Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/15046
DOI URL: http://dx.doi.org/10.21474/IJAR01/15046

RESEARCH ARTICLE

APPLICATIONS AND EFFECTS OF CARDIOTHORACIC SURGERIES WITH THE HELP OF ARTIFICIAL INTELLIGENCE

Krit Jansaenroj
King Mongkut's International Demonstration School (KMIDS), Samutprakarn, Thailand.

Manuscript Info

Manuscript History
Received: 15 May 2022
Final Accepted: 18 June 2022
Published: July 2022

Key words:-
Applications, Artificial Intelligence, Cardiothoracic Surgeries, Effects

Abstract

Humans' great and quick technology breakthroughs in previous decades have undoubtedly influenced how surgical duties are conducted in the operating room (OR). As high-tech workplaces, modern ORshave introduced unique computational technologies into the clinical workflow, with the goal of optimizing operations and assisting the surgical team. Artificial intelligence (AI) is becoming increasingly important in surgical decision making to assist surgeons and patients in making better predictions about the consequences of surgical decisions by addressing diverse sources of information such as patient risk factors, anatomy, disease natural history, patient values, and costs. However, there was a controversy whether AI's capacity to deliver on its promises is contingent on effectively overcoming the ethical and practical concerns outlined, such as explainability and algorithmic bias. Even if such concerns appear to be purely practical or technical, a deeper investigation reveals considerations of value, justice, and trust. This review will discuss AI applications as well as its effects and limitations that appear and should be considered.

Introduction:-

Artificial intelligence or AI is the capacity of a computer or a robot controlled by a computer to do activities that normally require human intelligence and judgement. Nowadays, AI is slowly becoming a part of humans' lives in many ways, which makes life easier and more effortless, for instance, the autonomous driving. [19] This system helps reduce car accidents and reduce the workload of humans. Moreover, AI encompasses a wide variety of concepts, ranging from particular types of AI such as machine learning to a more far-fetched concept of AI that fits consciousness and sentient requirements. AI systems range from those that attempt to model human reasoning in order to solve a problem, to those that solely rely on large datasets to generate a framework in order to solve the problem of interest, and to those that attempt to incorporate elements of human reasonings but do not require accurate modeling of human processes. Machine learning (ML) is a collection of statistical and mathematical modeling techniques that employs a number of ways to learn and improve the prediction of a target state without the need of explicit programming. [19]

The word cardiothoracic means relating to the heart and chest part of the body, so cardiothoracic surgery is one of the branches in surgeries that medical doctors need to be specialized in surgical procedures of heart, lungs, esophagus, and other organs in the chest area which will treat diseases of cardiovascular system that mainly focus on heart and blood vessels.[20] The examples of the case to meet cardiothoracic surgery are lungs cancer, strokes, heart

Corresponding Author:- Krit Jansaenroj
Address:- King Mongkut's International Demonstration School (KMIDS), Samutprakarn, Thailand.

valves disease, and heart muscle disease. After a certain disease is treated by a surgeon, patients may face few side effects such as insomnia or chest pain; thus, the surgeon has to ask for a routine checkup for a while to ensure that those individuals are truly cured.

AI is becoming more significant in surgical decision-making to help surgeons and patients make better predictions about the implications of surgical decisions by addressing a variety of sources of information, such as patient risk factors, anatomy, disease natural history, patient values, and costs. [22] A deep learning model, for example, was used to identify whether people with treatment-resistant epilepsy would benefit most from surgery. AI platforms can give roadmaps for surgical teams in an operating room, lowering risk and making surgery safer.[22] Previous research in cardiothoracic surgery has established machine learning algorithms that can predict intrahospital mortality following cardiac surgeries better than typical operational risk scores.[21]

Application of AI in Cardiothoracic Surgeries

AI is the technology that has endless applications. Focusing on surgeries, AI is becoming more significant in surgical decision-making to help surgeons and patients better forecast the effects of surgical decisions by addressing multiple sources of information such as patient risk factors, anatomy, disease natural history, patient values, and costs. [8,11] AI may be used to modify surgical practices in addition to planning and decision-making. Remote-controlled robotic surgery has been found to increase the safety of operations in which doctors are exposed to high doses of ionizing radiation and to allow surgery in anatomic areas that would, otherwise, be impossible to reach with human hands. As the technology for autonomous robotic surgery advances, physicians will undoubtedly be called upon to supervise robot movements in some circumstances.[10,11,12,19]

