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ARTIFICIAL INTELLIGENCE IN HEALTHCARE, BIOMED AND PHARMA

(ARTIFICIAL INTELLIGENCE IN CARDIOTHORACIC SURGERY)

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ABSTRACT

AI has improved patient care and clinical outcomes in healthcare, biomedical, and pharmaceutical industries by analyzing data to identify patterns and anomalies. It has transformed biomedical industry by discovering new drugs and treatments, but data privacy and regulatory frameworks must be addressed for AI to fully revolutionize healthcare. AI is crucial in surgical decision-making, addressing various sources of information for better predictions and integration of human-machine collaboration for improved performance and patient safety in high-tech operating rooms.

The purpose of this research paper is to analyze the present condition of AI in Surgery, particularly in Cardiothoracic surgery. It also aims to analyze the possible effects of AI on the medical industry, which is experiencing a high degree of technological advancement due to the increased utilization of artificial intelligence (AI) in numerous sectors.

1) INTRODUCTION

Artificial intelligence (AI) refers to a category of technologies that can include both those that attempt to imitate human reasoning and those that develop solutions entirely based on massive datasets. Artificial intelligence (AI) is becoming more and more important in surgical decision-making to address many information sources such patient risk factors, anatomy, illness development, patient values, and cost, and assist surgeons and patients in accurately predicting the outcomes of surgical procedures. The integration of new technology and the gathering of enormous volumes of patient surgical care data in the operating room (OR) has given rise to Surgical Data Science (SDS), which has been used to evaluate physician performance in a variety of contexts. SDS's major goal is to enhance the value and quality of interventional healthcare by collecting, processing, and modelling data from a variety of sources, including patients, operators, sensors, and domain knowledge. Through the introduction of non-human systems, the complexity of the operating room has made it possible to enhance human cognition at both the individual and team levels. The cardiothoracic operating room (OR) is a high-risk,

high-stakes environment because it necessitates the coordination of numerous specialized personnel and equipment. Information obtained in the OR can be gathered, processed, and made meaning of by AI systems. They should comprehend how to use real-time contextual information to modify their algorithms and offer context-aware support. For team cognitive tasks to be supported and guided, predictive accuracy is essential. Since they enable real-time objective measures of cognitive load, physiological metrics like heart rate variability (HRV), electroencephalography (EEG), and near-infrared spectroscopy (NIRS) are frequently employed to monitor cognitive states at both the individual and team levels. The evaluation of intraoperative performance at the individual and team levels is one of the most important uses of AI in surgery. The current gold standards for evaluating technical and non-technical intraoperative abilities are subjective and rely on expert observation and rating, which has a negative impact on inter-rater reliability as well as limited reproducibility and scalability. An exciting possibility to automate, standardize, and scale performance assessment in surgery—including cardiothoracic surgery—lies in the application of AI, particularly computer vision. As opposed to conventional, labor-intensive human rater approaches, prior studies have demonstrated the validity of video-based surgical motion analyses for evaluating laparoscopic performance, including technical skills like suturing, knot tying, fluidity of motion, tissue handling, and motion economy.

AI is not only useful for planning and decision-making, but it may also be used to modify surgical procedures. It has been demonstrated that remote-controlled robotic surgery increases the safety of operations where doctors are exposed to large doses of ionizing radiation and enables surgery in anatomical regions that would not otherwise be reachable by human hands. Surgeons will likely occasionally direct the motions of robots as autonomous robotic surgery advances. All things considered, AI has enormous potential to improve the standard and security of surgical care. However, due to the complexity of the surgical sector and the need for a thorough grasp of human physiology and the surgeon's decision-making process, the integration of AI into the surgical workflow must be done with caution. As a result, to successfully incorporate AI into surgical practice, a multidisciplinary approach is required. AI has the potential to revolutionize surgical treatment and greatly improve patient outcomes with careful adoption and ongoing innovation.

