

## Review

# Artificial Intelligence Tools in Surgical Research: A Narrative Review of Current Applications and Ethical Challenges

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## Abstract

**Background/Objectives:** Artificial intelligence (AI) holds great potential to reshape the academic paradigm. They can process large volumes of information, assist in academic literature reviews, and augment the overall quality of scientific discourse. This narrative review examines the application of various AI tools in surgical research, its present capabilities, future directions, and potential challenges. **Methods:** A search was performed by two independent authors for relevant studies on PubMed, Cochrane Library, Web of Science, and EMBASE databases from January 1901 until March 2025. Studies were included if they were written in English and discussed the use of AI tools in surgical research. They were excluded if they were not in English and discussed the use of AI tools in medical research. **Results:** Forty-two articles were included in this review. The findings underscore a range of AI tools such as writing enhancers, LLMs, search engine optimizers, image interpreters and generators, content organization and search systems, and audio analysis tools, along with their influence on medical research. Despite the multitude of benefits presented by AI tools, risks such as data security, inherent biases, accuracy, and ethical dilemmas are of concern and warrant attention. **Conclusions:** AI could offer significant contributions to medical research in the form of superior data analysis, predictive abilities, personalized treatment strategies, enhanced diagnostic accuracy, amplified research, educational, and publication processes. However, to unlock the full potential of AI in surgical research, we must institute robust frameworks and ethical guidelines.

**Keywords:** AI; research; ethics; writing; large language model; data



Academic Editor: Andrew A. Gumbs

Received: 23 April 2025

Revised: 25 June 2025

Accepted: 7 July 2025

Published: 9 July 2025

**Citation:** Lim, B.; Seth, I.; Cevik, J.; Mu, X.; Sofiadellis, F.; Cuomo, R.; Rozen, W.M. Artificial Intelligence Tools in Surgical Research: A Narrative Review of Current Applications and Ethical Challenges. *Surgeries* **2025**, *6*, 55. <https://doi.org/10.3390/surgeries6030055>

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## 1. Introduction

Recent breakthroughs in artificial intelligence (AI), especially large language models (LLMs), have shown impressive potential in surgical research [1–6]. This includes synthesizing large swaths of data, understanding natural language, and recognizing patterns. Consequently, AI's role in enhancing the quality of scientific literature has become crucial due to the ever-growing body of articles and data, challenging researchers to thoroughly review the literature. AI holds substantial potential to aid surgeons and are instrumental in facilitating rapid understanding and application of the literature [7].

The integration of AI tools into academic workflows can expedite scientific communication. AI writing tools facilitate the articulation of complex ideas with increased clarity and precision, making them more comprehensible to a broader audience [8]. Additionally, English being the prevailing language of scientific communication can disadvantage those with limited proficiency, leading to underrepresentation of their ideas. AI tools can help bypass these linguistic barriers, aiding effective translation for researchers and promoting greater contribution.

This study synthesizes the current literature regarding the integration of AI in surgical research. By exploring and summarizing how these tools assist in research, we will provide insight into their future contributions and highlight potential challenges when integrating AI into surgical academia.

2. Materials and Methods

The primary aim is to conduct a narrative review of the application of artificial intelligence in surgery, focusing on identifying diverse AI tools that have advanced medical research. The secondary aim is to investigate the extent to which widely used AI tools enhance medical research by comparing findings from AI-intervention studies with those conducted solely by human researchers.

Two independent authors (BL and IS) searched for relevant studies on PubMed, Cochrane Library, Web of Science, and EMBASE from January 1901 until March 2025. The search terms included, but were not limited to, “Artificial Intelligence,” “AI,” “machine learning”, “large language models”, “LLMs”, “surgical research”, “scientific writing”, “grammar enhancement”, “content generation”, “data organization”, “image interpretation”, and “content search”. These terms were used in various combinations using Boolean operators “AND” and “OR”. Google and Bing search engines were also searched to uncover relevant articles, blogs, and reports discussing popular AI tools in surgical research. This ensured the incorporation of non-academic sources, which, while not always peer-reviewed, may offer practical insight into the use of AI tools in real-world settings. Articles were included if they were published in English, peer-reviewed, and focused on the use of artificial intelligence tools in surgical research, including preclinical, clinical, or outcome-based studies. Eligible studies applied AI methods such as machine learning (ML) or natural language processing to surgical datasets or research workflows. Exclusion criteria included non-English language, non-surgical focus, editorials, reviews without original data, and studies describing AI use solely for administrative purposes or clinical practice without a research objective. Commonly used AI tools in scientific research are depicted in Table 1, and compared to each other in Table 2.

