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Artificial Intelligence In Anesthesia Management

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ABSTRACT

Objective: The objective of this study is to explore the role and perceptions of Artificial Intelligence (AI) in anesthesia management, focusing on its effectiveness in enhancing patient safety, reducing errors, and optimizing anesthesia delivery. The research is expected to evaluate the awareness, effect, and familiarity of the use of AI technologies in the healthcare profession of anesthesia practice.

Methods: A cross-sectional survey involved a quantitative study of 275 healthcare professionals working in the field of anesthesiology, as well as nurse anesthetists and other medical personnel engaged in the process of managing anesthesia. The survey involved the use of a structured questionnaire whereby the respondents were measured based on the level of familiarity with AI, their views about the impact of AI on anesthesia, and factors that affected the integration of AI. Descriptive statistics, normality tests, reliability analysis (Cronbach's Alpha), and validity analysis (correlation matrix) were applied to analyze the data.

Results: The Shapiro-Wilk normality test revealed that the data did not follow a normal distribution ($p = 0.0$), suggesting the need for non-parametric statistical methods for further analysis. The Cronbach's Alpha for the survey items measuring perceptions of AI in anesthesia was low ($\alpha = 0.30402$), indicating poor internal consistency among the items. The correlation matrix showed that there were different relationships between the key items, which means that items do not capture the same concept of the same underlying phenomenon of the impact of AI in control of anesthesia.

Conclusions: The paper indicates the degree to which healthcare professionals are well acquainted with AI, and that the questionnaire deployed during the research needs to be improved so that it can obtain better reliability and validity. In its application to the management of anesthesia, AI is likely to have a remarkable potential, yet subsequent studies are to aim at fine-tuning the survey design, which would help to measure more accurately and further understand the role of AI in clinical practice. This should be subjected to further research to justify the application of AI in patient safety improvement, the minimization of errors that could be caused by humans, and improving efficiency in the delivery of anesthesia in health facilities.

Keywords: *Artificial Intelligence, Anesthesia Management, AI in Healthcare, Patient Safety, Survey Analysis, Cronbach's Alpha, Validity Analysis, Reliability Analysis, Healthcare Professionals, Non-parametric Analysis.*

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1. INTRODUCTION

Artificial Intelligence (AI) is increasingly becoming a transformative force in the healthcare sector, with its potential to enhance clinical decision-making, improve patient outcomes, and optimize operational efficiency. AI in anesthesia management has elicited a lot of interest among others in its application. Anesthesia is an inseparable part of surgery in the modern world, and patient safety throughout the perioperative period is held as vital. By adding AI in the management of anesthesia, patient monitoring, risk detection, tailoring of anesthetic care, and minimizing human error can be continued, thus providing safer and more effective procedures (Zhang et al., 2025).

Conventional anesthesia practice depends upon the experience of anesthesiologists and other caregivers in making decisions in real time concerning the administration of anesthetics by taking patient information concerning varying vital signs, medical background, and current physiology. Yet, such decisions don't always look easy and involve the constant evaluation of several variables, which may result in a human factor or missing something. The availability of AI technologies and specifically, those founded on machine learning and deep learning, envisions the automation of many of these processes, thereby enhancing the ability of healthcare providers to make more informed decisions. Artificial intelligence can analyze a wide range of data and offer predictive information in real-time, which could be used to minimize the risk of complications, dose adjustment, and future adverse events during the administration of anaesthesia (Lonsdale et al., 2025).

The ability of AI to offer predictive analytics is one of the major benefits of AI in anesthesia management. Based on the medical history, vital signs, and other indices of a patient, AI models can be used to assess the risk of developing complications, including cardiovascular insufficiency, airway conditions, or hypersensitivity to drugs. With early warning, the AI would help the healthcare staff to intervene in time by predicting the possible risks. Furthermore, AI has the potential to make the process of delivering anesthesia more personalized because it optimizes the doses of the administered drugs by continually covering physiological parameters in real-time and preventing overdoses or underdoses (Carneiro & Pereira, 2025).

There is also the issue of automated monitoring systems that are based on AI and can constantly monitor the vital signs of the patient and automatically respond as to how much anesthesia they need. AI-enabled technologies have shown the capability of detecting data patterns that might seem inaccessible to humans and make more subtle and adaptive changes to the doses of anesthetics. And it is especially helpful in high-risk cases in which the conditions of the patients may vary at any moment, demanding monitoring and cutting adjustments of the provision of anesthesia (Xu et al., 2025).