2) LITERATURE REVIEW

(Kilic, 2020) An overview of artificial intelligence (AI) and machine learning (ML) in relation to cardiovascular health care is given in this study. The author evaluates works that have been published up to August 1, 2019, in the area of AI and ML in cardiovascular medicine and explains the terminology and algorithms used in ML. Results demonstrate the use of ML in predictive analytics, natural language processing, data extraction from electronic health records, and automated image interpretation. These techniques have a promising future in clinical practice, especially when it comes to automated imaging interpretation, data extraction, and clinical risk prediction, but they still need to be improved and put through more testing.

(Jian Zhao, 2018) The purpose of this study was to assess the feasibility and safety of robotic gastrotomies combined with intracorporeal sutures for patients who had gastrointestinal stromal tumors (GISTs) in the cardia and sub cardiac area. From January 2014 to August 2016, the operation was performed on 11 people. The average surgical procedure lasted 82.7 minutes, and 30.0 ml of blood was lost on average. After a 25.5-month follow-up, no problems were noted, and all patients survived without experiencing a recurrence or metastasis. The study concludes that certain sorts of GISTs can be successfully treated with robotic gastrotomy and intracorporeal suture.

(Hao Shen, 2018) This study used laparoscopic Roux-en-Y gastric bypass procedures recorded by the Operating Room Black Box technology in order to examine the link between technical and non-technical performance in the operating room. The correlation between the two categories of performance was examined using Spearman rank-order correlation and N-gram statistics. Technical and non-technical assessments were conducted using a variety of instruments. The findings revealed a moderate to substantial association between the non-technical performance of the surgical and nursing teams and technical adverse events and rectifications. The study also discovered that, regardless of the operator, after technical errors, events, and rectifications, both the staff surgeon and the scrub nurse displayed positive non-technical behaviors.

(Newmarker, 2018) this article focuses on the information that Digital Surgery in London has developed a real-time AI system designed for use in operating rooms that includes surgical procedure roadmaps to make surgery safer and reduce risk. The patented AI platform has already developed algorithms for multiple procedures across surgical specialties like orthopedics and bariatrics. Surgeons have lauded the potential of Digital Surgery, with Dr. Sanjay Purkayastha of Imperial College Healthcare NHS Trust comparing the technology to the advent of

laparoscopy. The goal of Digital Surgery is to harness data to improve outcomes, boost access and training, and reduce costs and waste in the healthcare marketplace.

(Jerome Allyn, 2017) In Predicting Mortality after Elective Cardiac Surgery: Decision Curve Analysis, this study compares a machine learning model with Euro SCORE II. - The use of a machine learning-derived early warning system in conjunction with a hemodynamic diagnostic guidance and treatment protocol, along with continuous invasive blood pressure monitoring, resulted in less intraoperative hypotension compared to standard care, according to a preliminary unblinded randomized clinical trial among adult patients undergoing elective noncardiac surgery under general anesthesia. 60 (88%) of the 68 patients who were randomly assigned to the study completed it. The median time-weighted average of hypotension in the intervention group was 0.10 mm Hg and in the control group it was 0.44 mm Hg, representing a median difference of 0.38 mm Hg. To thoroughly examine safety and generalizability and to fully understand the effect on additional patient outcomes, more research with bigger study populations in varied contexts is required.

(Geoffrey Rance, 2019) It has been discussed that the purpose of AI is to build a redundant verbal and digital communication protection system to protect patients from blunders like failure to ventilate following cardiopulmonary bypass. A software program utility was used to retrieve and analyze data from the ventilator and pump and to trigger a pre-set intelligent alarm. The software program is able to decipher data from the ventilator and pump.

(Germain Forestier, 2012) Surgical Processes (SPs) are defined as symbolic dependent representations of surgical interventions using a pre-described level of granularity and a specialized nomenclature. It is explained that SPMs make up SPs. The introduction of new criteria for the comparison and evaluation of SPs is one of the most important tasks in this context. To categorize surgical procedures and highlight exact information about the surgical technique itself as well as the surgeon, including his or her level of experience, correlations between those metrics and pre-operative facts are utilized.

(Yohannes Kassahun, 2016) According to this research, as technology develops, computers play an ever-more-important role in the development of modern surgical tactics and paradigms. With a focus on surgical robots (SR), this paper discusses the state-of-the-art position of system learning (ML) methodologies within the context of surgical operation.

