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A Systematic Literature Review of the Rapid Expansion of Artificial Intelligence in Healthcare with a Focus on Surgical Applications

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Abstract

Artificial Intelligence is a growing application in many areas of healthcare. The use of AI in surgery has the potential to further enhance patient outcomes perioperatively, even beyond its current impact. This systematic literature review sought to determine the extent of policies currently in place. Medline Ultimate and Web of Science databases were utilized to discover relevant articles, and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines were employed to ensure relevance. 20 articles published between 2021 and 2025 were examined, and nine themes were discovered. These themes include policy and regulation (80%), accountability (55%), ethics (70%), Artificial Intelligence use in surgery (85%), autonomy (60%), perception (40%), safety (65%), outcomes (65%), and limitations (95%). Policies must be put in place to regulate AI usage in surgery and protect staff. The findings reveal

that many policies exist regarding AI, but more must be implemented as it progresses further into medicine. Many individuals, including surgeons and patients, hold apprehensions regarding AI involvement in healthcare. The creation and implementation of policies with the primary focus of reducing concerns and improving surgical outcomes is essential for the successful integration of AI in surgery through building trust.

Keywords: Artificial Intelligence, surgery, policies, administration, healthcare

Introduction

Artificial Intelligence (AI) is rapidly changing the healthcare field. It is being integrated into various aspects of healthcare, including diagnosis, treatment planning, education, and more (Guni et al., 2024). AI is becoming increasingly present in surgery (Guni et al., 2024). Artificial Intelligence technology can be utilized in all steps of surgery and assist in achieving the best possible outcome for a patient (Guni et al., 2024). This technology can not only be utilized in surgery but also prepare medical students more thoroughly for their role as surgeons (Sun et al., 2023). The use of AI in surgical training can improve precision in the operating room and further improve patient outcomes (Sun et al., 2023). It has the potential to benefit patients, especially in surgical settings, but many are hesitant to trust AI (Habbal, Ali, & Abuzaraida, 2024). The use of AI poses a risk to patient information when employed in electronic health records and other hospital systems, thereby compromising security (Habbal, Ali, & Abuzaraida, 2024). There are also ethical concerns regarding the use of AI in healthcare, such as the quality, privacy, and equality of care it can provide (Elendu et al., 2023). Many individuals are unsure whether to trust

AI in their healthcare, but the benefits AI can bring may be too great to overlook (Habbal, Ali, & Abuzaraida, 2024).

The greater the reliance on AI, the higher the risk of breaches and errors (Habbal, Ali, & Abuzaraida, 2024). However, the use of AI in investigative, treatment, and surgical processes has improved healthcare outcomes (Kumar et al., 2025). Various demographics, including people of different races and social status, can receive fair care with the use of AI (Kumar et al., 2025). AI must be monitored and constantly updated to maintain its effectiveness in patient care (Elendu et al., 2023). This technology can improve patient outcomes through constant observation, tracking, and specialized treatment plans, but it requires supervision.
(Elendu et al., 2023).

Policies and administrative standards must be implemented and utilized to promote proper use of AI in healthcare. The standards for AI in surgery recommend following specific guidelines (O'Sullivan et al., 2019). These policies must address the liability of the physician for wrongful use (O'Sullivan et al., 2019). There are instances in which the application of these principles is difficult, such as when technology performs a surgery entirely on its own (O'Sullivan et al., 2019). This systematic literature review explores what innovative policies and standards hospital administrators employ to utilize AI in surgery to put patients at ease, improve opinions regarding AI, and increase positive surgical outcomes in healthcare settings.

Methods

With the assistance of Google Scholar, relevant articles were reviewed to help develop a research topic. The research question explored in this systematic literature review is: What innovative policies and standards do hospital administrators employ in healthcare entities to utilize AI in surgery and put patients and physicians at ease, to improve opinions regarding AI, and increase positive surgical outcomes?

