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Short Communication

Anaesthesia Section

Role of Artificial Intelligence in Delivering Anaesthesia: A Communication

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INTRODUCTION

Anaesthesia is one of the vital branches of contemporary medicine, ensuring the possibility of painless surgical and diagnostic procedures. Previously, anaesthesia management was based on the estimation and titration of the doses of administered anaesthetic agents by an anaesthetist. Nonetheless, with advancements in medical sciences, Artificial Intelligence (AI) has found its way into the practice of anaesthesia [1]. AI can play a critical role in improving anaesthetic administration through better decision-making systems, enhanced patient outcomes and improved overall organisational efficiency in clinical settings [2]. This communication aims to highlight the advances in the use of AI in anaesthesia, the existing issues and future directions.

History of AI in Medicine

AI has been applied in medical sciences since the mid-20th century, with pioneers who dreamed of potential computers assisting in diagnosis and treatment. Despite the early constraints of computation, AI has come a long way in the past decades and has impacted nearly every aspect of healthcare. In his 1950 paper, "Computing Machinery and Intelligence," the father of computer science, Alan Turing, laid out the idea of a thinking and reasoning machine [3]. AI's first programmes in medical diagnosis highlighted certain diseases, such as thyroid disorders and heart disorders. These early systems employed rule-based applications that depended on established rules and knowledge bases.

In the modern age, big data sets and available computing capabilities have paved the way for deep learning- a subbranch of machine learning. The use of deep learning models has been praised across several domains, including image recognition, language translation, and even drug design. AI is gradually penetrating healthcare facilities, where it is used for diagnosing illnesses, developing treatment protocols, discovering drugs and keeping track of patients' health conditions [4]. These applications include diagnostic tools, virtual health assistants and predictive solutions for disease propensity.

This can be achieved by using AI to analyse patient data and develop a health intervention plan tailored to individual needs and traits. AI is facilitating the faster process of drug discovery by simulating molecular interactions with potential targets. Modern algorithms in the application of AI enhance the effectiveness of X-ray, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) scans. Wearable devices and Remote Monitoring and Management (RMM) systems can send data to AI for screening disease symptoms and enhancing the patient experience [5].

REVIEW

Decision Support System (DSS) in Delivering Anaesthesia

DSS is a computer-based tool designed to assist in making informed decisions by analysing complex data. It integrates data from various sources, provides interactive interfaces and supports decision-making processes. Patient safety comes first in health-related aspects and regulations. Moreover, this can lead to positive change if there are well-designed decision support systems dedicated solely to such purposes. The most common use of DSS in relation to anaesthesia is in the evaluation and treatment of patient risk. Because DSS integrates patient data from electronic health records, vital signs monitoring and laboratory results, it can identify high-risk patients with potential complications such as hypotension, hypoxemia, or arrhythmias [6]. It can then recommend specific management strategies for anaesthetics, such as which agent to use how much to use, and how to monitor for any adverse effects of anaesthetic use. Such systems can employ complex computations to analyse records of Electroencephalogram (EEG) data alongside other relevant physiological indices to assess the state of anaesthesia.

DSS provides anaesthesiologists with real-time assessments of the extent of sedation, which can help avoid intraoperative awareness or over-sedation. Furthermore, DSS can eliminate some bureaucracy, improve communication between healthcare providers and decrease treatment expenses. In terms of communication, DSS centralises patient information from various sources, ensuring that healthcare providers have access to comprehensive, up-to-date data in one place [7]. This facilitates clearer communication, as everyone involved in the patient's care is on the same page. The system also sends alerts and reminders to keep healthcare professionals informed about critical changes in a patient's condition or necessary follow-up tasks, fostering seamless collaboration.

Regarding treatment expenses, DSS helps optimise the use of healthcare resources by providing evidence-based recommendations that guide providers toward the most effective and efficient treatments, thus reducing unnecessary tests, procedures and medications. Additionally, by helping to reduce complications, shorten hospital stays and prevent readmissions, DSS directly cuts healthcare expenses while improving patient outcomes. DSS enhances operational efficiency, communication and clinical decision-making, all of which contribute to more cost-effective healthcare [8].

Nevertheless, the effective integration of DSS in anaesthesia requires careful planning, training and evaluation. Some challenges may involve resistance to change and data quality and updates may be required frequently. Therefore, to overcome these challenges, efforts should be made to involve anaesthesiologists and other caregivers in the creation of DSS, with the effectiveness of the systems evaluated periodically and enhanced or simplified as necessary [9].