(Jian Chen, 2019) They reviewed the present-day status; the present-day demanding situations and the destiny wishes of robotic reviews with a focal point on urological applications. Concerns remain concerning green and powerful surgeon training and credentialing. To conclude, as there is no universally familiar robot capabilities evaluation presently exists. The reason of evaluation (schooling or credentialing) can also additionally dictate whether manual or computerized general practitioner evaluation is extra suitable.

(Roger D Dias, 2019) According to their analysis, the dynamics of team sports may also provide useful information for understanding the myriad factors that influence surgical performance and patient protection outcomes. Prior research has demonstrated that positive styles derived from crew contributor role and movement records anticipate crew cohesion and cooperation. In this pilot study, we offer a unique integrative method that records role and movement data from a few team members generated by a computer vision system, as well as target measures of team cognitive load (coronary heart rate variability). Our goal is to investigate the viability of combining and visualizing crew dynamics and cognitive load indicators gathered from the OR crew at various points in a real-life heart surgery.

(Scott M Lundberg, 2018) The development and evaluation of a machine-learning-based tool that predicts the risk of hypoxemia and provides risk variables in real time during a stage of general anesthesia is the focus of this study. The device can contribute to improving medical understanding of the risk of hypoxemia during anesthesia care by giving general insights into the specific changes in risk triggered by favorable patient or process features.

(David P Azari, 2019) According to the research, computer vision was utilized to predict professional performance ratings from general practitioners' hand gestures for procedures like tying and suturing. Along with three assignment measures customized from the larger OSATS, movement economy, fluidity of movement, and tissue handling, an expert panel of three attending surgeons scored tying and suturing movies on continuous scales from zero to 10. The computer set of rules consistently predicted the panel ratings of individual tasks and were more objective and reliable than individual evaluation by means of surgical specialists.

(Joyce A Wahr, 2013) According to this study, both mortality and morbidity following coronary artery bypass surgery have decreased over the past ten years (Figure 1).1 However, even the very skilled and dedicated staff members of cardiac operating rooms are only human and prone to mistakes. One in every 28 000 of the 350 000 to 500 000 patients who undergo cardiac surgery each year may experience a bad outcome, and 0.33 of deaths associated with coronary artery bypass graft (CABG) procedures may be avoidable.

(Tom Vercauteren, 2019) This study looked at how important it is to take context and human factors into account to deal with these challenges. We looked at some of the most exciting trends in system learning and artificial intelligence for computer-assisted interventions. The possibility of contextual synthetic intelligence for computer-assisted intervention (CAI4CAI), which is a subfield of surgical statistics research, is emerging.

(Hannes G Kenngott, 2017) This study claims that computer scientists and surgeons in the interdisciplinary field of "cognitive surgery" find and develop new methods of statistics processing and management in order to overcome this obstacle. It examines the possibilities for utilizing cutting-edge smart devices and software throughout the entire treatment process for patients who end up under the care of a "Intelligent Hospital" or "Hospital 4.0," where the boundaries between IT infrastructures, medical devices, medical staff, and patients are bridged with the aid of technology.

3) OBJECTIVES

1) To compare the cutting-edge country of synthetic intelligence (AI) in cardiothoracic surgery, consisting of its cap potential advantages and limitations, and to discover gaps in know-how and regions for in addition research.

2)To check out the accuracy and reliability of AI-primarily based totally diagnostic and remedy gear in cardiothoracic surgery, consisting of their capacity to expect outcomes, enhance affected person safety, and decorate surgical precision.

4) RESEARCH METHODOLOGY

The study data was obtained via secondary sources, for example journals, articles, already published papers and internet portals. The available sources provided a rich pool of material related to the investigation of Surgery, regardless of the specific field of exploration. The study focused specifically on the impact of AI on Cardiothoracic surgery and only referred to sources related to this area, with around 15 research papers being arranged according to the paper's structure. The researcher conducted theoretical research on the impact of AI on Cardiothoracic surgery.

