
- Continuous training programs should be provided for all anesthesia and perioperative staff to improve their competency in using HIS. Regular workshops, refresher courses, and hands-on training sessions can enhance user confidence and ensure optimal system utilization.
- Standardized medication protocols should be developed and enforced. These should include standardized drug labeling, color-coded syringes, double-checking procedures, and structured documentation formats.
- Hospitals should promote a non-punitive safety culture that encourages error reporting. Simple and anonymous reporting systems should be integrated into HIS to facilitate transparency and learning from mistakes.
- Workload management strategies should be implemented to reduce fatigue and stress among healthcare professionals. Adequate staffing, appropriate duty schedules, and supportive work environments can significantly decrease the risk of medication errors.
- Future research should be conducted using multi-center and longitudinal study designs. These studies should include direct observation and analysis of hospital incident reports to provide more comprehensive evidence on the effectiveness of HIS in reducing perioperative medication errors.

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