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USE OF ARTIFICIAL INTELLIGENCE FOR PRE-OPERATIVE ANAESTHESIA EVALUATION – A SYSTEMATIC REVIEW

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ABSTRACT:

AIM:

This systematically review aims to evaluate the application of artificial intelligence (AI) in pre-operative anaesthesia evaluation and assess its effectiveness in enhancing clinical decision-making and patient safety.

MATERIALS AND METHOD:

A systematic review with total number of 662 articles were searched using PubMed, SCOPUS, Elsevier Science Direct, Wiley online library, Cochrane library, Prospero, and web of science was conducted using PRISMA guidelines. Studies focused on AI applications in pre-operative anaesthesia evaluation using machine learning (ML) or deep learning (DL). Data extracted includes study design, AI model used, sample size, and clinical application. Eight studies meeting inclusion criteria were included for analysis. Bias assessment was done using Cochrane-based assessment tool 2 (ROB2).

RESULTS:

The included studies demonstrated a wide range of AI applications, such as ASA classification, difficult airway prediction, and risk stratification using platforms like MySurgeryRisk. Machine learning was the predominant technique, with deep learning used in select studies. AI models achieved high sensitivity and specificity in predicting perioperative complications and were accepted by clinicians. Sample sizes varied, reflecting both exploratory and large-scale validation efforts.

CONCLUSION:

AI shows strong potential to enhance the accuracy, efficiency, and personalization of pre-operative anaesthesia assessments. Integration of AI into routine practice may improve perioperative outcomes, streamline workflows, and support global standardization in anaesthetic care.

KEYWORDS: Artificial Intelligence, Preoperative Anaesthesia, Machine Learning, Deep Learning, Risk Stratification, ASA Classification.

INTRODUCTION:

Pre-operative anaesthesia evaluation is crucial in ensuring patient safety and optimizing surgical outcomes. Traditionally, this process relies on detailed clinical assessments conducted by anaesthesiologists, involving evaluation of medical history, physical examination, and diagnostic tests. However, the increasing complexity of patient profiles and the growing demand for surgical services have highlighted the need for more efficient, accurate, and standardized approaches. A comprehensive pre-anaesthetic evaluation is essential for systematically identifying and mitigating perioperative risks, thereby enhancing the patient's functional and physiological status before surgery and reducing potential complications. The primary goal of this assessment is to foster a strong understanding between the anaesthesiologist and the patient, ensuring mutual agreement on the anaesthesia plan and recognizing any associated risks. Additionally, pre-anaesthetic consultations help guide the administration of premedications and determine the need for any interventions before surgery (1).

Individualized risk evaluation often requires tailored investigations and, when necessary, consultations with other specialties. Efficient and thorough preoperative assessments are critical in minimizing surgical delays and

cancellations on the day of the procedure (2). Over time, significant transformations within the healthcare landscape have led to a growing number of elderly patients and those with multiple comorbidities undergoing surgical procedures. These changes have called for adaptations in perioperative management strategies to meet better the complex needs of modern surgical populations (3). With the rise in patient awareness regarding anaesthesia safety and surgical outcomes, there is an increasing demand for more refined and sensitive tools for preoperative assessment. In this context, artificial intelligence (AI) has emerged as a transformative technology with the potential to revolutionize pre-anaesthetic evaluations.

Artificial intelligence (AI), with its capacity for data analysis, pattern recognition, and predictive modeling, has emerged as a promising tool to enhance pre-operative assessments. AI applications, ranging from machine learning algorithms to natural language processing, offer the potential to streamline evaluations, reduce human error, and support clinical decision-making. Early studies suggest that AI can assist in risk stratification, optimization of pre-operative investigations, and even prediction of perioperative complications.

Advances in computing capabilities, enhanced data storage solutions, and the widespread use of electronic health records (EHRs) and imaging repositories have significantly contributed to integrating artificial intelligence (AI) into various branches of medicine (4). AI applications have made substantial progress in radiology, pathology, cardiology, and surgery, demonstrating notable benefits in clinical practice.