5) APPLICATIONS OF AI IN SURGERY

AI can have a range of meanings, from machine learning to the more broader meaning of AI possessing ability and skills to perceive and feel things. AI systems that can try to replicate human reasoning to solve problems, to those that only depends on larger data to produce solutions, to those that attempt to incorporate human reasoning without modeling human processes accurately. Machine learning (ML) is a data-driven and mathematical approach that can automatically learn and provide an improved prediction for the target without complicated programming, AI uses various approaches such as Bayesian networks, random forests, deep learning, and artificial neural networks, different mathematical frameworks for data input.

In surgical decision-making, AI is increasingly crucial to address various information sources like how much is the patient at risk, what is the anatomy, if the disease is spreading? and cost and help surgeons to accurately predict what will be the outcome or result of their decision. For example, a model was used to predict which patient with treatment-resistant epilepsy will get the most benefit form the surgery. AI serves as a roadmap to assist the surgery in the operating room, decrease risk, and increase surgical safety.

In cardiothoracic surgery, old researches have developed ML algorithms that can surpass operative risk scores in predicting intrahospital mortality rate after cardiac procedures are done. Along decision-making, AI can help in changing surgical techniques too. Surgeries controlled by Robots improves the safety of Operation theatres

where clinicians expose themselves to high radiations and make surgery possible in architectural locations not otherwise attainable by human hands. As independence of robotic surgery improves, surgeons will probably supervise the movements of robots in some situations. Artificial intelligence (AI) is revolutionizing the field of surgery, offering advanced tools and solutions to assist surgeons in performing complex procedures. From planning done before operation to guidance given during operation and care provided after operation, AI is transforming the manner in which surgical care is delivered. In recent times, there have been several applications of AI in surgery that have shown promising results. The most important and noticeable applications of AI in surgery is in the area of pre-operative planning. Using AI-based algorithms and machine learning models, surgeons can now accurately predict the outcome of a surgery, helping them to plan and prepare better. For example, AI can conduct analysis of medical imaging data and determine potential complications before surgery, allowing surgeons to adjust their plans accordingly. This can lead to better outcomes and reduced post-operative complications. Another important application of AI in surgery is in the area of intra-operative guidance. With the help of AI-based systems, surgeons can now perform complex surgeries with better accuracy. For instance, AI can help in analyzing real-time data from sensors and cameras in the operating room, providing surgeons with details about the patient's anatomy and the surgical site. This can help them to make more informed decisions and reduce the risk of complications. AI is also being used to develop new surgical tools and technologies. For example, researchers are working on developing AI-powered robotic systems that can perform surgeries which involves smaller incisions and shorter recovery time, with better precision and control. These systems use advanced algorithms and intelligent retrieval models to analyze data from sensors and cameras, allowing them to adjust their movements and actions based on the surgical site and patient's anatomy. Along with these applications, AI is also being used in post-operative care. By analyzing ,electronic health record generated data and medical devices, AI can help clinicians to identify potential complications and intervene early to prevent them. This can improve patient health results and reduce the time of hospital stays. Despite these promising applications, there are hinderance that comes in the way while using AI in surgery. One of the many hurdles is assuring that the code and models used are accurate and dependable . This requires extensive testing and validation, as well as ongoing monitoring and maintenance. Ethical and legal issues also causes problems while AI is in use , such as liability for errors and patient privacy. In conclusion, AI is transforming the field of surgery, offering advanced tools and solutions to assist surgeons in performing complex procedures. From planning before operation to guidance during operation and care after operation, AI is changing the way surgical care is provided or implemented, improving outcomes, and reducing complications. However, there are hurdles in surgery associated with the use of AI and ongoing research and development will be required to overcome these challenges and ensure that AI is used safely and effectively in the operating room.