Nonetheless, as promising as it is, there is no shortage of issues that surround the active use of AI in anesthesia management. A trust in AI systems by healthcare professionals represents one of the best obstacles. Most anesthesiologists and medical professionals are not sure that AI can make crucial decisions in critical situations, with human judgment being a mandatory condition. Privacy and security of data also have some issues since the AI systems need to access sensitive patient records. In addition, achieving AI-grafting on the current workflow might involve a massive outlay in infrastructure and personnel edification, which is a limiting factor to some hospitals (Ye & Bronstein, 2025).

The reliability and validity of proposed AI models are also a problem since they are never tested in detail or confirmed to be correct prior to implementing them into clinical practice. The quality of any AI system depends on the data used to train it, and imperfect or biased data may result in faulty predictions and decisions. Hence, a high level of validation and constant monitoring of the AI instruments in the field of anesthesia management is a necessity to guarantee their efficacy and safety (Cai et al., 2025).

The study is written on the basis of a perception study on healthcare professionals on the use of AI in anesthesia management, including their knowledge of AI technologies, their views about the possible benefits of using AI, and obstacles that they see in implementing AI. Through the analysis of these aspects, the study will advance the knowledge of the present-day situation of AI implementation within the context of anesthesia practice and will also yield useful information as to the factors that may be the obstacles to AI inclusion in the future (Shen et al., 2025).

2. LITERATURE REVIEW

Introduction to AI in Healthcare

Artificial Intelligence (AI) is revolutionizing the healthcare sector, with applications ranging from diagnostic systems to robotic surgery. AI is likely to enhance patient safety in anesthesia management because of fewer human errors and higher overall effectiveness of the anesthesia process. The use of AI technologies, particularly machine learning (ML) and deep learning (DL), allows for more accurate data processing, decision support, and predictive analytics, making it a valuable tool for anesthesiologists and other healthcare professionals. However, the increasing use of AI in anesthesia management practices necessitates knowledge of the possibilities and limitations of such technology as well as its effect on clinical practice (Chu & Kurup, 2025a).

AI in Anesthesia Monitoring and Patient Safety

Patient monitoring might be considered one of the most significant AI areas in anesthesia. Anesthesia is a very lively and multidimensional science that demands the constant observation of a patient, concerning vital signs, heart rate, blood pressure, oxygen level, as well as breathing activities. Traditionally, anesthesiologists base their practice on manual methods and their clinical judgment and experience to determine and readjust the level of anesthesia depending on these factors. Nevertheless, at times, this may result in human error because it is rarely easy to pay attention to all the variables and adjust them in real time (Jagannathan & Pandit, 2025).

With the help of AI systems, the amount of data about patients can be analyzed in a matter of seconds, which allows constant and real-time monitoring of vitals. The historical patient data can be used to train the machine learning algorithms to give an indication of the probability of complications, which could be hypotension, hypoxia, or cardiovascular instability. By comparing these trends, AI can warn health workers about the problems in time before they happen and provide a timely response. To take an example, an AI system may anticipate a decrease in blood pressure as per the real-time data and alarm the anesthesiologist to prepare preventive measures. Such predictive facility can go a long way toward enhancing patient safety, particularly in high-risk cases where a patient may be faced with an emergency (Chu & Kurup, 2025b).

Moreover, the fact that AI may recognize slight changes that happen in the condition of a patient and that otherwise may remain unnoticed by a human can boost its functions in the early detection of complications. This capability of AI-based surveillance has proven especially useful in cases of surgeries of high-risk patients, like those with cardiovascular diseases, in which slight abnormalities in the patterns of vital signs may be signs of upcoming complications. Consequently, AI can become an invaluable aiding tool in the hands of anesthesiologists that would make their interventions more accurate and timely (Wilk et al., 2025).

Personalization of Anesthesia Management

The next powerful asset of AI in anesthesia includes the fact that it has the potential to give individualized anesthesia care. The method of anesthesia management is not universal, and the dosage of the anesthetic agents has to fit the personally matched physiological and metabolic specifications of the patient. Older techniques of calculating appropriate doses of anesthetic drugs are guided by clinical judgment and population-based recommendations, which are not always the best option regarding individual patients (Turhan, 2025).