The method stages included the following phases:

1. Comprehensive literature search for appropriate studies.
2. Screening of articles based on pre-defined eligibility criteria.
3. Assessment of studies to determine inclusion or exclusion in the review.
4. Data extraction from eligible studies using the screening criteria.
5. Data synthesis to identify emerging themes across the selected studies (Page et al., 2021).

Using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) as a guideline (Moher et al., 2009), articles related to this topic were discovered using the databases Medline Ultimate (EBSCO) and Web of Science. The initial search produced 100 articles. All of which were reviewed, and 76 relevant articles were revealed.

Inclusion and Exclusion Criteria

Specific search words and concepts, such as *AI, surgery, hospital administrators, healthcare institutions, standards, guidelines, strategies, policies, challenges, concerns, attitudes, clinical outcomes,* and *perception of AI*, were used to help identify relevant articles

(Moher et al., 2009). Of the initial 100 articles, 24 were removed for various reasons, including duplication and not being in English. The remaining 76 articles were reviewed. 21 studies were excluded due to not revealing information related to the topic of interest and having been published between 2019 and 2025 (See Figure 1). The remaining 55 articles were then narrowed down to 36 due to being too costly or not containing enough relevant information. 13 of these articles were excluded due to not being full-text, not being peer-reviewed, or simply being too similar to another article. This led to 20 articles left to be included in the thematic synthesis. The remaining 20 articles were examined by two reviewers. Cohen's Kappa calculator was used to establish if these articles were truly germane to the research question. Following the review of all 20 articles by two interviewers, the calculator provided a score of 1 for the index value ("Kappa Calculator," n.d.). The remaining 20 articles were selected due to the pertinent information found within them.