Table 1. Commonly used artificial intelligence tools in scientific research.

| Primary Function(s)           | AI Tool       | Function                                                                                                     | Weblink                                                                                     |
|-------------------------------|---------------|--------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| Improving writing and grammar | Grammarly     | Improves grammar, spelling, and punctuation. Paid functions improve writing style and checks for plagiarism. | <a href="https://www.grammarly.com/">https://www.grammarly.com/</a> (accessed 2 March 2025) |
|                               | Quillbot      | Improves writing, grammar, assists with citations, and paraphrases text.                                     | <a href="https://quillbot.com/">https://quillbot.com/</a> (accessed 2 March 2025)           |
|                               | Trinka        | Online grammar checker that also improves syntax and spelling.                                               | <a href="https://www.trinka.ai/">https://www.trinka.ai/</a> (accessed 2 March 2025)         |
|                               | Jenni         | Assists and improves written language.                                                                       | <a href="https://jenni.ai/">https://jenni.ai/</a> (accessed 2 March 2025)                   |
|                               | Hemingway     | Improves the quality of writing.                                                                             | <a href="https://hemingwayapp.com/">https://hemingwayapp.com/</a> (accessed 2 March 2025)   |
|                               | ProWritingAid |                                                                                                              | <a href="https://prowritingaid.com/">https://prowritingaid.com/</a> (accessed 2 March 2025) |
|                               | Rytr.me       | Assists with writing.                                                                                        | <a href="https://rytr.me/">https://rytr.me/</a> (accessed 2 March 2025)                     |

Table 1. Cont.