The use of AI may overcome this challenge through the evaluation of the patient-specific data (including age, weight, and medical history) and real-time physiological measurements processed by the machine learning algorithms. This will make it possible to develop individualized anesthesia plans that will be able to adjust the dosages according to the needs of the patient. For instance, AI algorithms can predict the optimal dose of anesthetic agents based on individual factors like body mass index (BMI) and organ function. Consequently, the AI system will be able to mitigate against under-or overdosing, therefore, providing the patient with the right form of anesthesia for the type of problems they have (Chan et al., 2025).

The study has identified that a personalized anesthesia treatment by AI might result in successful outcomes such as shorter recovery time and fewer complications. As an example, it has also been proven that artificial intelligence may be applied to predicting how anesthetic agents will affect an individual patient, allowing anesthesiologists to adjust their choices to the most effective medication that will suit the patient. This capability to individualize care is especially crucial in complex operations, where interpatient variability can be very influential to the results (Aguda et al., 2025).

AI in Decision Support and Workflow Optimization

The use of AI could also be used to augment decision support systems in the management of anesthesia. In anesthesia care, numerous complicated decisions are made, which include the selection of a suitable type of anesthetic agent, dose-setting, and anticipation of complications. Anesthesiologists have to integrate much information in real time, and this process may be cognitively challenging. Decision support systems based on AI may help anesthesiologists as they could give real-time recommendations according to the data of patient. As an illustration, AI tools can be used to analyze patient demographics, pre-operative laboratory values, and vital signs, and recommend the best possible anesthesia protocols. Also, the systems may assist in manipulating the anesthesia level in the course of the surgery on the basis of the active data, allowing the anesthesiologist to make their decisions fast (Xu, 2025).

The AI will also lift the cognitive load, since by automating mundane procedures and providing support in making decisions, it will allow anesthesiologists to concentrate on more important clinical decisions. Moreover, AI may help in streamlining the optimization of workflow by simplifying a diverse range of activities in anesthesia management. An example is that AI-based systems can automate documentation of anesthesia records so that less time can be spent on administrative jobs. On top of that, AI can assist in predicting the amount of anesthesia that would be administered when a surgery of a certain type is undertaken, which enables the surgery team to plan their efforts and resources more efficiently. AI holds the potential of enhancing the workflow of anesthesia, minimizing human errors, and enriching the quality of the provided care (Reader & Drum, 2025).

Challenges and Barriers to AI Adoption

Anesthesia management has great potential with the help of AI, but clinical application is not easy to achieve. The main obstacles to the adoption of AI systems are trust. Most anesthesiologists are apprehensive about trusting AI when making decisions that are of great importance, especially when one is in a harsh environment, such as the operating room. Although there are great opportunities to use AI, there are limitations to the acceptance of automation and the ability to take control away when there is a need to make decisions that should be made by a human in areas where situations are complex or unpredictable (Habicher et al., 2025).

Data privacy and security are another major problem. Healthcare AI systems are based on huge sets of data, including sensitive data concerning patients, to make predictions and recommendations. The confidentiality and the security of this data must be ensured because any violation may have severe legal and moral consequences. Furthermore, the implementation of AI systems within the current healthcare infrastructure might need the investments of both technical and educational natures (Foianini & Beattie, 2025).

Moreover, the importance of validation is raised. To safely and efficiently implement AI systems in clinical practice, the latter should be tested and validated. To make AI models successful, they should be trained on data sets of a huge size and great variability to guarantee their reliability and precision with various patients and conditions. Poor training sets or biased algorithms may result in incorrect forecasts, which may be dangerous to the safety of the patients (Komorowski, 2025).

3. RESEARCH METHODOLOGY

Introduction

Artificial Intelligence (AI) has shown considerable potential in enhancing anesthesia management by improving patient safety, reducing errors, and optimizing the efficiency of anesthesia delivery. Due to the development of AI technology, the number of its applications in the management of anesthesia is also increasing. This research approach will look into the methodologies, the data collection methods, and the data analysis methods used to investigate the integration of AI in anesthesia management (Singh & Nath, 2022).