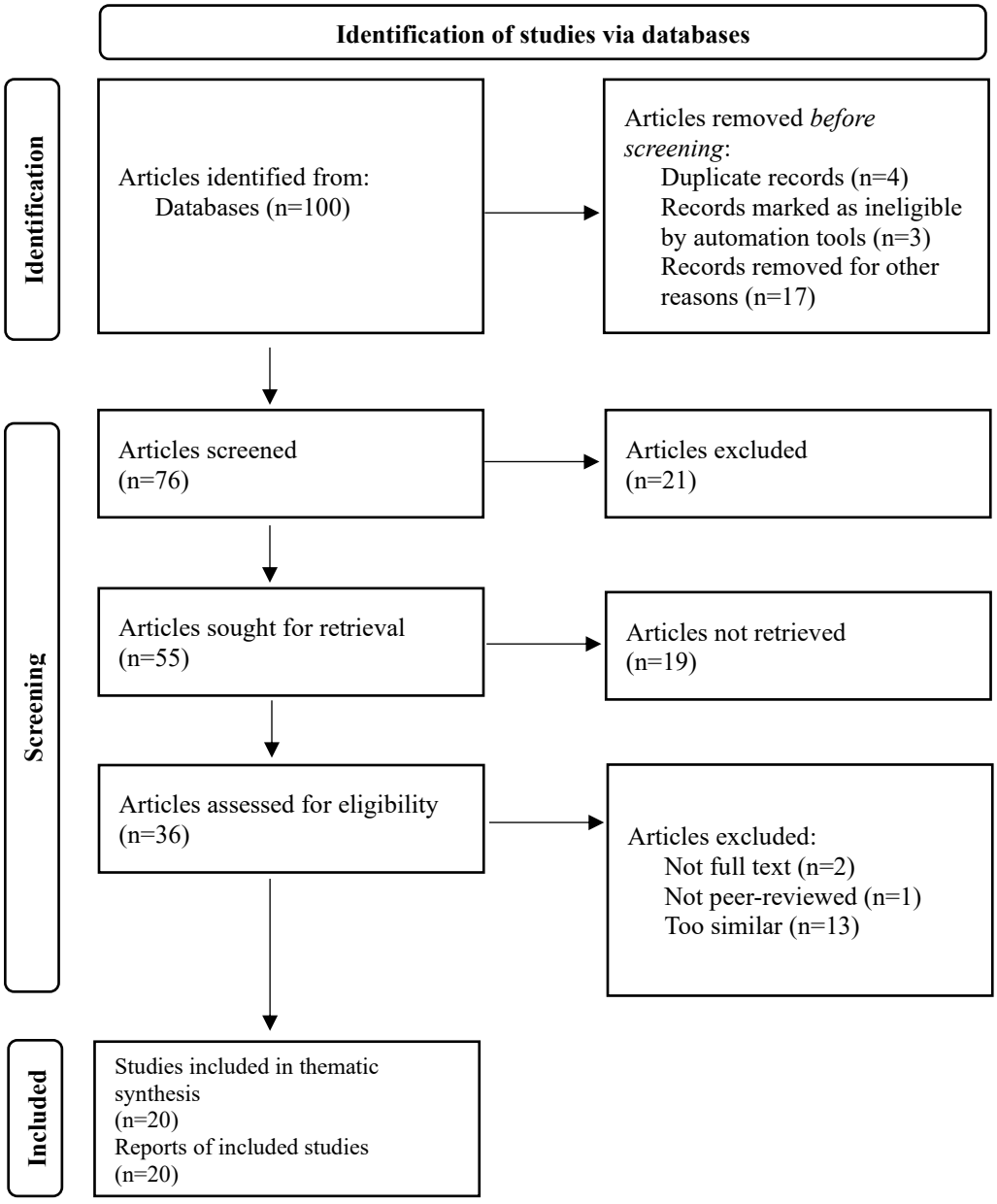

Figure 1: *PRISMA 2020 flow diagram of the study selection process*

Results

The research question explored within this systematic literature review was what innovative policies and standards do hospital administrators employ in healthcare entities to utilize AI in surgery and put patients and physicians at ease, to improve opinions regarding AI, and increase positive surgical outcomes? Medline Ultimate (EBSCO) and Web of Science were databases utilized to identify necessary resources for this topic. The screening was conducted using specific criteria that aligned with PRISMA guidelines (Moher et al., 2009). Using this established process, the original 76 articles were narrowed down to 20 relevant studies that met the inclusion criteria (see Figure 1). Table 1 displays key findings from the final 20 selected articles.

Table 1

Summarized findings of the literature.

Title	Findings
[1] Artificial Intelligence in Surgery: The Future Is Now	This article highlights the growing application of AI in various aspects of healthcare, with a particular focus on intraoperative robotics. Responsibility and monitoring are essential for safe usage.
[2] Artificial Intelligence Surgery: How Do We Get to Autonomous Actions in Surgery?	AI has many different components that are utilized in healthcare today. The prospect of AI in surgery is presented, as well as why surgeons are skeptical of its use within surgery.
[3] Fairness of artificial intelligence in healthcare: review and recommendations	This article highlights the importance of fairness in the use of AI in healthcare. Strategies to eliminate bias in AI are revealed and explained to assist in the creation of fair AI in healthcare. Patient and physician skepticism are also discussed.
[4] Transparency of AI in Healthcare as a	Transparency is crucial in the use of AI, particularly in healthcare. Many different avenues can be used to achieve transparency in AI, and policies that are in place to assist in keeping AI from being evasive.