In addition, AI can be used as the augmented cognition within an operation room. Humans' extraordinary and quick technical breakthroughs in the previous decade have had a significant influence on how surgical procedures are conducted in an operating room.[1]A modern operation room, as a high-tech work environment, has introduced innovative computational technologies into the clinical workflow, with the goal of optimizing operations and assisting surgical teams. This sophisticated computational-based environment has enabled the augmentation of human cognition at both individual and team levels, in addition to creating a huge quantity and diversity of data that can be utilized to construct predictive machine learning models.[1] In this kind of high-tech operating room, cognition extends beyond individual brains to the whole surgical team, encompassing not just human agents but also non-human systems that are active during surgery.

Another application is the computer vision for the surgery.[5,6,7] The surgical workflow segmentation, tool recognition and detection, and image-guided surgical procedures are the key uses of computer vision in surgery.[16,18] However, analyzing individual and team behaviors is a new field of using computer vision in an operating room, especially in team-based complicated operations like cardiothoracic surgery.[9,15] Automated body position and movement monitoring are already being used in other sectors of health and psychology to examine human nonverbal behaviors. The majority of uses of this technology in surgery include recording surgeons' gestures and hand mobility in order to obtain objective measurements of technical psychomotor abilities.[9] Recent research, on the other hand, has looked at using position and motion data provided by computer vision technologies to assess team dynamics and coordination in an operating room. These studies looked at behavioral indicators such as team centrality and team closeness.

AI is also used in the surgical data science. A new scientific discipline called surgical data science (SDS) was born as a result of the introduction of modern technology and their integration into the operating room, as well as the massive amount of data generated by patient surgical treatment. SDS's major purposesare to capture, organize, process, and model data in order to improve the quality and value of interventional healthcare. Complex data can come from a variety of sources within SDS, including patients, care providers, sensors for measuring patient and procedure-related data and domain knowledge. Promising AI and ML applications have been built on top of SDS, with the ultimate goal of assisting surgical decision-making and enhancing patient safety. SDS uses machine learning techniques to learn associations between data features without much input from human modelers, as opposed to more typical data modeling approaches that are largely dependent on regression techniques. There are no pre-existing labels or annotations in unsupervised machine learning, for example, needing minimal human supervision. In the past, supervised and unsupervised machine learning approaches were employed to evaluate physician competency in a number of scenarios.[15]The operating room black box system is an illustration of how SDS may be utilized for quality improvement projects. This analytic platform enables both human and AI-based

measurements by capturing and integrating a wide range of intraoperative data (e.g. audio, video, and physiological indicators). This platform has been used in recent studies to investigate technical and non-technical surgical performances, as well as their relationship with patient outcomes. Few studies have lately been able to demonstrate the feasibility and validity of machine learning algorithms in both noncardiac and cardiothoracic surgery to anticipate intraoperative problems such as hypotension and hypoxemia. Another data-driven AI application in surgery is the evaluation of intraoperative performance at both the individual and team level.[15] Expert observation and grading are the current gold standard assessments of intraoperative technical and non-technical skills. Despite their widespread use, these methods have a number of drawbacks, including intrinsic subjectivity, poor inter-rater reliability, and limited reproducibility and scalability. The application of AI, particularly computer vision, has the potential to automate, standardize, and scale performance evaluation in surgeries, including cardiothoracic surgery. Prior research has shown that video-based surgical motion assessments are more reliable than the traditional time-consuming human rater approach for measuring laparoscopic performance in the operating theater.