AI has been explored in perioperative medicine for multiple purposes, including risk stratification before surgery, real-time intraoperative monitoring, and post-operative care management in intensive care units (5,6). Emerging evidence suggests that AI-driven models match and may surpass traditional statistical methods and even the performance of experienced clinicians in certain areas (7,8,9).

Given AI technologies' rapid evolution and potential impact on anaesthesia practice, it is important to review the current evidence systematically. This review aims to explore the use of AI in pre-anesthetic evaluation, assess the quality and outcomes of existing research, and identify areas for future development.

MATERIALS AND METHOD:

STUDY DESIGN

This study is a systematic review conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The aim was to gather and synthesize evidence on the application of artificial intelligence in pre-operative anaesthesia evaluation.

SEARCH STRATEGY

This systematic review was conducted using PRISMA guidelines. A total of 662 articles were searched using PubMed, SCOPUS, Elsevier Science Direct, Wiley online library, Cochrane library, Prospero, and web of science among those 8 articles included in this systematic review.

A combination of the following keywords used are "artificial intelligence", "machine learning", "deep learning", "pre-anesthesia" and "anesthesia".

ELIGIBILITY CRITERIA:

INCLUSION CRITERIA:

1. Studies published in the English language
2. Full-text articles
3. Comparing Artificial Intelligence and Preoperative Anesthesia
4. Articles published from 2015 to 2025
5. Clinical trials, and retrospective analyses.

EXCLUSION CRITERIA:

1. Unrelated articles
2. Only abstracts available
3. Review articles, Original research articles, observational studies, case reports or series are excluded
4. Studies not specifically focused on pre-operative anaesthetic evaluation

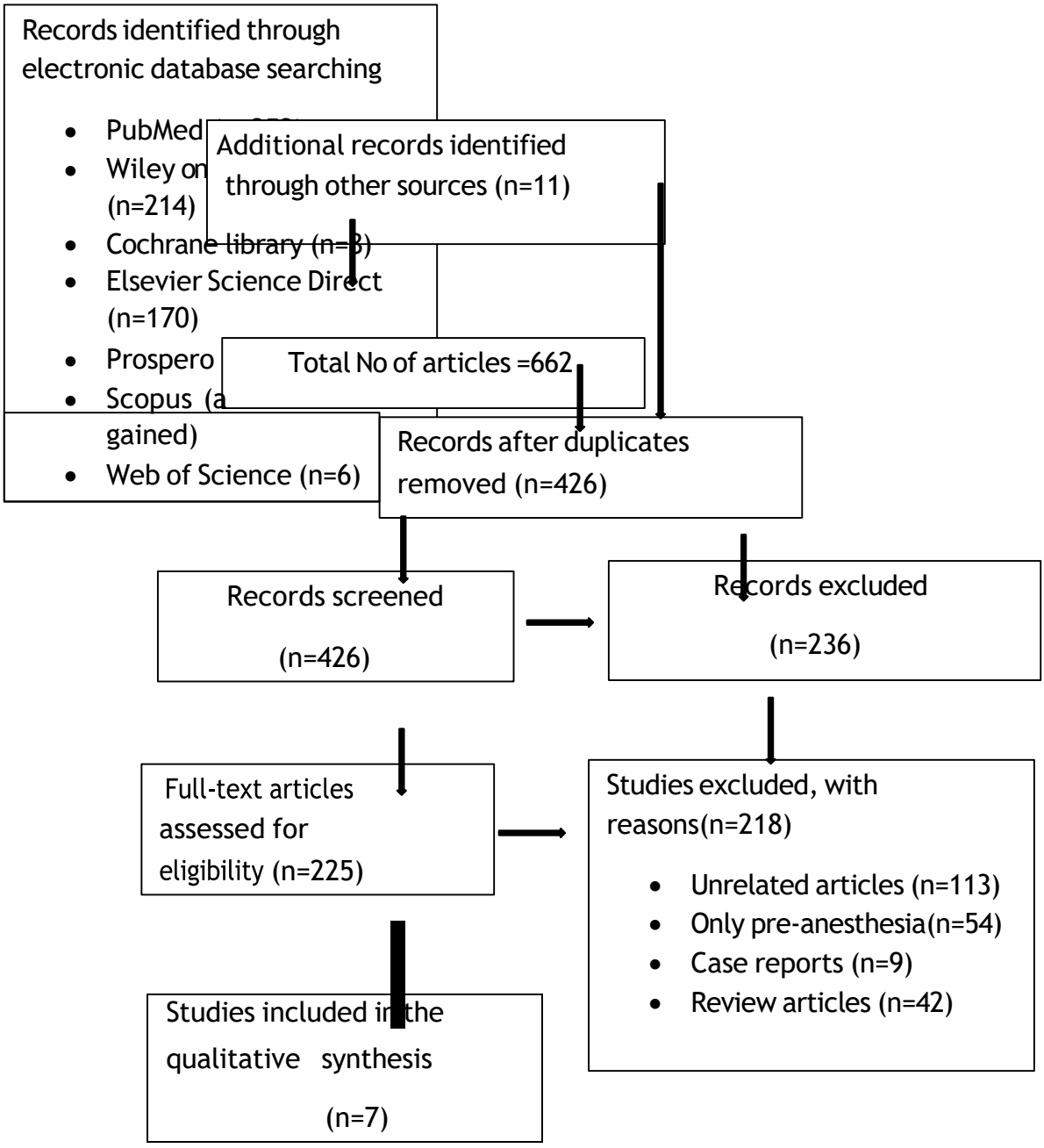
DATA EXTRACTION:

Data extracted from 2015 to 2025. The information was collected utilizing the methodologies and techniques established in the study. The extracted data included detailed study characteristics such as author name, year of publication, and country of origin. Additionally, each study's type of artificial intelligence (AI) model was recorded, encompassing machine learning algorithms and deep learning.

QUALITY ASSESSMENT METHODS:

The quality of the included studies was assessed using appropriate tools, such as the Cochrane Risk of Bias Tool for randomized controlled trials. The authors' assessments regarding bias were categorized as "low risk," "high risk," or "unclear."

FIGURE 1: Flow Diagram showing the number of studies identified, screened, assessed for eligibility, excluded, and included in this systematic review using the PRISMA Flow chart



RESULTS:

TABLE 1: CHARACTERISTICS OF EIGHT STUDIES INCLUDED IN THIS SYSTEMATIC REVIEW:

AUTHOR NAME	YEAR	SAMPLE	TYPE OF PATIENT	TYPE OF AI	CLINICAL APPLICATION
Kim et al[10]	2021	1677	OP	ML	Cormack-Lehane Classification, Pre-Operative Prediction
Zhang et al[11]	2018	419,321	OP	ML	ASA Classification, Preoperative Assessment
Bihorac et al[12]	2019	51,457	OP	ML	Preoperative Risk (MySurgeryRisk)
Brennan et al[13]	2019	150	OP	ML	Preoperative Risk Assessment (MySurgeryRisk)
Xue et al[14]	2021	111888	OP	ML	Predicting Preoperative Complications
Tavolara et al[15]	2021	152	OP	DL	Preoperative Assessment
Lee et al[16]	2018	59985	OP	DL	ASA Classification, PreOperative Score to Predict PostOperative Mortality, Risk Quantification Index, and the Risk Stratification Index
Alekberli et al[17]	2020	Not mentioned	OP	ML	Preoperative Evaluation