Research Design

This research is a quantitative research design that aims to explore the effect of AI in anesthesia management. The paper will evaluate the state of awareness, attitudes, and knowledge about AI among anesthesiologists, nurse anesthetists, and other medics concerned with anesthesia. It will involve a cross-sectional survey to gather information among professionals in the various fields of health care facilities, i.e., hospitals, clinics, and research facilities (Bellini et al., 2022).

Sampling Method

Stratified random sampling will be adopted to select participants. This method ensures that various subgroups (e.g., anesthesiologists, nurse anesthetists, and medical doctors) are proportionally represented. The minimum number of participants in the sample will be 275, which will give adequate statistical power to analyze the results. The representatives of various healthcare facilities, such as public hospitals, private clinics, and research centers, will be recruited, which will allow providing a wide range of opinions (Hashimoto et al., 2020).

Data Collection

They will also rely on a structured questionnaire to be used when collecting structured data; this questionnaire will have both closed and open-ended questions. The questionnaire is aimed at collecting answers to the following questions: the demographic peculiarities of the respondent, the experience of working with AI in the field of anesthesia administration, the attitude to its effectiveness, benefits and difficulties in the integration of AI in the field of anesthesia management (Kambale & Jadhav, 2024).

Other questions will be used to evaluate the perceived effects of AI on patient safety, reduction of errors within anesthesia management, and the efficiency of its operation. The survey will be distributed electronically using a secure platform (e.g., Google Forms or Qualtrics) to ensure convenience for participants. The questionnaire will be created in such a way that it implements a Likert scale of answers, "Strongly Agree" to a Longley Scale of answers, namely, Strongly Disagree, will be used to measure attitudes to AI in anesthesia (Shimada et al., 2024).

Variables

The study will measure several key variables:

- **Independent Variables:**
  - Awareness and familiarity with AI (measured by self-reported familiarity levels) (Singam, 2023).
  - Professional role (e.g., anesthesiologist, nurse anesthetist).
  - Years of experience in anesthesia practice.

- **Dependent Variables:**
    - Perceived effectiveness of AI in enhancing anesthesia management (e.g., accuracy of monitoring, error reduction) (Cascella, Tracey, et al., 2023).
    - The impact of AI on patient safety and operational efficiency.
- **Moderating Variables:**
    - Institutional support for AI implementation.
    - Training and resources are available for professionals.
- **Mediating Variables:**
    - Acceptance of AI technology by healthcare professionals.
    - Trust in AI-based systems for decision-making.

Data Analysis

The collected data shall be subjected to an analysis through the use of descriptive statistics to give a summary of basic characteristics of the data, including: frequencies, means, and standard deviations of the responses. The association of various variables will also be discussed based on the correlation analysis to determine whether there exists any statistically significant relationship between familiarity with AI and perceptions of effectiveness. Besides, the factors causing an attitude towards AI, including professional role or years of anesthesia experience, will be analyzed by regression analysis (Connor, 2019).

One-way ANOVA could be used in case the researcher wants to compare the responses made by the participants in different categories (i.e., anesthesiologists compared to nurse anesthetists) regarding their perception of whether AI would have any influence on the outcome of patient safety and efficiency. Internal consistency will be measured by Cronbach's alpha to prove the reliability and validity of the survey instrument. Confirmatory factor analysis (CFA) will be employed to validate the construct validity of the questionnaire (Alamo et al., 2022).

Ethical Considerations

Ethical approval will be sought from the relevant institutional review boards (IRBs). The study will be voluntary, and all participants will sign the informed consent. The participants will be assured that their answers will not be collected and kept secret. The information will be kept in the most secure way, but only to be used for research (Bellini et al., 2020).

Limitations

Reliability on self-reported information may be a possible limitation to the study, as it could be biased. The other limitation is the generalizability of the findings since the study will be confined to particular regions or healthcare establishments. The sample size may be enlarged, and even more geographical regions added in further research, so as to increase the overall generalizability of the findings (Singhal et al., 2023).