A) SURGICAL DATA SCIENCE

Surgical data science (SDS) was designed with integration of new technologies and the collection of vast amounts of patient surgical care data in the operating room (OR). The primary aim of SDS is to betterment of the quality and value of health by organizing, capturing, processing, and modeling data that arises from various sources such as patients, operators, sensors, and domain knowledge. AI and ML applications have been developed based on SDS to support surgical decision-making and enhance patient safety. Unlike conventional data modeling methods that mostly use regression techniques, SDS employs machine learning techniques to discover data relationships without much input from human modelers. ML techniques have come in use in evaluating physician competence in a range of setting. One example of how SDS can be used for improving quality is through the OR black box system, which captures and integrates data produced during operations (e.g., audio, video, physiological parameters). OR Balack box system is used to investigate technical and non-technical performances played during surgery and their relations with patient results. In recent years, machine learning algorithms have demonstrated the feasibility and validity of early prediction of complications occurring during operations, such as hypotension and hypoxemia in noncardiac and cardiothoracic surgery. Another data-based application of AI in surgery is the analysis of intraoperative performance at both individual and group levels. Use of AI particularly in computer, provides an opportunity to analyze , record , generate automatic results, evaluate and scale performance assessment in surgery, also in cardiothoracic surgery.

Previous studies established the reliability of the video-based surgical motion analyses for assessing laparoscopic performance, including technical skills such as stiches, knot tying, fluidity of motion, tissue handling, and motion economy, as compared to traditional, time-intensive human rated approaches.

- Surgical data science is the application to surgical data of data science techniques, with the aim of improving surgical outcomes and patient care. latterly, there has been an increasing interest in the applications concerning surgical data science in cardiothoracic surgery. Cardiothoracic surgery is a complex and high-risk specialty that involves the incision of diseases and disorders related to heart, lungs, esophagus, and other organs in the chest. One of the key applications of surgical data science in cardiothoracic surgery is in the area of predictive modeling. With the help intelligent retrieval. and predictive modeling techniques, surgeons can now predict the likelihood of complications and adverse events before surgery. This can help them to develop personalized treatment plans and adjust their surgical approach, accordingly, leading to improved outcomes and reduced risks. Another important application of surgical data science in cardiothoracic surgery is in the area of real-time decision-making. With the help of advanced analytics and real-time data monitoring systems, surgeons can now make more informed decisions during surgery, based on real-time data about the patient's physiology and anatomy. For example, surgeons can use data from intraoperative sensors to adjust their surgical approach, such as modifying the position of the patient or adjusting the angle of the surgical instruments. Surgical data science is also being used to develop new surgical techniques and technologies. For example, researchers are working on developing new imaging technologies that can provide more detailed and accurate information about the patient's anatomy, making easy for surgeons to plan and execution of surgeries with greater precision and efficiency, which can lead to improved outcomes and reduced risks. In addition to these applications, surgical data science is also being used to improve post-operative care. By analyzing data from electronic health records and other sources, surgeons can identify potential complications and intervene early.

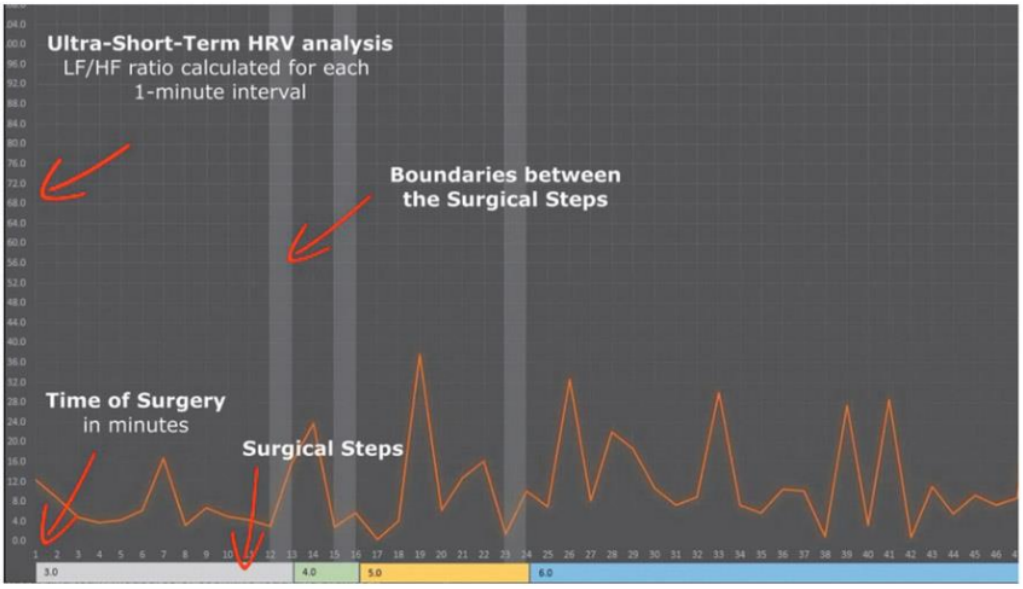
B) AUGMENTED COGNITION IN OPERATING ROOM