Table 1shows the characteristics of the intervention in the included studies. This highlights the diverse and evolving role of artificial intelligence (AI) in pre-operative anesthesia evaluation, with most studies predominant using machine learning (ML) techniques. Sample sizes varied significantly, ranging from small-scale pilot studies like Brennan et al. (2019) with 150 patients to large-scale datasets like Zhang et al. (2018) with over 419,000 cases, indicating both exploratory and robust validation efforts. All studies were conducted in outpatient (OP) settings, focusing on enhancing preoperative assessment workflows and clinical decision-making. Clinical applications of AI included Cormack-Lehane classification prediction (Kim et al.), ASA classification and risk stratification (Zhang et al., Lee et al.), and comprehensive preoperative risk prediction using models like MySurgeryRisk (Bihorac et al., Brennan et al.). Deep learning (DL) was utilized in two studies (Tavolara et al. and Lee et al.), particularly in complex tasks such as risk quantification and natural language processing for electronic health record analysis. Overall, the included studies demonstrate that AI, particularly ML, shows substantial potential to streamline preoperative evaluations, improve risk prediction accuracy, and support anesthesiologists in optimizing patient outcomes.

TABLE 2: OUTCOME DATA AS REPORTED IN INCLUDED STUDIES:

AUTHOR NAME AND YEAR	TYPE OF STUDY	COUNTRY	OUTCOME
Kim et al[10] 2021	RCT	South Korea	Machine learning models can effectively predict difficult laryngoscopy using simple, accessible predictors like neck circumference and thyromental height. While overall performance was moderate, certain models achieved high sensitivity or specificity. Model accuracy may improve with more data, additional variables, or ensemble methods, supporting AI's potential in enhancing pre-operative anaesthesia evaluation.
Zhang etal[11] 2018	Retrospective	Nashville	This study developed an AI model capable of predicting ASA Physical Status with accuracy comparable to anesthesiologists. The model offers a continuous risk score for greater granularity. The model can assist in

			identifying high-risk patients, enhancing pre-operative anaesthesia evaluation through data-driven support.
Bihorac et al[12] 2019	RCT	USA	This study developed and validated a real-time machine learning algorithm using electronic health record data to predict postoperative complications and mortality with high sensitivity and specificity. It highlights AI's potential in improving pre-operative risk stratification, though external validation and clinical implementation studies are needed.
Brennan et al[13] 2019	RCT	USA	Implementing the validated MySurgeryRisk AI algorithm for real-time pre-operative anesthesia evaluation using EHR data is feasible and well-accepted by physicians. Early physician involvement in the design and deployment process is essential for successful integration and clinical adoption.
Xue et al[14] 2021	Retrospective	Missouri	Machine learning models with model-agnostic interpretation enable real-time risk prediction for postoperative complications, supporting clinical decision-making and enhancing perioperative planning to reduce patient risk.
Tavolara et al[15] 2021	RCT	USA	The proposed AI method outperforms traditional bedside tests and existing deep learning approaches, highlighting the importance of frontal facial features in enhancing pre-operative anesthesia evaluation
Lee et al[16] 2018	Retrospective	Irvine	A deep learning model using intraoperative EMR data accurately predicts postoperative in-hospital mortality, outperforming or matching traditional risk scores. Its performance is further enhanced by integrating preoperative data such as ASA scores or POSPOM, enabling fully automated, reliable risk assessment.
Alekberli[17] et al 2020	Retrospective	Israel	AI with standardized preoperative assessment tool that unites anesthesiologists globally through a shared framework with common language to promote safer anesthesia practices.

Table 2 highlight the growing integration of artificial intelligence (AI) and machine learning (ML) in preoperative anesthesia evaluation across multiple studies and countries. Several randomized controlled trials (RCTs) and retrospective studies demonstrate AI models' feasibility, accuracy, and clinical utility in predicting critical perioperative parameters such as difficult laryngoscopy, ASA physical status, and postoperative complications or mortality. Studies like those by Kim et al. and Tavolara et al. underscore the effectiveness of ML in improving diagnostic accuracy through accessible clinical features and facial recognition, respectively. Others, such as Bihorac et al. and Brennan et al., emphasize the real-time applicability and physician acceptance of AI algorithms like MySurgeryRisk, reinforcing the value of early clinician involvement in AI deployment. Additionally, models integrating intraoperative and preoperative data, as seen in Lee et al., demonstrate superior predictive performance compared to traditional risk scores. These findings collectively support AI's potential to enhance clinical decision-making, streamline risk stratification, and promote standardized, globally applicable anesthesia practices.