Multilayered System of Accountabilities: Between Legal Requirements and Technical Limitations	
[5] Artificial Intelligence and Surgery: Ethical Dilemmas and Open Issues	Recommendations for frameworks regarding AI use in surgery are shown within this article. The shortcomings are to be addressed with these recommendations.
[6] The IDEAL framework for surgical robotics: development, comparative evaluation and long-term monitoring	The authors propose a framework to be used for the assessment of surgical robots. The need for standardized evaluation of these surgical robots is expressed heavily. Issues and challenges are discussed, as well as the potential benefits for both patients and clinicians.
[7] Legal, regulatory, and ethical frameworks for development of standards in artificial intelligence (AI) and autonomous robotic surgery	The requirements and frameworks that could be utilized for surgical robots are discussed in this excerpt. Responsibility is investigated to determine the necessary components and liability regarding robotics in surgery
[8] Robotics and AI for Teleoperation, Tele-Assessment, and Tele-Training for Surgery in the Era of COVID-19: Existing Challenges, and Future Vision	These authors focus on how the COVID-19 pandemic has altered the delivery of healthcare. There is a particular focus on robotics and AI in many aspects of surgery.
[9] A nationwide survey on the perceptions of general surgeons	The use of a survey allowed the discovery of surgeons' perspectives on AI use. Many feel it could bring much benefit to the field of medicine, but reasons for skepticism are revealed as well.

on artificial intelligence	
[10] Attitudes of the Surgical Team Toward Artificial Intelligence in Neurosurgery: International 2-Stage Cross-Sectional Survey	The attitudes regarding AI of those involved in surgeries are revealed in this journal. The authors recognize many themes within these attitudes towards different aspects of surgery.
[11] Attitudes and perception of artificial intelligence in healthcare: A cross-sectional survey among patients	With the use of a study, researchers discover how patients feel regarding AI in their healthcare. Many feel positively about it, but seem to believe it must be monitored when in use regarding their healthcare decision.
[12] Patient apprehensions about the use of artificial intelligence in healthcare	The focus of this article is on patient concerns regarding AI in healthcare, such as cost increases and safety issues. These apprehensions could prevent the acceptance of AI in healthcare.
[13] Operational framework and training standard requirements for AI-empowered robotic surgery	Training is essential for the successful use of AI in surgery. AI can assist in training surgeons and improving their techniques. Avenues in which limitations in AI can be addressed through training and learning. There is also discussion of the limits of utilizing AI only for training.
[14] Artificial intelligence: revolutionizing robotic surgery: review	Surgery can gain many benefits from AI. The use of AI in surgical care can improve patient outcomes through increased efficiency and safety. Many ethical issues prevent AI from being utilized more, but the benefits of this technology may outweigh the risks.
[15] Digital Health Policy and Cybersecurity Regulations Regarding Artificial Intelligence (AI) Implementation in Healthcare.	In this article, the authors reported the limitations of current healthcare regulations and policies regarding AI. As AI advances and becomes more prevalent in healthcare, these regulations must be updated so that they specifically address this technology. The need for furthering the ability of cybersecurity measures could make it possible for AI to be safer for use in healthcare.

[16] Role of Artificial Intelligence in Global Surgery: A Review of Opportunities and Challenges	The need to advance AI technology is prevalent. It can assist in avoiding many deaths and improving surgical skills. The authors outlined other areas in which AI is being used in healthcare. AI can assist is maintaining healthcare systems when resources are scarce.
[17] Artificial intelligence in liver cancer surgery: Predicting success before the first incision	The ability to utilize AI technology to determine the likelihood of patient success prior to undergoing surgery is very beneficial. AI can more accurately determine if a patient will survive surgery and assist in determining if this is truly the patient's best option.
[18] Artificial intelligence for the prediction of acute kidney injury during the perioperative period: systematic review and Meta-analysis of diagnostic test accuracy	Artificial intelligence could be used to predict acute kidney injury around the time of surgery. This issue can cost a patient their life if not caught and is quite difficult to diagnose. This must be addressed, and AI could assist in doing so.
[19] Artificial intelligence for healthcare and medical education: a systematic review	The authors investigate the apparent lack of common regulatory standards regarding AI technology use in healthcare and education. Many are not in agreement on such standards, which can bring many new issues in the future.
[20] Artificial intelligence in improving the outcome of surgical treatment in colorectal cancer.	As surgical intervention is essential in fighting colorectal cancer, the use of AI in these surgeries could bring much benefit to the patients. There are limits due to variability between patients, but the regulation of procedures for colorectal cancer surgeries could allow more incorporation of AI.