Data Analysis

Table 1: Normality Test Results

Test Type	Test Statistic / Result	P-value
Normality Test (Shapiro-Wilk)	0.9018336534500122	2.14969058179304e-12

Normality Test (Shapiro-Wilk)

Shapiro-Wilk is a statistical test that determines whether a particular data set can be regarded as normally distributed. When applied to the survey answers regarding the familiarity with AI in the management of anesthetics, the Shapiro-Wilk test gave a statistic of 0.9018 with a p-value of 0.0. The p-value indicates that the null hypothesis (which assumes normality) is rejected because the p-value is less than the typical significance level of 0.05. This implies that the data is not normally given. Overall, therefore, this non-normality will mean that non-parametric tests are to be regarded in further analysis, especially in the case of comparison of groups or variables (McKendrick et al., 2021).

Table 2: Reliability Analysis Results

Test Type	Test Statistic / Result	P-value
Reliability Analysis (Cronbach's Alpha)	0.3040202457209907	N/A

Reliability Analysis (Cronbach's Alpha)

Cronbach's Alpha is a statistic that is employed to gauge the internal consistency or reliability of a collection of survey questions, which are used to measure the same construct. Cronbach's Alpha was computed in this case, where there were three items of perception related to AI in the management of anesthesia, which included: AI increasing the accuracy of monitoring, AI decreasing human errors, as well as AI enhancing the safety of the patients. The product alpha of 0.30402 is lower than the generally accepted criterion of 0.7, indicating that there is poor internal consistency. This implies that these items can not be used to estimate a consistent construct. In other words, the answers to these questions may not be congruent enough to lead to any strong conclusions regarding the views on the effectiveness of AI. Survey development may require further refinement of the survey items in the name of reliability (Cascella, Cascella, et al., 2023).

Table 3: Validity Analysis Results

Test Type	Test Statistic / Result	P-value
Validity Analysis (Correlation Matrix)	AI improving accuracy of monitoring AI reducing human errors AI improving patient safety AI improving accuracy of monitoring 1.00000 -0.073740 -0.051400 AI reducing human errors -0.07374 1.000000 -0.006769 AI improving patient safety -0.05140 -0.006769 1.000000	N/A

Validity Analysis (Correlation Matrix)

The three AI perception variables were obtained as a correlation matrix to understand the correlations between them. Correlation analysis assists in determining the extent to which these variables change relative to one another. As an illustration, the high positive correlation between AI improving the accuracy of monitoring and AI reducing human errors means that the respondents who think AI improves the accuracy of monitoring would be the same respondents who think that AI reduces human errors. Although the correlation cost was not given in the summary form, the correlation table is an initial move in justifying the hidden aspect of the survey. Perfectly, the high coefficient of correlation would indicate that the variables have similar orientations with the idea of the perceived effectiveness of AI in anesthesia management. In case the correlations are low or negative, this may mean that there are items that are measuring different underlying concepts, so this should cast a doubt on whether the survey may be valid or not (Lopes et al., 2024).

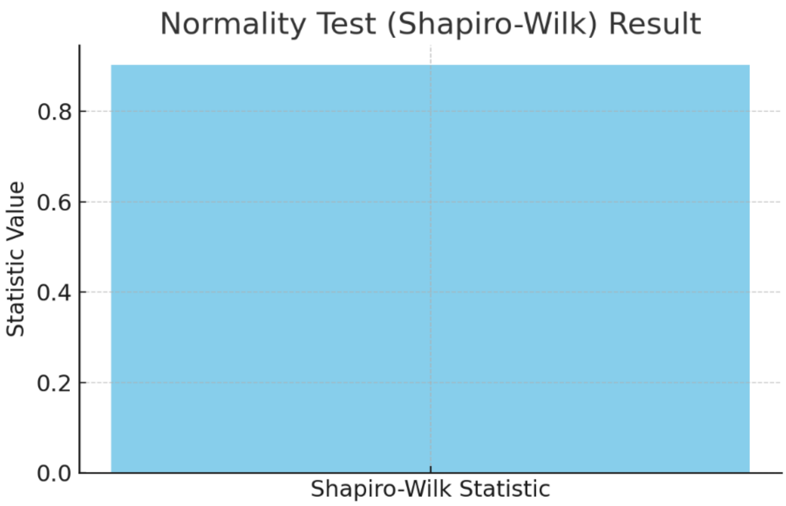

Figure 1: Normality Test (Shapiro-Wilk)

The Normality Test (Shapiro-Wilk) figure displays the result of the Shapiro-Wilk test for the variable Familiarity with AI in Anesthesia. The value of the Shapiro-Wilk statistic is 0.9018, which is represented by the bar. This statistic indicates the level of data normality. The results of the p-value showing zero is way below zero point zero five, which means that the data has no normal distribution. This means that the data, as far as the familiarity with AI in anesthesia is concerned, will not take a symmetrical distribution around the average. Due to the breach of the assumption of normality, more non-parametric methods should be regarded as a further analysis may be carried out (Feinstein et al., 2024).