Automated Anaesthesia Delivery

Automated anaesthesia delivery systems remain a novel innovation in perioperative care that may provide better patient outcomes, enhanced cost-effectiveness, and ultimately result in improved patient safety. These systems offer a more accurate means of managing the delivery of anaesthetic agents, monitoring patient physiological status, and providing feedback mechanisms to the

anaesthesiologist. One of the major advantages of using automated systems for anaesthesia delivery is the ability to provide a consistent and easily predictable level of anaesthesia [10]. These systems allow for the observation and recording of the patient's responses to the administered anaesthetic agents through subtle algorithms and sensors, enabling the delivery rate of the system to be adjusted continuously. This helps keep patients well-sedated but not over-sedated during the procedure, thereby eliminating the chances of intraoperative awareness or over-sedation. In addition, automated anaesthesia delivery systems can reduce human error in anaesthesia administration. They are also capable of alerting the anaesthesiologist whenever a likely complication arises, such as hypotension, hypoxemia, or arrhythmias. Furthermore, the mechanisation of processes alleviates some pressure on anaesthesiologists, allowing them to focus on more critical tasks, such as managing airway complications or monitoring the patient's haemodynamics [11].

Another conceivable advantage associated with automated anaesthesia delivery is increased productivity, along with a corresponding reduction in expenses [12]. Moreover, these automated systems can enhance patient flow in operating rooms, thus increasing the number of surgical procedures and boosting hospital revenues. However, performing anaesthesia using robots has its pros and cons, and both the advantages and disadvantages must be considered. Such systems entail a high initial cost, and there is a need for ongoing maintenance; they may only be ideal for certain patients or types of operations. Additionally, continuous training and education are necessary to ensure that hospital personnel are proficient in the use of such systems [13].

Predicting Patient Risk

In the field of anaesthesia, the use of AI can greatly assist in the evaluation and subsequent control of patient risk. Therefore, with the help of anaesthesiologists using advanced algorithms and tools for data analysis, AI can predict the probability of developing perioperative complications and thus enhance outcomes [14]. Demographic data, medical history and results of preoperative tests help AI models examine large amounts of patient information to recognise risk factors for hypotension, hypoxemia and arrhythmias. Such predictions can help anaesthesiologists anticipate future difficulties and modify their anaesthetic management plans accordingly.

In addition, AI can aid in evaluating the risk of intraoperative awareness in patients. With the help of EEG data and other physiological parameters, AI is capable of determining the depth of anaesthesia and identifying patients at risk of awareness. It can also assist anaesthesiologists in modulating the type and amount of anaesthetic agents to achieve an adequate level of sedation [15].

Airway management is one of the significant areas in which robotics is particularly useful in anaesthesia. Various types of robotic airway devices assist anaesthesiologists in intubating patients, thereby minimising the risks of aspiration and laryngospasm [16]. These devices can also provide real-time displays of the airway, allowing for safer and better-monitored intubation. Robotic arms can administer anaesthetic agents, track the patient's vital signs, and control the level of anaesthesia with high accuracy based on real-time information. This automation can help minimise human errors and ensure the correct and safe dosages of anaesthesia [17].

Postoperative Monitoring and Pain Management

AI may improve the selection, diagnosis and treatment of postoperative pain, which is a prevalent and often poorly controlled issue after surgery. It can identify the risk level of postoperative pain and suggest approaches for its management. AI may contribute to better pain management, a decreased rate of adverse reactions associated with opioids, and higher patient satisfaction [18]. Additionally, AI can enhance the automated administration of pain medication, ensuring that patients are neither over-medicated nor under-medicated. By utilising patient feedback regarding responses to pain medication and regulating the dosage of administered medicines, these systems contribute to targeted pain management with minimal side-effects. Furthermore, based on a patient's age, weight and other parameters, AI can improve the likelihood of developing an effective pain management plan tailored to the individual patient [19].

Risk Factors Associated with AI in Anaesthesia Delivery

It is also pertinent to recognise the threats and obstacles associated with the use of AI in the delivery of anaesthesia, as presented here. Potential drawbacks of using AI for recommendations include false information, such as missing or inaccurate data. This could result in inequitable treatment of patients and the exacerbation of existing health disparities. The security of patient data is of utmost importance, as this information is among the most sensitive that a patient may reveal to a physician [20]. Transparency and accountability in the development and implementation of AI also play a vital role in overcoming public trust issues. However, from a clinical perspective, there are situations in which AI systems may be incapable of handling unexpected or rarely experienced clinical scenarios. Furthermore, free-form systems may not perform well in situations where they are needed, potentially leading to suboptimal care for patients. Additionally, since recommendations are generated by AI, there is a risk that these recommendations may be misunderstood or misapplied by clinicians. The consequences of such misunderstandings could negatively impact patients [21]. To avail the benefits of this technology, it is crucial to begin working on data assurance and data quality initiatives. There is a need to establish an ethical code of practice to address the rising issues of privacy, security, and accountability. Moreover, ongoing research and evaluation are necessary to identify and mitigate potential limitations and biases in AI [22].

CONCLUSION(S)

The introduction of AI in anaesthesia management is a revolution. AI uses efficient algorithms to enhance patient safety, improve efficiency and optimise outcomes. One of the major advantages of using AI in anaesthesia is that it can take over some of the less complicated aspects of the operation, allowing the anaesthesiologist to focus on other aspects of the surgical process that may be more sensitive or challenging. Anaesthetic dosing can be administered by computers integrated with AI, the patient's physiological parameters can be closely monitored and managed, and the intensity of the anaesthetic effect can be maintained. This automation may minimise the chances of human error and deliver anaesthesia safely and efficiently.

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