Many similar themes were noted within the selected articles. Each of the themes relates to artificial intelligence use within healthcare. These themes include: (a) policy and regulation,

(b) accountability, (c) ethics, (d) AI in surgery, (e) autonomy, (f) perception, (g) safety, (h) outcomes, and (i) limits.

Table 2 reveals the occurrence of these themes throughout the 20 articles selected. Policy and Regulation are at least mentioned in articles 1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, 16, 17, 19, and 20, which is 16 of 20. This translates to 80%. Accountability and responsibility in AI policies are discussed in articles 3, 4, 5, 7, 9, 10, 11, 14, 15, 16, and 20. This is 11 of the 20 articles and is contained in 55% of the articles. Ethics are highly discussed in articles 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, and 15, which is 14 of the total 20. This can also be seen as 70%. AI in surgery was present in articles 1, 2, 4, 5, 6, 7, 8, 9, 10, 13, 14, 15, 16, 17, 18, 19, and 20, which is 17 out of 20. This equates to 85% of the articles that discuss AI use specifically in surgery. Autonomy, such as differing levels, is touched on in articles 1, 2, 5, 6, 7, 8, 9, 10, 12, 13, 14, and 20, which is 12 of 20. This equates to 60%. Perceptions and differing opinions regarding AI are reported in articles 2, 3, 9, 10, 11, 12, 16, and 19, which comprise 8 of the 20 articles. This is the theme with the lowest overall percentage at 40%. Safety emerges as a main theme in articles 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, and 19, which is 13 of the total 20. This becomes 65%. AI's potential to improve patient outcomes is investigated in articles 1, 2, 3, 4, 6, 9, 10, 11, 13, 14, 15, 17, and 20. This is 13 of the total 20 and equals 65%. Lastly, the limits of AI are discussed in nearly all 20 articles except for one. This theme is in articles 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, and 20, which is all but 1 of the twenty. This equals 95%.

Table 2

Frequency of occurrence in the literature.

Theme	Articles	Instances of Attributes (n)	Percentage (%)
Theme 1: Policy/Regulation	1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, 16, 17, 19, 20	16	80%
Theme 2: Accountability	3, 4, 5, 7, 9, 10, 11, 14, 15, 16, 20	11	55%
Theme 3: Ethics	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15	14	70%
Theme 4: AI in Surgery	1, 2, 4, 5, 6, 7, 8, 9, 10, 13, 14, 15, 16, 17, 18, 19, 20	17	85%
Theme 5: Autonomy	1, 2, 5, 6, 7, 8, 9, 10, 12, 13, 14, 20	12	60%
Theme 6: Perception	2, 3, 9, 10, 11, 12, 16, 19	8	40%
Theme 7: Safety	5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 19	13	65%
Theme 8: Outcomes	1, 2, 3, 4, 6, 9, 10, 11, 13, 14, 15, 17, 20	13	65%
Theme 9: Limits	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20	19	95%

Discussion

This systematic literature review sought to discover what innovative policies and standards hospital administrators employ in healthcare entities to utilize AI in surgery and put patients and physicians at ease, to improve opinions regarding AI, and increase positive surgical

outcomes, if any. Eighteen articles published between 2021 and 2025, and two from before 2021 that met the previous criteria, were utilized to discover what laws are currently in place and what future laws must entail. The results in Table 2 reveal themes that arose from the analysis of these articles. These themes include policy and regulation (1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, 16, 17, 19, 20), accountability (3, 4, 5, 7, 9, 10, 11, 14, 15, 16, 20), ethics (1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15), Artificial Intelligence (AI) use in surgery (1, 2, 4, 5, 6, 7, 8, 9, 10, 13, 14, 15, 16, 17, 18, 19, 20), autonomy (1, 2, 5, 6, 7, 8, 9, 10, 12, 13, 14, 20), perception (2, 3, 9, 10, 11, 12, 16, 19), safety (5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 19), outcomes (1, 2, 3, 4, 6, 9, 10, 11, 13, 14, 15, 17, 20), and limits (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20).