TABLE 3:- BIAS ANALYSIS OF INCLUDED STUDIES

AUTHOR NAME AND YEAR	Randomisation process	Deviation from the intended intervention	Missing outcome data	Measurement of the outcome	Selection of the reported result
Kim et al[10] 2021	-	-	-	-	-
Zhang et al[11] 2018	-	-	-	-	-
Bihorac et al[12] 2019	-	-	-	-	-
Brennan et al[13] 2019	-	-	-	?	-
Xue et al[14] 2021	+	-	-	-	-
Tavolara et al[15] 2021	-	-	?	-	-
Lee et al[16] 2018	+	-	-	-	-
Alekberli[17] et al 2020	+	-	-	-	-

Table 3: shows the bias analysis of all the included studies. It is categorized as high-risk bias "+", low risk bias "-" and unclear "?".

DISCUSSION

This systematic review highlights the increasing utilization of artificial intelligence (AI), particularly machine learning (ML) and deep learning (DL) models, in the domain of pre-operative anaesthesia evaluation. Across the included studies, AI has demonstrated substantial promise in improving precision, efficiency, and personalization of preoperative assessments. Traditional pre-anaesthetic evaluations are often time-intensive and dependent on subjective clinical judgment.

Several studies have validated AI's ability to improve risk stratification and pre-operative assessment. Kim et al. (2021), in a randomized controlled trial (RCT) from South Korea, demonstrated that ML models could accurately predict difficult laryngoscopy using readily available clinical indicators such as neck circumference and thyromental height. While the models showed moderate overall accuracy, specific algorithms achieved high sensitivity or specificity, indicating potential for refinement through larger datasets or ensemble learning approaches (10).

In a large-scale retrospective study, Zhang et al. (2018) developed an AI model capable of predicting ASA physical status classifications with performance on par with experienced anesthesiologists. This model offered a continuous risk score, which enhances granularity in clinical decision-making and provides an early warning system for high-risk surgical candidates (11).

The MySurgeryRisk platform, developed by Bihorac et al. (2019) and Brennan et al. (2019), is a notable example of AI-driven pre-operative evaluation. Using real-time EHR data, this ML algorithm predicted postoperative complications and mortality with high sensitivity and specificity. Importantly, Brennan et al. emphasized the value of physician engagement in the algorithm's design and implementation, which improved acceptance and usability in clinical environments (12,13).

Similarly, Xue et al. (2021) reported that ML models with model-agnostic interpretability features enabled real-time, individualized risk predictions for postoperative complications. Their findings support the utility of AI in dynamic perioperative planning, where traditional static models may fall short (14).

Deep learning approaches, as seen in Tavolara et al. (2021) and Lee et al. (2018), have also shown promise. Tavolara's RCT highlighted the predictive power of facial recognition features over conventional bedside airway assessments. Another essential aspect ofAI in preoperative evaluation is the airways assessment(15).

Machine learning (ML) is currently being explored for risk stratification by analyzing vast amounts of perioperative data and intervention-related outcomes derived from electronic health records (EHR) across multiple healthcare centers. This approach to risk prediction is particularly valuable for preoperative counseling, patient optimization, and individualized anesthetic planning, especially in cases involving rare comorbidities. Lee et al. (2018)has utilized deep neural networks (DNNs), a subset of AI, to predict postoperative mortality successfully.

This study also illustrated that deep learning models using intraoperative EMR data and pre-operative metrics such as ASA scores outperformed traditional risk assessment tools like POSPOM in predicting in-hospital mortality (16).

