Research Output Journal of Public Health and Medicine 3(2):42-46, 2024

ROJPHM ISSN ONLINE: 1115-9715
ISSN PRINT: 1115-6147

https://rojournals.org/roj-public-health-and-medicine/

https://doi.org/10.59298/ROJPHM/2024/324246

The use of AI in Predicting Surgical Complications

Kamanzi Ntakirutimana G.

School of Natural and Applied Sciences Kampala International University Uganda

ABSTRACT

Significant obstacles exist for both patient outcomes and healthcare systems in the form of surgical complications. New approaches to anticipate these issues are being investigated by artificial intelligence (AI) researchers using machine learning, quantile regression forest, and Bayesian optimisation. This paper examines the predictive potential of AI for early postoperative problems, specifically in the context of coronary artery bypass graft surgeries. AI models offer insights into patient hazards through the analysis of large datasets, facilitating better surgical planning and early treatments. Implementing AI is fraught with difficulties, including data quality, clinician trust, and legal barriers, despite encouraging outcomes. In addition to outlining future research possibilities, this paper looks at the promise and constraints of AI in lowering surgical complications.

Keywords: Artificial intelligence, surgical complications, coronary artery bypass graft, machine learning

INTRODUCTION

Surgical complications represent a growing concern in clinical practice, health policy, and public health. Many specialties are investing heavily to find a way to acutely establish bacterial and viral infections, cancer, as well as heart and vessel diseases. The discoveries are amazing. Advances in medical imaging technologies or new laboratory tests provide quick and reliable predictions. Some specialties, however, are not able to predict acute diseases, infections, or exacerbations of the disease and propose the need for risk stratification in elective patient surgical procedures. For instance, despite remarkable advancements in several areas of cardiological surgery, the prevention of a stroke, ischemia, myocardial infarction, bleeding, pulmonary embolism, or complications after a coronary bypass graft procedure and early management in patients who develop these complications is a poorly predictive, complex problem [1]. machine learning, quantile regression forest, support vector machines, Bayesian optimization, and unsupervised learning to predict the occurrence of early surgical complications after coronary artery bypass graft procedures. As the number of surgical procedures rises, so does the number of surgical complications that have occurred. Modeling, with the aid of advanced artificial intelligence, recognizes the onset of infections and, enabled by a selection of features, maybe a vital instrument for predicting infections and proposing patient outcomes where early antibiotic treatment may be beneficial. Also, by removing the influence of potential outliers with missed symptoms of early complications over the first three postoperative days, these models can recognize those operations that will have lateral postoperative complications [2].

OVERVIEW OF SURGICAL COMPLICATIONS

Surgical complications are not uncommon. Approximately 9.7% of patients can experience complications. Numerous factors contribute to the occurrence of surgical complications, including surgical methods, patient conditions, and the complexity of the procedures. The complications can lead to prolonged length of stay, a need for nursing care, and an increase in final medical expenditure. Furthermore, the existence of surgical complications can lead to poorer functional status of patients after surgery. The occurrence of postoperative complications also distorts the psychological status and physical rehabilitation processes of patients. They can impede the progress of treatment, prolong the recovery period, and even influence the survival of the patients. Analysis of preoperative risk status for the prediction of different surgical complications has important clinical significance for prevention and treatment [3]. Despite the fundamental importance of preoperative estimation of patient risk status, it has not received extensive attention yet, especially concerning the development of artificial intelligence. In recent years, investigations related to predicting major surgical complications based on AI have been increasing. The purpose of this paper is to provide a review of such investigations and establish AI-based tools and models for predicting surgical complications. Specifically, this study reviews the preoperative predictive models for organ-specific and non-organ-specific surgical complications that are available in the current literature [4].