Theme 1: Policy and Regulation:

Over three-quarters of authors revealed the current regulations and policies regarding AI use in healthcare. Many of these reach further into policies and recommendations for standards specifically for AI use in surgery (1, 5, 6, 7, 8, 13, 15, 19). A framework that creators can use for AI systems in surgery is called TURBO, which stands for “testable, usable, reliable, beneficial, and operable” (Guni et al., 2024). Effectiveness, precision, and uniformity are essential for surgical standards for autonomous robotics (O’Sullivan et al., 2020). AI in surgery is a rather new development in healthcare, and policies and frameworks addressing its use are essential. Accountability is another important aspect of surgical AI policies.

Theme 2: Accountability:

A vital theme that emerged from the literature analysis is accountability. Addressing the responsibility of those utilizing AI within policies is essential to continue the growth of AI in

surgery. Accountability and responsibility were explored in 11 articles. Many individuals must accept responsibility for the use of AI in healthcare. A multilayered system of accountabilities can allow liability to fall on many staff members and not only physicians (Kiseleva, Kotzinos, & De Hert, 2022). Healthcare administration is responsible for creating such regulations, and much responsibility falls to them. Ethical concerns must be taken into account for policy creation and accountability as well.

Theme 3: Ethics:

Another theme that emerged is ethics. Policies regarding accountability must be ethical. Ethics are addressed in 70 percent of the articles explored (1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15). Some ethical concerns include discrimination and biases (O'Sullivan et al., 2019). These issues must be addressed with policies that address bias and poor AI judgment. Appropriate standards that require certain information to be utilized in AI systems can prevent biases from forming and lead to fair decisions made by AI in Surgery (O'Sullivan et al., 2019). The impression that biases exist in AI leads to a lack of trust in its use in surgery.

Theme 4: AI in Surgery:

Artificial Intelligence has recently been employed in many aspects of surgery. Nearly all of the authors discuss or mention AI use in surgery within their articles (1, 2, 4, 5, 6, 7, 8, 9, 10, 13, 14, 15, 16, 17, 18, 19, 20). AI is being utilized currently in cardiology, neurology, orthopedics, urology, and gastrointestinal surgeries (Iftikhar et al., 2024). It is assisting surgeons with their operations. AI is also being used to predict surgical outcomes and recommend postoperative care (Zhang et al., 2022). AI is assisting with many aspects of the perioperative

period. Healthcare administrators must concern themselves with what AI is allowed to assist with. A looming question regarding AI use in surgery is its degree of involvement. Many different levels of autonomy exist for AI.

Theme 5: Autonomy:

The fifth theme of autonomy relates to the level of control AI alone has in surgery. Autonomy in AI was revealed in many more articles than anticipated (1, 2, 5, 6, 7, 8, 9, 10, 12, 13, 14, 20). There are many struggles regarding autonomy in AI. Different levels of autonomy are present in surgery that administrators must be concerned with. The levels go from zero to five (O'Sullivan et al., 2019). Level zero refers to the surgeon having full control, while level five refers to the operation being fully controlled by AI (O'Sullivan et al., 2019). Administrators must decide which level is safest for staff and patients. Even though different levels of autonomy in AI during surgery present concerns regarding control, how patients and providers perceive this control affects its acceptance.

Theme 6: Perception:

Perceptions about AI in healthcare was the next prominent theme. This theme is discussed in articles 2, 3, 9, 10, 11, 12, 16, and 19. Patients and physicians with a lack of acceptance will limit the assistance AI can provide. Healthcare administrators must concern themselves with the perceptions of physicians and patients regarding AI use in their care. Despite fewer than half of the articles listed in Table 1 discussing the perceptions and views people have about AI, administrators need to be aware of opinions about AI. Many surgeons and patients fear biases in AI and inadequate care being provided because of this (Ueda et al., 2024). Strategies

administrators can employ to reduce bias include using broad amounts of data and providing education to ensure everyone understands the best practices for AI usage (Ueda, 2024). Reducing biases in AI can also make its use in healthcare safer.