One of the applicattionsis the diagnostic and the detection of heart failure (HF). HF is linked to poor patient outcomes, a high risk of recurrence, mortality, and a significant cost burden. With the use of AI in diagnostic modalities, outcome forecasts, and HF care, there has been a significant advancement in the field of cardiovascular medicine. The use of AI Deep Learning components like artificial neural network (ANN) and convolutional neural network (CNN) for HF diagnosis, as well as remote monitoring of at-risk patients via internet of things (IoT) and mobile health (mHealth), can substantially reduce mortality associated with all structural heart disorders, including HF.[23] Though AI has the potential to revolutionize medical diagnosis, treatment, risk prediction, clinical care, and drug discovery by more efficiently interpreting vast databases than the human brain, it is limited by the lack of a healthcare system that supports it, as well as a shortage of trained clinicians who can use AI models in clinical decisions and patient monitoring.[23] To give more accurate outcomes, it is critical to develop a bridge between AI models and clinical practitioners using hybrid expert and ML-driven systems like the artificial intelligence for clinical decision on support (AI-CDSS). While AI systems will never be able to replace a human brain's competence, they have the potential to revolutionize accurate diagnosis and prognosis of decompensation and mortality in heart failure patients by functioning as a tool of help. In the post-COVID-19 pandemic era, when healthcare systems will be overburdened with HF-related hospitalizations, HF specialists should make efforts to train themselves in incorporating AI so that AI-dependent medicines can be made more efficient and provide accurate diagnosis in a short period of time.[23]

Lastly, In the not-too-distant future, robotic technology will revolutionize surgery.[3,4,11,12,15] Many popular treatments such as cardiac bypass and abdominal surgery are projected to be replaced by robots.[15,17] Autonomous and semi-autonomous modes are increasingly being researched and utilized in surgical operations, automating various aspects of the procedure. The complexity of these activities is, likewise, increasing, with complicated endoscopic surgical motions and shared-control techniques in stabilized image-guided beating-heart surgery replacing early medical robots' low-level automation. With innovations like nanorobots entering the area, further advancement will need continual multidisciplinary collaboration. Autonomous robotic surgery is a subject of study that incorporates artificial intelligence advancements.[11,15] As a result, humans would team up with AI in an operation room. New forms of contact, communication, and coordination have emerged as computational systems have grown pervasive, and workplacesare full of computer-based gadgets and networks. The design and operation of computer-based systems in a cardiothoracic operating room has a significant impact on workflow efficiency, clinician cognitive load, and, ultimately, surgical performance. When AI technologies are integrated into a complex operating room environment, the possibility of human-machine teaming develops, opening up new cognitive engineering possibilities that could improve patient safety and clinical results in complex team-based surgery.

Effects of Artificial Intelligence in Cardiothoracic Surgery

AI in cardiothoracic surgery has both aspects of effects as AI takes a major role in order to improve and develop the medication. A lot of things will change and being affected.

A positive effect of artificial intelligence isthat, first of all, it reduces the workload for humans. Regular surgery requires a team that contains different roles to help one surgery case, but if artificial intelligence is utilized for the surgery, fewer people will be required in a case, which leads to reduced cost in staff and effort. Aside from cost and effort, the use of AI in the medical field will reduce the time and resources as medical personnel have more time to analyze patients and identify illnesses and ailments as more important processes are automated. AI is speeding up procedures at medical facilities, allowing them to save valuable production hours. Time is money in any industry, so

AI has the potential to save a lot of money. The healthcare business is estimated to waste roughly $200 billion per year. Administrative burdens, such as filing, evaluating, and resolving accounts, account for a large percentage of these wasteful costs.Another area where there is a need for improvement is determining medical necessity. To adequately establish medical necessity, hours of evaluating patient history and information are generally required. Physicians can use new natural language processing (NLP) and deep learning (DL) algorithms to help them analyze hospital cases and avoid denials. Moreover, AI has very few errors compared to a human, which shows that AI in surgeries will be safer.[24] Furthermore, AI has the potential to improve patient outcomes as well as the productivity and efficiency of healthcare delivery. It can also improve day-to-day lives of healthcare providers by allowing them to spend more time caring for patients, hence improving staff morale and retention. Medical practitioners are given more time to assist and interface with patients by freeing up valuable productivity hours and resources.[24] Lastly,medical staff in the present develops both physical and mental stress because their work can affect people's lives and they have a long working period, but AI is going to reduce this problem. Due to deadline demands and other employment factors, half of primary care physicians are stressed. AI aids in the streamlining of procedures, the automation of activities, the quick sharing of data, and the organization of operations, all of which relieve medical personnel of the burden of dealing with many jobs."Patient load and the nature of the job are the most major contributors to physician burnout," Yang says. However, because AI can help with more time-consuming tasks, such as explaining diagnosis, medical practitioners may feel less stressed. [24]