In recent years, humans have made significant and rapid technological advancements that have greatly influenced how surgical procedures are carried out in the operating room (OR). The contemporary OR is now a high-tech environment that incorporates novel computational systems into the clinical workflow, with the aim of improving processes and providing support to the surgical team. This complex computational-based environment generates vast amounts of statistical details that could be used for development of predictive machine learning models .Also, augmentation of human cognition at both individual and at team levels is enabled, extending cognition beyond the minds of individual team members to include non-human systems involved in the surgery.

Cardiothoracic surgery is a prime example of use of artificial intelligence (AI) to support surgical care through cognitive augmentation. The cardiothoracic OR is a environment with high level of risk where various specialized professionals interact with each other, coordinate the tasks efficiently as a team, and make use of various available equipments, technological support by devices, and interfaces in order to provide care for patients in complexity and who are in need of surgical treatment. This team operates as a complex socio-technical system that performs tasks in a systematic and coordinated order, which requires empirical abilities which goes beyond the performance of individual team members. Since a team member individually does not have control over the team's performance as a whole, cognitive activities are emergent processes of teamwork instead of individual tasks.

Although with the help of existing AI systems the data can be collected, processed and could make sense .data gathered in the OR, an important requirement of these systems is their ability to understand and adapt to their algorithms which is eventually based on real-time contextual information. This enables them to provide assistance which is aware contextually to the surgical team. Predictive accuracy is also important to support and guide team with respective cognitive tasks, and a AI system should anticipate the future states by using past and current information from the OR's human and non-human systems. Cognitive state monitoring and human activity recognition are also important features of an AI system for cognitive augmentation in the OR. Physiological metrics like heart rate variability (HRV), electroencephalography (EEG), and near-infrared spectroscopy (NIRS) are used most commonly to monitor cognitive states at individual level as well as team levels, as real-time objective measures of cognitive load is provided by them. Figure 1 illustrates the cardiac surgeon's cognitive load, indexed by HRV (LF/HF ratio) during different steps of a cardiac procedure. Artificial

Intelligence (AI) is being increasingly used in the field of medicine and healthcare to improve patient outcomes and enhance clinical decision-making. One area where AI is being used is in the augmentation of cognition in the operating room. Here are some applications of AI in augmentation cognition in the operating room in current times: Image Recognition: intelligent retrieval could be used to analyze medical images, like X-rays and MRI scans, and provide real-time feedback to surgeons during surgery. This can help to identify potential complications and improve surgical outcomes. Surgical Navigation: AI could be used to create three dimensional models of a patient's anatomy and help surgeons with navigation of complex surgical procedures. which can help to reduce the complications risk and upgrades patient outcomes. Predictive Analytics: AI algorithms can analyze large amounts of patient data in order to predict complications which potentially could occur during surgery. This can help surgeons to make more informed decisions and reduce the risk of adverse outcomes. Virtual Reality: AI-powered virtual reality systems can be used to create simulated surgical scenarios for training purposes. This can help to improve surgical skills and reduce the risk of complications during real surgeries. Natural Language Processing: AI-powered natural language processing could be used to transcribe and analyze conversations between surgeons and other medical staff during surgery. This can help to improved communication and reduced risk of errors. Overall, AI has potential to bring revolution in the field of surgery and improve patient outcomes with enhanced cognitive abilities of surgeons in the operating room.