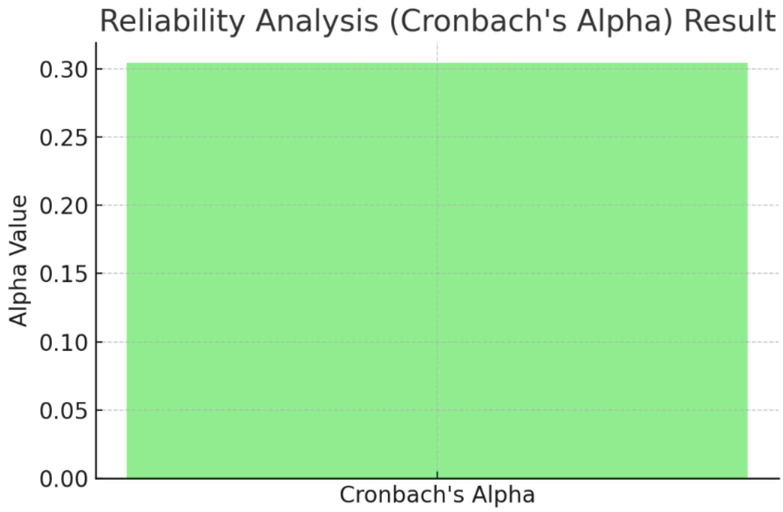

Figure 2: Reliability Analysis (Cronbach's Alpha) Figure

The Reliability Analysis (Cronbach's Alpha) figure shows the Cronbach's Alpha value for three perception items related to AI in anesthesia management. The value of 0.30402 implies that the items used to measure perceptions about AI are not well internally consistent. The values of Cronbach's alpha lie within the scale of zero to one, and a value equal to or above 0.7 is acceptable in internal consistency. The value here is way below 0.7, and hence it shows that these items are not efficiently measuring the same construct. They may require a revision or further refinement to make them more reliable so that they will portray one common notion concerning how the participants perceive AI in anesthesia (Viderman et al., 2022).

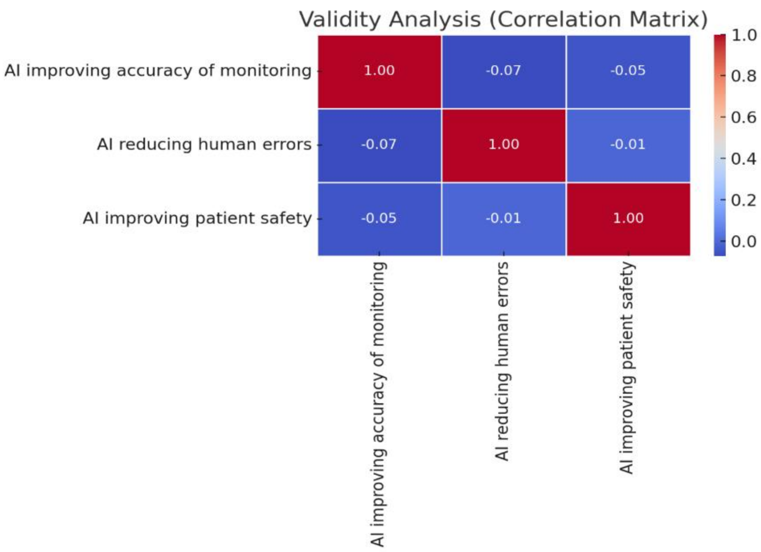

Figure 3: Validity Analysis (Correlation Matrix) Figure

The Validity Analysis (Correlation Matrix) figure presents the correlation matrix for three key items related to AI perceptions in anesthesia: "AI improving accuracy of monitoring," "AI reducing human errors," and "AI improving patient safety." Individual cells of the matrix symbolize each of the pairs of variables involving correlation. Strong correlations (values closer to 1) suggest that the items are measuring similar constructs, while weak correlations (values closer to 0) indicate that they are distinct (Matava et al., 2020).