TYPES OF SURGICAL COMPLICATIONS

When surgery is performed, out of a million operations in developing countries, complications occur in 33–50% of cases. There is no single standard classification of their development, but all classifications suggest division into Early and delayed complications. Surgical complications, as a result of improper performance of the operation (primary wound suppuration, occurrence of an abscess, formation of purulent-septic complications) and secondary complications (metabolic ones, resulting from a violation of the patient's internal environment as a result of pathological changes - swelling, shock, toxemia, anuria, respiratory and hepatic insufficiency). Local and common complications, developing postoperative mandibular retention against its insufficient dootuki, and purulent accumulation in tissue spaces. Aseptic and antiseptic infections that could not be prevented by antiseptic or preventive antibiotic therapy. There are many names for the term "surgical complication," but the essence of these phenomena is important. There are common complications that occur after any surgical intervention, regardless of its volume and specific ones that can develop only in a certain type of operation (cesarean section against the background of the occurrence of purulent-septic infectious complications specific to obstetric surgery). Arrest of bleeding is accompanied by hematoma in soft tissues. Not less dangerous than continuing bleeding, sometimes even more dangerous, it can lead to the development of anemia as a result of the loss of a significant amount of blood and hemorrhagic shock. A consultation regarding surgical pathology is necessary for the patient [1].

ARTIFICIAL INTELLIGENCE IN HEALTHCARE

Incorporating AI into healthcare has the potential to transform patient care and health system operations. A variety of AI techniques fall under the umbrella of healthcare applications, including machine learning, deep learning, and data analytics. These tools can enable advanced data analysis and predictions that are now used to enhance patient and provider decision-making. AI has slowly been incorporated into medicine over the past few decades, especially after new data generated from the modern digital health era has been made available for training and validation purposes. Such data includes large-scale patient records and omics data, among others. More recently, there has been a push to standardize AI applications across medical fields, which has prompted the development and oversight of digital standards and privacy protections. The growing integration of AI in the medical sector has also prompted concerns, particularly regarding patient privacy and the transparency behind AI decision-making [5]. One of the most significant barriers to AI adoption in surgery is that the majority of surgical data is still entered manually, which is both tedious and prone to human error. Nonetheless, AI is being used to solve challenges in the surgical domain, as researchers work to understand how AI can be used to predict clinical outcomes, such as surgical complications. Given the growing interest in predicting surgical complications, we conducted a scoping review to understand how AI can contribute to these predictions. First, we learned that many of the planned and established studies focused on using AI to predict post-surgical complications, particularly in the context of pre-operative patient assessments. However, there are still very few studies that have successfully used AI to predict long-term or post-surgical complications when patients present at the ER. Data used in these studies comes from a variety of sources, including medical imaging, clinical patient data, and data from the public domain. Despite the diversity of data sources, the quality of each individual dataset is crucial for AI success. In one recent study, models trained on datasets from multiple centers only failed to predict surgical complications if one or more centers had bad data, emphasizing the importance of data quality. In sum, we believe that AI has the potential to improve surgical care, but challenges such as automating EHR data entry and ensuring best practices across institutions must be overcome [6].

APPLICATIONS IN SURGERY

The predictive power of AI by integrating and analyzing vast amounts of data is showing hope as complications related to surgical procedures can be predicted. In surgery, AI-enabled tools can be used to combine imaging, physiological data, and prior case-based knowledge to provide a surgical plan and the associated risk of complications, assist surgeons in making real-time decisions while the surgery is ongoing, and provide an estimation of potential surgeries that can be undertaken in light of individual patient risk assessment. During colonoscopy, the algorithm would suggest additional examinations for patients with a higher risk of developing cancer, and it could then deliver an up-to-the-minute risk prediction that draws on the displayed polyps as well as the patient's surgery-related variables from past cases. Importantly, the risk displayed eliminates the need for any other invasive or expensive blood tests while pointing to the best course of action [7]. AI can also assist in surgical planning to manage patient risk. Combining application ranges of prosthetic devices with part of a patient's foot image can make something more specific that can make surgery safer. This approach to personalized surgical design could contribute to the reduction of injury accidents in developing countries, where surgical procedures are generally more dangerous. By including imaging data as part of decision support tools, AI can help to inform patient-based surgical strategies. Predictive analytics is proving to be an increasingly powerful tool in estimating surgical risk based on new and previous cases, adding a new patient case and its outcomes to the list, and continuously training and learning to reassess patient risk and surgical strategies. AI is also beginning to be implemented to reduce post-surgery complications. AI has been used to facilitate and monitor the fit of pacemakers within the heart to reduce common post-surgery complications that currently occur, such as infections. Recently, it has been identified how complications preceding transplantation surgeries could be predicted by analyzing a patient's genetic code. This allowed for the provision of preventative strategies before surgery starts to minimize risk during an already complicated procedure [8]. The inclusion of predictive modeling as a part of the preoperative process is being examined to assist the surgeon in focusing attention on the potential complications a patient might develop, as well as produce preparedness for patient-specific risk factors before commencing surgery, among others. Multiple use cases have been reported to predict and mitigate postsurgical complications, e.g., in bariatric surgery to predict resolution of type 2 diabetes, enteral autonomy in children undergoing surgery, short and long-term complication rates, anastomotic leakage, prolonged leak after gastroesophageal surgery, hepatectomy-specific morbidity or mortality prediction, and to predict in-hospital adverse events in older cancer patients undergoing general, orthopedic, and vascular surgeries. AI-driven prediction of patient outcomes following lung cancer resection using data has been demonstrated, supporting the delivery of post-acute care service decision engines, and simulating operational use cases to optimize patient outcomes in an automated decision system of care pathways based on personal characteristics and anticipated patient recovery [7].