Source: *''Julie A.Shah's research while affiliated with Massachusetts Institute of Technology and other places''*

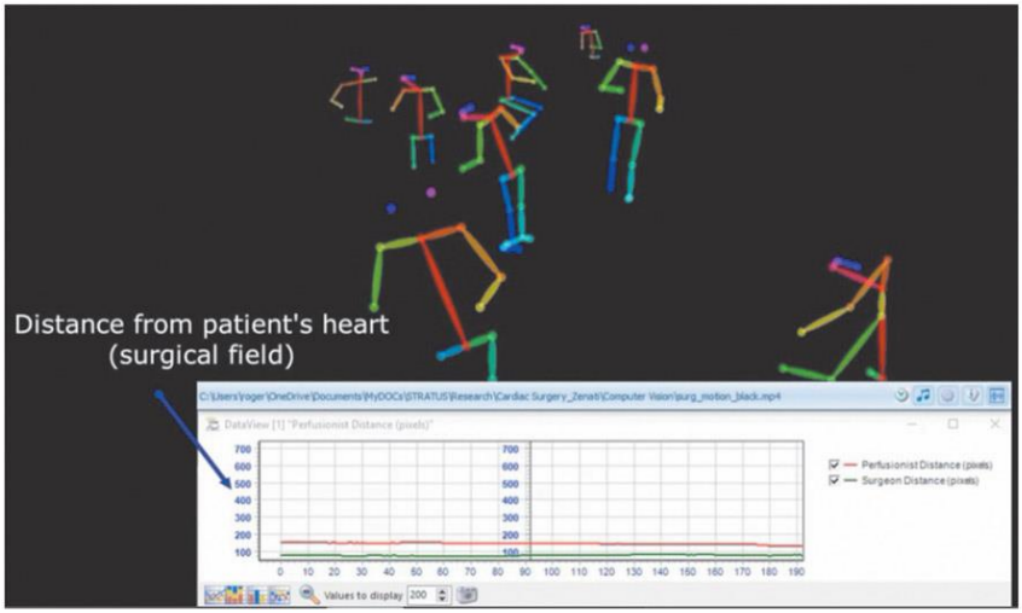
Figure 1.—

As captured by a wearable physiological sensor a surgeon's cognitive load as per measurement of the HRV parameter: low frequency (LF)/high frequency (HF) ratio

C) COMPUTER VISION IN SURGERY

Computer vision, an AI technique that draw out and analyzes the data from videos and images, shows promising human activity recognition, particularly in surgical task segmentation and monitoring team dynamics. This technology has led to the creation of the new interdisciplinary field called "cognition-guided surgery", which aims to enhance cognition in the OR using AI. Computer vision technologies have the ability to achieve performance at human level and even surpass human capabilities in certain fields.

In surgery, computer vision has been applied to surgical workflow segmentation, instrument recognition and detection, and image-guided surgical interventions. However, it is now being used to understand individual and team behaviors in team-based complex procedures, such as cardiothoracic surgery. More fields where the medicine and psychology are the part of, have already used automated pody positioning and movement tracking to investigate the human behavior which in non verbal in nature. In surgery, this renowned technology has been used in tracking the gesture and the hand motion of the doctors to know objective metrics of technical psychomotor skills. In the latest studies it has been known the use of position and the motion data that is generated by the vision application of the computers to measure the very important team dynamics and coordination in the OR. Including the metrics which are team centrality and team proximity. Some of the application which are potential in nature include: image reorganization. Artificial intelligence can be used in recognizing and classifying the pictures that are from medical imaging devices such as the scans and MRIs. Image segmentation: Artificial intelligence can segment the pictures of the medical into individual structure that allow more of the identification. Object tracking: the artificial intelligence can be used in tracking the movement of the such objects that are in the medical images, like the movement of the heart which is beating. Virtual and augmented reality: Artificial intelligence can also be used in creating the virtual simulations of the process that are related to the surgery which allow the doctors to practice in safety and accuracy. Decision support: artificial intelligence provides the pillar to the surgeons, provide real time feedback on vital stage, the flow of the blood and the other metrics that can impact the surgical outcomes. In submission the artificial intelligence has the great power to improve the results in the cardiothoracic surgery by giving them real time feedback, 101% accuracy and pillar for the decision making.



Source: *"Minerva Cardioangiol,2020 Oct"*

Figure 2. —

Computer vision system extracting human body position and motion in the cardiac operating room.

D) AUTONOMOUS ROBOTIC SURGERY

The process that the surgeons do are on the brink of being overtaken by the robotic technology. Robots are the one who are expected to become the noem foe many such process where accuracy is demanded. Autonomous and semi- autonomous are being investigated to make the process of surgery automated.