Alekberli et al stated that Artificial intelligence (AI) and machine learning (ML) are revolutionizing the field of preoperative anesthesia assessment, fundamentally transforming how anesthetic care is delivered. These technologies offer advanced predictive capabilities that enhance clinical decision-making by applying complex algorithms to analyze large volumes of patient data. By uncovering patterns and insights that may be missed by human observation, AI enables better risk stratification, outcome prediction, and personalized care planningultimately leading to improved patient outcomes.A key application of AI in anesthesiology is the development of predictive models that forecast perioperative complications. Another valuable function of AI lies in anesthetic drug selection and dosage optimization. By referencing past data from similar patient profiles, AI can recommend safer, more effective anesthetic regimens, especially for patients with known sensitivities. This ensures both efficacy and safety, enhancing individualized patient care. Furthermore, AI systems continuously learn from new data, refining their predictive accuracy over time—a crucial feature in adapting to complex and evolving clinical scenarios. In teaching hospitals, for instance, AI can analyze incoming elective surgery data to detect patterns and emerging risks, informing institutional improvements in anesthesia protocols (17).

The first online application powered by artificial intelligence (AI) for perioperative anesthesia evaluation introduces advanced features designed to support anesthesiologists in their clinical workflow. Fully compatible with ICD-11 codes, the app minimizes terminology and language inconsistencies, ensuring accurate communication across healthcare systems. It reduces the need for manual input by maximizing automation, and it is accessible across multiple platforms, including Android, iOS, and Windows devices—smartphones, tablets, laptops, and computers alike.By streamlining the assessment process through its digital interface, the app saves time and increases efficiency, allowing anesthesia teams to focus more on clinical decision-making. It enables rapid patient screening and assessment via an intuitive, user-friendly design, improving surgical planning and reducing delays in the referral-to-treatment pathway. The system, known as "Smart-Anesthesia," supports safe anesthetic practice by alerting clinicians to critical preoperative concerns and providing real-time recommendations based on the latest ASA and ESAIC guidelines.Smart-Anesthesia offers swift, bedside evaluations with automated ASA classification and personalized perioperative guidance for urgent surgical cases, enhancing patient safety. It also simplifies the collection and analysis of patient data, supporting institutional quality improvement and research efforts. This technology aims to reduce global anesthesia-related complications and improve operating room outcomes by emphasizing preoperative assessment and providing continuous support. Ultimately, its goal is to establish a universal, standardized platform with common languagethat unites anesthesiologists worldwide through a common framework for safer, more efficient anesthesia care (17).

LIMITATION OF THE STUDY

Despite encouraging progress, the use of AI in pre-operative anaesthesia evaluation faces key limitations. Many studies rely on retrospective, single-center data, limiting generalizability. There is also a lack of standardization in data sources, preprocessing techniques, and evaluation metrics, which complicates comparisons across studies and hinders reproducibility. The reliability of AI models is highly dependent on the quality and completeness of electronic health records (EHR), and missing or biased data can adversely affect performance. Deep learning models often lack interpretability, which can hinder clinician trust and adoption. Ethical concerns, data privacy issues, and the need for significant infrastructure and training also present barriers, particularly in low-resource settings.

CONCLUSION

This systematic review underscores the transformative potential of artificial intelligence (AI), particularly machine learning (ML) and deep learning (DL), in pre-operative anesthesia evaluation. Across multiple studies, AI models have demonstrated consistent utility in enhancing the precision, efficiency, and personalization of pre-anesthetic assessments. From predicting difficult airways and ASA classifications to anticipating postoperative complications and mortality, AI-driven tools are steadily bridging the gap between subjective clinical judgment and objective, data-driven decision-making.Applications such as the MySurgeryRisk platform and Smart-Anesthesia app illustrate how real-time, automated, and scalable AI solutions can streamline workflows, reduce delays, and improve patient safety. These technologies not only optimize individual patient care but also support broader institutional goals such as quality improvement and standardization of practice. Importantly, continued refinement of AI models through larger datasets, clinician feedback, and integration of new variables will be critical to ensuring accuracy, adoption, and clinical relevance.Overall, this study, AI holds substantial promise for

revolutionizing pre-operative anesthesia care. By enabling early risk identification, tailored anesthetic planning, and continuous learning, it can serve as a powerful adjunct to clinical expertise, leading to safer surgeries, better outcomes, and more efficient healthcare delivery. It also streamlines data analysis for quality improvement and aims to create a universal, standardized platform for global anesthetic practice.

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