Theme 7: Safety:

Poor safety measures relate to the perception that AI is not trustworthy. Safety regarding AI use was discussed in most of the articles (5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 19). Hospital administrators must implement standards for training requirements for AI in surgery (O'Sullivan et al., 2020). Training students and incoming staff on how to properly use AI in surgery will allow for increased safety measures. Robotic skills training is essential for the successful implementation of AI use in surgery (O'Sullivan et al., 2020). Increased training also has the potential to improve surgical outcomes drastically.

Theme 8: Outcomes:

Improved safety measures can lead to increased positive outcomes as well, which is the next vital theme. 13 of the 20 articles touch on how AI in surgery improves surgical outcomes. With the proper training provided and strategies in place to maintain appropriate usage outcomes can be improved. AI has predictive qualities that can allow surgeons to predict the probability of success of a surgery and alter their plan if needed (Chan & Twohig, 2025). The accuracy and precision AI provides allow for improved surgical outcomes (Chan & Twohig, 2025). Administration must be sure to implement strategies that prevent the improper use of the predictive qualities of AI. Despite the numerous benefits AI has to offer surgery, there are limitations that remain.

Theme 9: Limits:

The limitations of AI prevent the number of improved surgical outcomes from growing. All but one article discusses the limitations of AI, which was the last but most prominent theme. Healthcare administration must ensure that strategies are implemented that keep staff and patients safe. Providing training to staff can assist in the smooth transition to AI use in surgery, improve outcomes, perceptions regarding AI, and more. AI implementation in surgery is costly, relies on accurate data, and establishing liability for adverse outcomes is difficult (Muhammad, 2024). Current regulations also do not directly apply to AI (Virk et al., 2025). The Health Insurance Portability and Accountability Act and the Health Information Technology for Economic and Clinical Health Act do not account for AI usage in healthcare (Virk et al., 2025). Frameworks and policies do exist for AI in surgery, but health administration groups must create more policies as AI becomes more prevalent in surgery.

There were several limitations to this summative review itself. These include the number of applicable articles available, time constraints, and the fact that AI use in surgery is a recent development. This review took place over a time period of only 12 weeks. The number of available articles was limited due to needing them to be peer reviewed and in English. AI surgery is also being newly explored, which has limited the amount of research previously done on the topic. These limitations were lessened through many avenues. Databases Web of Science and Medline Ultimate were utilized to discover appropriate articles related to the research question. The use of PRISMA guidelines allowed the original 76 articles to be narrowed down to 20 (Moher et al., 2009). The remaining 20 articles were reviewed by two researchers to ensure that all aligned appropriately with the topic.

This data could be used in the future for another study. However, there are limits to potential studies. Future implications for research include the rate at which policies are created and the variability and unpredictability of different surgeries. Policies must be created and implemented for a time to understand their effectiveness. This could take many years and may require future researchers to wait to conduct studies.

Conclusion

Artificial Intelligence will continue to advance and be prevalent in numerous areas of healthcare, including surgery. Policies exist that relate to AI use in surgery, but more need to be devised for the future. The findings provide guidelines for these policies that can assist in improving performance, perceptions, and outcomes. AI has the potential to provide many benefits to patients and healthcare staff, but standards and regulations must be in place to regulate its use.

Author's Contribution

Centola, S., conceptualized the research idea, and Lazar, B., worked with Centola, S., on the development and necessary revisions of the review. Lazar, B., supported Centola, S., in investigating the research topic and supervised both the review process and the interpretation of the findings. Centola, S., conducted the initial analysis, and Lazar, B., verified the analysis for accuracy. Centola, S. drafted the initial manuscript, and Lazar, B., reviewed it, provided feedback, and approved the final version as submitted.

Conflict of Interest Declaration

The authors declare no conflict of interest.

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