On the other hand, a negative effect of AI is that while AI may help lower costs and relieve clinician stress, it may also eliminate some jobs. This variable may result in the displacement of healthcare professionals who have invested time and money in their education, posing equitable issues. According to a forecast published by the World Economic Forum in 2018, AI will generate a total of 58 million employments by 2022. However, according to the same report, AI will displace or eliminate 75 million employments by the same year. The main reason for the loss of job possibilities is that as AI becomes more integrated across industries, positions that require repetitive tasks will become obsolete. Though AI has the potential to improve many aspects of healthcare and medicine, it is critical to address social implications of its implementation.[24,14] Furthermore, AI systems are vulnerable to security issues since they rely on data networks. Improved cyber security will be necessary from the start of Offensive AI to ensure the technology's long-term viability. According to Forrester Consulting, 88 percent of security industry decision-makers believe aggressive AI is a growing concern. Cyberattacks will make AI wiser with each success and failure, making it more difficult to forecast and avoid as AI leverages data to make systems smarter and more accurate. When malicious threats outsmart security defenses, attacks will become considerably more difficult to counter.[24] In addition, AI may lead to the overlook of the social variables. The requirements of patients frequently go beyond their immediate physical ailments. Appropriate recommendations for specific patients might be influenced by social, economic, and historical variables. For example, an AI system might be able to assign a patient to a specific treatment center based on a diagnosis. However, this system may not take into consideration the patient's financial constraints or other personal preferences. When an AI system is used, privacy becomes a concern. Regarding gathering and utilizing data, companies like Amazon have complete control. Hospitals, on the other hand, may encounter difficulties while attempting to transmit data via Apple mobile devices. These legal and social constraints may limit AI's potential to aid medical practices.[24]

Limitation of Artificial Intelligence in Cardiothoracic Surgery

The limitation that appears in bringing the AI into the medical field is about ethical issues.[14] Some discuss how AI might change and disrupt care on the ground, such as the impact on the doctor-patient relationship and values of trust and empathy,[13,14] the risk of a new type of paternalism as healthcare professionals defer decisions to AI tools, and the dehumanization of healthcare as more and more tasks are outsourced to intelligent machines.[1,2] Other concerns are mostly about how technology is produced and implemented. These challenges may appear to be simple practical or technical concerns that may be overcome with appropriate methodologies and technological development steps. However, the manifestation as well as the resolution of these challenges can have significant ethical implications. The challenge of the ability to explain, sometimes known as the "black box" dilemma, should be concerned.[14] This issue is related to AI techniques that optimize results using DL and artificial neural networks (ANNs). The AI (images of malignant skin legions) supplies information in the form of data, which are utilized by the system to 'autonomously' learn and deliver the desired outputs (identify cancerous skin legions when presented with new pictures). However, individuals who use AI, as well as those who design it, are unaware of the 'thinking process' that leads to these results. As a result, when mistakes are made, it is hard to comprehend and examine the cause of the error in order to correct it. This is especially troublesome in fields like surgery, where errors may have a dramatic and immediate impact on people's health or lives. However, there are AI tools that do not suffer from the

ability to explain a problem, such as those based on the tree branching, a sort of machine learning algorithm that humans can understand.[2] There have been discussions regarding the significance of the ability to comprehend and explain the process by which certain healthcare choices are made. As a result, a value judgment must be made as to whether the ability to explain AI-driven decisions –and thus retain the ability to trace back and eliminate the sources of error– is more important than the potential to save more lives and improve the wellbeing of more people by employing more advanced, but less explainable, AI technologies.