CHALLENGES AND LIMITATIONS

AI undoubtedly has the potential to significantly improve surgical practice, research, and healthcare provision. However, for AI-supported technologies to be routinely and safely deployed in operating theaters, an array of technical, regulatory, and ethical challenges needs to be addressed. In this section, we critically outline existing evidence and identify key limitations and future directions. Data Limitations – AI algorithms require large quantities of high-quality data as inputs to maximize their predictive performance. Concerns have been raised that data from healthcare systems may lack the fidelity required for reliable predictions and that capturing the necessary training data requires significant resources. Clinician Acceptance – Understanding the "trust horizon" among clinicians and identifying the necessary threshold at which predictions are seen as acceptable for use in their practice is another important step in developing effective AI tools for the clinic. Biases – AI algorithms have been shown to integrate biases present in the data they are trained on, which could lead to misleading predictions and outcomes. Efforts to increase transparency in AI decision-making are ongoing. Legislative and Regulatory Considerations – In addition to the technical and ethical considerations associated with implementing AI technologies in clinical practice, there are several legislative and regulatory issues that must be navigated by developers. Over the past few years, regulatory bodies worldwide have responded to the increasing use of AI by examining the extent to which existing regulation is appropriate for AI-based healthcare technologies. Several key points are becoming clear: more consistent guidance to developers and end-users when building, evaluating, and deploying AI in medicine is urgently needed. In summary, though AI shows exciting potential in several areas of surgical complications, current evidence in the literature clearly shows that more research and work with stakeholders are required. The lack of a clear regulatory position, the difficulties that biases pose to clinical teams, and the importance of transparency and communication decisions between developers, regulatory bodies, and healthcare professionals are particularly relevant limiting factors that must be addressed in future work. User-centered co-design approaches are likely the way forward to develop AI tools with these various stakeholders. It is now timely to conduct large prospective studies that assess the utility of these data from existing cohorts used in the development of previous models. Importantly, integrating these tools with other types of homogeneous data available for surgical patients may significantly increase the predictive capabilities of these decision-support models. Ongoing patient and public engagement in the development will be key to understanding their risk threshold, risk tolerance, and ethical concerns as these tools evolve in their development [9].

FUTURE DIRECTIONS AND IMPLICATIONS

Some of the most exciting future directions in the use of AI for predicting surgical complications are subtle in scope and hidden from the patient. Increasingly, the actions of surgeons are not driven by what they think will be best based on empirical evidence, but by what will avoid an AI prediction of a higher-than-average risk. This influence of AI could lead to autonomous innovations in surgical techniques that reduce the incidence of complications, to begin with, being a driving force of improvement from the moment a new prediction is made. However, there are risks associated with the use of AI for surgical prediction and treatment, for recommendation, engines are not new; the risks of embedding or perpetuating pre-existing disparities in surgical outcomes based upon the training data are numerous. This is a clear area that will require close collaboration between medical, bioethical, and algorithmic researchers to ensure equitable progression. Moving forward, further work is imperative across multidisciplinary teams of clinical professionals and IT professionals to refine the accuracy, inclusivity, reliability, and transparency of AI algorithms trained to predict an individual patient's risk of post-operative complications. From an ethical perspective, as with any automated system that makes a recommendation to a human being, there should always be a human healthcare professional in charge of overseeing the decision to give an individual patient pre- or post-operative advice informed by surgery AI risk prediction. The immediate impact of the use of AI for individual patient risk prediction may be used to permit higher-risk operations in older or frail individuals. Increases in the invasiveness and extent of the operation safely may widen the number of patients who are candidates for these surgeries, although there is a tendency for higher-risk prediction thresholds to be used to advise against surgery. Surgical treatment will not only be safer, but will also motivate people to have surgeries that provide a greater health benefit [10].