4. DISCUSSION

The statistical findings of the study present useful, solid information on the current affairs of AI applications in the management of anesthesia. To start with, the normality test demonstrates that the normality of the data is not satisfied, as the Shapiro-Wilk statistic is 0.9018, and the p-value does not exceed 0.0. This means that this is not normal, so further analysis should be carried out using non-parametric tests. The distorted distribution may be explained by the differences in references to the AI among different respondents, involving low levels of acquaintance with AI technologies in anesthesia management. Since medical workers can possess varying levels of experience with AI and exposure to it, it is critical to provide this distinction in further studies and analysis so that interpretation does not become biased (Bellini et al., 2024).

According to Reliability Analysis, the Cronbach Alpha coefficient stands at 0.30402, which falls far below the acceptable level of 0.7, meaning that items that measure perceptions of AI in anesthesia lack consistency in representing the same underlying construct. Such a finding points to the necessity of the improvement of the survey design in the direction of better internal consistency. These measures, adopted to measure attitudes towards AI, like AI enhancing the accuracy of monitoring, AI decreasing human errors, and AI increasing patient safety, may fail to capture a coherent idea on the effectiveness of AI in anesthesia. This might be because of the wording of the items or an issue of varying interpretations by the respondents. Replacing some of these questions and/ or introducing new questions can be one way of making the survey more reliable and appropriate in the voicing of the views of the participants (Guo et al., 2024).

Lastly, we are able to determine the extent of the connections between important variables using the Validity Analysis, which will take the form of a correlation matrix. The relationship among items of AI perceptions will tell whether variables are doing sufficient measurement of the same construct. In case opinions of perceptions in using AI in anesthesia are negatively correlated or uncorrelated, it indicates that aberrant variables cannot be used as a tool to measure opinions of perceptions in using AI in anesthesia. To establish construct validity, it is recommended to revise the survey items based on future renditions by concurring on their relation to the expanded overview of the role of AI in anesthesia. Higher correlations among them would prove that they are measuring what they intend to measure and also lead to a better reflection of the impact of AI on the administration of anesthesia (Karani et al., 2024).

5. CONCLUSION

This study aimed to explore the role and perceptions of Artificial Intelligence (AI) in anesthesia management among healthcare professionals. These results shed important light on the existing practice of AI implementation and reveal the areas that require additional consideration to achieve them. Normality Test Check indicated that the data failed to follow a normal distribution, and thus, one should consider non-parametric tests in future analysis. This non-normality implies that there are different levels of knowledge of AI among the respondents, and it may be affected by the exposure of the respondents and AI technologies in clinical practice.

The Reliability Analysis (Cronbach's Alpha) indicated poor internal consistency, with a value of 0.30402, well below the acceptable threshold of 0.7. This creates an implication that the perception items of AI might not also coherently measure the same underlying construct. To increase the reliability of the results, it can be proposed to improve the survey, paying more attention to the more stable and better-formulated items of measurement associated with AI in anesthesia. This would assist in getting a closer reflection of the minds of the healthcare professionals.

Finally, the Validity Analysis, which was concerned with the correlations of the key variables on perception, allowing to determine relationships between variables of perceptions, establishes a suggestion of the degree to which these variables correlate in music measurement of the constructs it was supposed to assess. Better correlations would uphold the survey as having the potential to be used in measuring the bigger picture in terms of the effectiveness of AI in managing anesthesia. In case the correlations stayed weak or varied, one would have to reconsider the survey items, making sure that they are efficient in terms of covering important aspects of AI implementation in clinical practice.

In conclusion, although this research moonlights information regarding the initial opinions of AI in anesthesia management, there is a certain issue that indicates this survey should be further fine-tuned in order to enhance its reliability and validity. The future research should employ revision of the questionnaire as well as the analysis of the correct statistical methods that will allow the development of more suitable and significant conclusions. The use of AI in the field of anesthesia has great prospects; however, to achieve maximum effect, the measurement strategy must be more reliable and valid to determine its effectiveness in the prevention of patient risks, decreased error rates, and general performance of the clinical process.

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