Conclusion:-

In conclusion, people have aimed to create intelligent machine colleagues by using new computational techniques and broadening the usage of human cognitive models in AI. Moreover, people produced the team up among the AI and humans within the medication healthcare applications. Cardiothoracic surgery novel approaches have been created to link physicians' physiological data with patient data, and operating room medical equipment as a surrogate for cognitive ability. A positive effect is that it reduces workload for humans and stress, as well as saves money, time, and effort. However, AI in cardiothoracic surgery also has negative effects, which are that it overlook the social variables, increase the unemployment, and the susceptible to security risks. Moreover, the limitation about bringing the artificial intelligence into the medical field is about ethical issues. Some discuss how AI might change and disrupt care on the ground, such as the impact on the doctor-patient relationship. Other concerns are mostly about how technology is produced and implemented. The manifestation as well as the resolution of these challenges can have significant ethical implications.To enable the application of AI in cardiothoracic surgery, there are attempts at trying to incorporate a data-driven approach that merges human and non-human agents to enhance safety and mitigate errors in cardiothoracic operating rooms, and researchers aimed to maximize surgical coordination and team communication.

References:-

1. Assen, M. van, &Cecco, C. N. de. (2020). Table of contents page: European Journal of Radiology. Artificial intelligence in cardiothoracic imaging: A game changer. Retrieved June 24, 2022, from https://www.ejradiology.com/issue/S0720-048X(20)X0013-1
2. Barragán-Montero, A., Javaid, U., Valdés, G., Nguyen, D., Desbordes, P., Macq, B., Willems, S., Vandewinckele, L., Holmström, M., Löfman, F., Michiels, S., Souris, K., Sterpin, E., & Lee, J. A. (2021, May 9). Artificial Intelligence and machine learning for medical imaging: A technology review. Physica Medica. Retrieved June 24, 2022, from https://www.sciencedirect.com/science/article/pii/S1120179721001733.
3. Bozkurt, Y., &Karayel, E. (2021, July 16). 3D printing technology; methods, biomedical applications, future opportunities and Trends. Journal of Materials Research and Technology. Retrieved June 24, 2022, from https://www.sciencedirect.com/science/article/pii/S2238785421007134.
4. Chan, J., &Auffermann, W. F. (2020, April 18). Artificial intelligence in cardiopulmonary imaging. Advances in Clinical Radiology. Retrieved June 24, 2022, from https://www.sciencedirect.com/science/article/abs/pii/S2589870120300067?via%3Dihub
5. Kalfa, D., Agrawal, S., Goldshtrom, N., LaPar, D., & Bacha, E. (2019, December 13). Wireless Monitoring and artificial intelligence: A bright future in cardiothoracic surgery. The Journal of Thoracic and Cardiovascular Surgery. Retrieved June 24, 2022, from https://www.sciencedirect.com/science/article/abs/pii/S0022522319331216.
6. Namin, A. T., Jalali, M. S., Vahdat, V., Bedair, H. S., O'Connor, M. I., Kamarthi, S., & Isaacs, J. A. (2019, March 6). Adoption of new medical technologies: The case of customized individually made knee implants. Valuein Health. Retrieved June 24, 2022, from https://www.sciencedirect.com/science/article/pii/S109830151930066X.
7. Zhang, M., Zhang, Z., Wang, X., Yu, H., Xia, Y., Tan, K., Wang, X., & Wang, F.-Y. (2021, May 26). From AR to AI: Augmentation Technology for Intelligent Surgery and medical treatments. IFAC-PapersOnLine. Retrieved June 24, 2022, from https://www.sciencedirect.com/science/article/pii/S2405896321003165.
8. S;, E. (2020, April 20). Artificial Intelligence: The future for diabetes care. The American journal of medicine. Retrieved June 24, 2022, from https://pubmed.ncbi.nlm.nih.gov/32325045/.
9. Assen, M. van, &Cecco, C. N. de. (2020). Table of contents page: European Journal of Radiology. Artificial intelligence in cardiothoracic imaging: A game changer. Retrieved June 24, 2022, from https://www.ejradiology.com/issue/S0720-048X(20)X0013-1
10. T;, M. K. L. (2021). Artificial Intelligence and ophthalmic surgery. Current opinion in ophthalmology. Retrieved June 24, 2022, from https://pubmed.ncbi.nlm.nih.gov/34397576/