The task that are performed are more complex and with the high level of the autonomous featured like complex endoscopic surgical maneuvers and shared control approaches in stabilized image guided beating heart surgery. The progress in the future will seek for the interdisciplinary work with the nanorobots that are expected to enter the field. The machine development learning empowered instrumentation for the robotics surgery in continuously investigated as it is the matter of question. The knowledge of the expert is supplied by the experienced doctors for the learning of the machine flow. Implicit imitation learning is a special type of the supervised learning where the learning takes place under the supervision which aims at accelerating the reinforced learning by the help of the expert, mentor to guide. Artificial intelligence is something that is used in the field of the surgery that is practiced by the robots to increase the safety and efficiency of the process of the surgical methods. Some of the applications of AI in this field include Image analysis: AI can be used to analyze medical images such as X-rays, CT scans, and MRI s and assist the doctors in identifying important structures and the landmark during the medical process. Robotic control: artificial intelligence is used to control the movement of the surgical robots helping them in performing the complex maneuvers with the high accuracy. Surgical planning: Artificial intelligence help the doctors in planning and preparing for the complex surgical process just by analyzing the data of the patient and indentifying the approach in the surgery. Real-time feedback: artificial intelligence algorithms can get the real time feedback to the doctors indulge in it during the process of the surgery, helping the doctors to adjust the tools and technique and optimize the result. Predictive analytics: artificial intelligence can help in analyze data that is related to the patient and forecast the likelihood of the complexity during the process of the surgery. In submission the integration of the artificial intelligence into a robot surgery in expected to conquer in the field of the surgery.

E) HUMAN-MACHINE TEAMING IN OPERATING ROOM

With the increasing presence of computational systems in our workplaces, such as in the cardiothoracic operating room, new ways of transforming the thoughts and communication has been learned. Efficient design and operation of computer-based systems in the OR can have a significant impact on workflow efficiency, cognitive load of clinicians, and the process of surgery. Integrating artificial intelligence in the any environment creates opportunities for learning, which can lead to new opportunities. These opportunities will path the opportunities in enhancing the safety and efficiency I the term based surgeries that are complex in nature. AI has numerous applications in human-machine teaming in the operating room, some of which are: Surgical Assistance: AI can assist surgeons during procedures by analyzing data from medical imaging devices and providing real-time feedback to guide the surgeon's actions. For example, AI algorithms can help identify the location of critical structures like blood vessels, nerves, and organs, and provide guidance on the safest and most efficient way to access them. Predictive Analytics: AI can also help predict patient outcomes based on various data inputs, such as medical history, vital signs, and surgical procedures. This information can be used by surgical teams to develop personalized treatment plans and optimize patient outcomes. Virtual Reality Training: AI can also be used to develop virtual reality simulations that allow surgeons and surgical teams to practice procedures in a safe and controlled environment. This can help reduce the risk of errors during actual procedures and improve overall patient outcomes. Robotic Surgery: AI-powered robots can be used in the operating room to perform minimally invasive surgeries with greater precision and accuracy than human surgeons. These robots can be programmed to perform specific procedures with minimal human intervention, which can reduce the risk of human error and improve patient outcomes.

6) CONCLUSION

In recent years, research has been focused on creating intelligent machine teammates by utilizing innovative computational algorithms and human cognitive models for AI. These efforts have resulted in new forms of human-machine collaboration across various industries, such as healthcare, in transportation, manufacturing of the goods and in the security purpose. In the field of surgery, researchers learned new systems that aim to integrate the physiological data of clinicians, which serves as a measure of the performance with the earlier data of the patient and devices in the OR. Some studies have also explored the use of data-driven approaches that

involve both world of the universe to optimize surgical coordination, team communication, with the goal of enhancing safety and reducing errors in cardiothoracic surgeries. Overall, AI has the potential to revolutionize the way surgeries are performed and improve patient outcomes in the operating room. By leveraging the power of machine learning algorithms, surgical teams can work more efficiently, safely, and effectively to deliver the best possible care to their patients

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