CONCLUSION

AI has demonstrated substantial potential in predicting surgical complications, providing clinicians with tools to assess patient risk more effectively. AI-driven models can identify complications early, allowing for timely interventions and personalized surgical planning. However, the adoption of AI in surgical practice remains limited due to challenges in data quality, clinician acceptance, and regulatory frameworks. To fully harness AI's capabilities, it is essential to address these limitations through collaborative research, improving data standards, and developing transparent, unbiased algorithms. Future work should focus on integrating AI across surgical disciplines, ensuring that AI models contribute to safer surgeries and better patient outcomes.

REFERENCES

1. Dobson GP. Trauma of major surgery: a global problem that is not going away. International Journal of Surgery. 2020 Sep 1;81:47-54.
2. Nedadur, R., Bhatt, N., Lui, T., Chu, M. W., McCarthy, P. M., & Kline, A. (2024). The Emerging and Important Role of Artificial Intelligence in Cardiac Surgery. *Canadian Journal of Cardiology*.
3. Nedadur, R., Bhatt, N., Lui, T., Chu, M. W., McCarthy, P. M., & Kline, A. (2024). The Emerging and Important Role of Artificial Intelligence in Cardiac Surgery. *Canadian Journal of Cardiology*.
4. Moglia A, Georgiou K, Georgiou E, Satava RM, Cuschieri A. A systematic review on artificial intelligence in robot-assisted surgery. International Journal of Surgery. 2021 Nov 1;95:106151.
5. Xu Y, Liu X, Cao X, Huang C, Liu E, Qian S, Liu X, Wu Y, Dong F, Qiu CW, Qiu J. Artificial intelligence: A powerful paradigm for scientific research. The Innovation. 2021 Nov 28;2(4).
6. Hopkins BS, Mazmudar A, Driscoll C, Svet M, Goergen J, Kelsten M, Shlobin NA, Kesavabhotla K, Smith ZA, Dahdaleh NS. Using artificial intelligence (AI) to predict postoperative surgical site infection: a retrospective cohort of 4046 posterior spinal fusions. Clinical neurology and neurosurgery. 2020 May 1;192:105718.
7. Gumbs AA, Frigerio I, Spolverato G, Croner R, Illanes A, Chouillard E, Elyan E. Artificial intelligence surgery: How do we get to autonomous actions in surgery?. Sensors. 2021 Aug 17;21(16):5526. mdpi.com

8. Benzakour A, Altsitzioglou P, Lemée JM, Ahmad A, Mavrogenis AF, Benzakour T. Artificial intelligence in spine surgery. International orthopaedics. 2023 Feb;47(2):457-65. [HTML]
9. Aldoseri A, Al-Khalifa KN, Hamouda AM. Re-thinking data strategy and integration for artificial intelligence: concepts, opportunities, and challenges. Applied Sciences. 2023 Jun 13;13(12):7082.
10. Benovic S, Ajlani AH, Leinert C, Fotteler M, Wolf D, Steger F, Kestler H, Dallmeier D, Denkinger M, Eschweiler GW, Thomas C. Introducing a machine learning algorithm for delirium prediction—the Supporting SURgery with GEriatric Co-Management and AI project (SURGE-Ahead). Age and Ageing. 2024 May 1;53(5):afae101. oup.com

CITATION: Kamanzi Ntakirutimana G. (2024). The use of AI in Predicting Surgical Complications. Research Output Journal of Public Health and Medicine 3(2):42-46. https://doi.org/10.59298/ROJPHM/2024/324246