11. OR;, H. D. A. R. G. R. D. M. (2018). Artificial Intelligence in surgery: Promises and perils. Annals of surgery. Retrieved June 24, 2022, from https://pubmed.ncbi.nlm.nih.gov/29389679/
12. MG, U., N, P., C, H., A, E., JW, K., I, I., & PL, G. (2019). Artificial Intelligence, robotics and eye surgery: Are we overfitted? International journal of retina and vitreous. Retrieved June 24, 2022, from https://pubmed.ncbi.nlm.nih.gov/31890281/
13. B, S., N, H., S, M. S., J, R., C, W., P, B., R, V., Z, E., R, T., M, P., J, R., A, K., S, R., & N, P. (2020). Public perceptions of artificial intelligence and robotics in medicine. Journal of endourology. Retrieved June 24, 2022, from https://pubmed.ncbi.nlm.nih.gov/32611217/
14. A;, K. (2021). Ethics of Artificial Intelligence in global health: Explainability, algorithmic bias and trust. Journal of oral biology and craniofacial research. Retrieved June 24, 2022, from https://pubmed.ncbi.nlm.nih.gov/34567966/
15. MA;, D. R. D. S. J. A. Z. (2020). Artificial Intelligence in cardiothoracic surgery. Minerva cardioangiologica. Retrieved June 24, 2022, from https://pubmed.ncbi.nlm.nih.gov/32989966/
16. E;, M. W. K. J. G. (2020). Artificial intelligence pertaining to cardiothoracic imaging and patient care: Beyond image interpretation. Journal of thoracic imaging. Retrieved June 24, 2022, from https://pubmed.ncbi.nlm.nih.gov/32141963/
17. M, A., M, O., T, M., J, C., & KR, P. (2020). Artificial intelligence-based diagnosis of cardiac and related diseases. Journalof clinical medicine. Retrieved June 24, 2022, from https://pubmed.ncbi.nlm.nih.gov/32209991/ .
18. A, L., M, K., M, M., I, I., P, M.-H., PJ, S., & D, D. (2021). Artificial Intelligence in cardiovascular imaging for risk stratification in coronary artery disease. Radiology. Cardiothoracic imaging. Retrieved June 24, 2022, from https://pubmed.ncbi.nlm.nih.gov/33778661/
19. Spiegeleire, S. D., Maas , M., &Sweijs, T. (2017). 2 what is Artificial Intelligence? - JSTOR. ARTIFICIAL INTELLIGENCE AND THE FUTURE OF DEFENSE: STRATEGIC IMPLICATIONS FOR SMALL- AND MEDIUM-SIZED FORCE PROVIDERS. Retrieved June 24, 2022, from https://www.jstor.org/stable/resrep12564.7
20. Jennifer Whitlock, R. N. (2021, March 4). Types of cardiothoracic surgery. Verywell Health. Retrieved June 24, 2022, from https://www.verywellhealth.com/cardiothoracic-defined-3157055
21. Baker, A., Perov, Y., Middleton, K., Baxter, J., Mullarkey, D., Sangar, D., Butt, M., DoRosario, A., & Johri, S. (1AD, January 1). A comparison of artificial intelligence and human doctors for the purpose of triage and diagnosis. Frontiers. Retrieved June 24, 2022, from https://www.frontiersin.org/articles/10.3389/frai.2020.543405/full
22. M;, B. M. Z. T. R. (2020). Artificial Intelligence and robotic surgery: Current Perspective and Future Directions. Current opinion in urology. Retrieved June 24, 2022, from https://pubmed.ncbi.nlm.nih.gov/31724999/.
23. Yasmin, F., Shah, S. M. I., Naeem, A., Shujauddin, S. M., Jabeen, A., Kazmi, S., Siddiqui, S. A., Kumar, P., Salman, S., Hassan, S. A., Dasari, C., Choudhry, A. S., Mustafa, A., Chawla, S., & Lak, H. M. (2021, December 22). Artificial Intelligence in the diagnosis and detection of heart failure: The past, present, and future. IMR Press. Retrieved June 24, 2022, from https://www.imrpress.com/journal/RCM/22/4/10.31083/j.rcm2204121
24. a, n. (2021). Pros & Cons of Artificial Intelligence in medicine. College of Computing & Informatics. Retrieved June 24, 2022, from https://drexel.edu/cci/stories/artificial-intelligence-in-medicine-pros-and-cons/.