| Primary Function(s)                    | AI Tool               | Function                                                                                                                                                                                      | Weblink                                                                                                                                                                                                             |
|----------------------------------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Assisting writing and generating ideas | ChatGPT (ChatGPT-3.5) | OpenAI's LLM utilizes supervised and reinforcement learning techniques to generate relatively accurate and fruitful outputs from user prompts.                                                | <a href="https://chat.openai.com/">https://chat.openai.com/</a>                                                                                                                                                     |
|                                        | BARD                  | Google's LLM which functions similarly to ChatGPT.                                                                                                                                            | <a href="https://bard.google.com/">https://bard.google.com/</a> (accessed 2 March 2025)                                                                                                                             |
|                                        | BERT                  | Google's family of language models introduced in 2018 can answer user's questions.                                                                                                            | <a href="https://github.com/google-research/bert">https://github.com/google-research/bert</a> (accessed 2 March 2025)                                                                                               |
|                                        | Bing AI               | Bing's LLM that utilized live internet data to provide outputs from user prompts.                                                                                                             | <a href="https://www.bing.com/">https://www.bing.com/</a> (accessed 2 March 2025)                                                                                                                                   |
|                                        | Claude                | A transformer-based LLM which enables it to generate human-like responses to user input.                                                                                                      | <a href="https://console.anthropic.com/login">https://console.anthropic.com/login</a> (accessed 2 March 2025)                                                                                                       |
|                                        | Med-PaLM 2            | Google's LLM dedicated to answering medical queries and assisting in medical research. As of this paper's publication date, it has not been made public yet.                                  | <a href="https://sites.research.google/med-palm/">https://sites.research.google/med-palm/</a> (accessed 2 March 2025)                                                                                               |
|                                        | Osteosynthesis        | Generates research articles based on keywords that user's input.                                                                                                                              | <a href="https://www.osteosynthesis.org/pubmed-search">https://www.osteosynthesis.org/pubmed-search</a> (accessed 2 March 2025)                                                                                     |
|                                        | AI-Writer             | Generates articles from a simple headline.                                                                                                                                                    | <a href="https://ai-writer.com/">https://ai-writer.com/</a> (accessed 2 March 2025)                                                                                                                                 |
|                                        | WriteSonic            | Assists with writing research articles with SEO-optimized keywords and meta-descriptions.                                                                                                     | <a href="https://writesonic.com/">https://writesonic.com/</a> (accessed 2 March 2025)                                                                                                                               |
| Search engine optimization             | Consensus             | Searches the literature and provides a list of relevant articles and their summaries based on user input.                                                                                     | <a href="https://consensus.app/">https://consensus.app/</a> (accessed 2 March 2025)                                                                                                                                 |
|                                        | Elicit                | Shows the user relevant systematic reviews and their summaries based on user input, enabling one to filter through based on intervention and side effects.                                    | <a href="https://elicit.org/">https://elicit.org/</a> (accessed 2 March 2025)                                                                                                                                       |
|                                        | SEO.ai                | Search engine optimization.                                                                                                                                                                   | <a href="https://seo.ai/">https://seo.ai/</a> (accessed 2 March 2025)                                                                                                                                               |
| Generate/interpret images              | Dall-E3               | Generates images based on user input.                                                                                                                                                         | <a href="https://openai.com/index/dall-e-3/">https://openai.com/index/dall-e-3/</a> (accessed 2 March 2025)                                                                                                         |
|                                        | Jasper AI             |                                                                                                                                                                                               | <a href="https://www.jasper.ai/">https://www.jasper.ai/</a> (accessed 2 March 2025)                                                                                                                                 |
|                                        | DermEngine            | Generates differentials based on the image of skin lesion uploaded.                                                                                                                           | <a href="https://www.dermengine.com/">https://www.dermengine.com/</a> (accessed 2 March 2025)                                                                                                                       |
|                                        | V7                    | Process images, videos, imaging files, and documents based on data uploaded by the user.                                                                                                      | <a href="https://www.v7labs.com">https://www.v7labs.com</a> (accessed 2 March 2025)                                                                                                                                 |
|                                        | Midjourney            | Generates images from natural language descriptions.                                                                                                                                          | <a href="https://www.midjourney.com">https://www.midjourney.com</a> (accessed 2 March 2025)                                                                                                                         |
|                                        | SkinVision            | Utilizes AI algorithms to diagnose skin moles and classify them as benign or malignant.                                                                                                       | <a href="https://www.skinvision.com/">https://www.skinvision.com/</a> (accessed 2 March 2025)                                                                                                                       |
|                                        | Lateral               | Automatically organize papers for use in future research.                                                                                                                                     | <a href="https://www.lateral.io/">https://www.lateral.io/</a> (accessed 2 March 2025)                                                                                                                               |
| Organization and Content Search        | Research Rabbit       | Tracks citations, creates bibliographies, and generates summaries of papers, allowing researchers to organize their research better.                                                          | <a href="https://www.researchrabbit.ai/">https://www.researchrabbit.ai/</a> (accessed 2 March 2025)                                                                                                                 |
|                                        | ReadCube Papers       | Helps manage bibliographies and references when writing papers.                                                                                                                               | <a href="https://www.papersapp.com/">https://www.papersapp.com/</a> (accessed 2 March 2025)                                                                                                                         |
|                                        | Connected Papers      | Creates graphs by analyzing thousands of papers from Semantic Scholar, then selects a few dozen that possess the strongest connection to the original paper.                                  | <a href="https://www.connectedpapers.com">https://www.connectedpapers.com</a> (accessed 2 March 2025)                                                                                                               |
|                                        | Scite                 | Able to automatically extract key information from relevant scientific articles such as research questions, methods, citations, and results.                                                  | <a href="https://scite.ai/">https://scite.ai/</a> (accessed 2 March 2025)                                                                                                                                           |
|                                        | Iris                  | Creates a research map by extracting keywords, contextual synonyms and hypernoms of the research question, then compares them to over 100 million OpenAccess papers to find relevant matches. | <a href="https://iris.ai/">https://iris.ai/</a> (accessed 2 March 2025)                                                                                                                                             |
|                                        | ChatPDF               | Analyzes PDF files and provides brief summaries of the contents.                                                                                                                              | <a href="https://www.chatpdf.com/">https://www.chatpdf.com/</a> (accessed 2 March 2025)                                                                                                                             |
|                                        | Scholarcy             | Generates summary flashcards from documents, links to references, and extract visuals like figures, tables and images.                                                                        | <a href="https://www.scholarcy.com/">https://www.scholarcy.com/</a> (accessed 2 March 2025)                                                                                                                         |
|                                        | Fireflies.ai          | Analyze, record, and transcribe voice inputs.                                                                                                                                                 | <a href="https://fireflies.ai/">https://fireflies.ai/</a> (accessed 2 March 2025)                                                                                                                                   |
| Audio analysis                         | PowerScribe360        | Understands user's speech and transcribes them onto textual documentation.                                                                                                                    | <a href="https://www.nuance.com/en-au/healthcare/medical-imaging/powerscribe-360-reporting.html">https://www.nuance.com/en-au/healthcare/medical-imaging/powerscribe-360-reporting.html</a> (accessed 2 March 2025) |
|                                        | audEERING             | Intended to diagnose pathologies like Parkinson's and COVID-19 by collecting audio data from patients.                                                                                        | <a href="https://www.audeering.com/technology/health-ai/">https://www.audeering.com/technology/health-ai/</a> (accessed 2 March 2025)                                                                               |

**Table 1.** *Cont.*

| Primary Function(s)           | AI Tool  | Function                                                                                                  | Weblink                                                                                                 |
|-------------------------------|----------|-----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| Publication and Collaboration | SciSpace | Aids researchers in publishing their works by facilitating the manuscript publication and peer reviewing. | <a href="https://scispace.com/">https://scispace.com/</a> (accessed 2 March 2025)                       |
|                               | PubMed   | A versatile search engine for biomedical literature.                                                      | <a href="https://pubmed.ncbi.nlm.nih.gov/">https://pubmed.ncbi.nlm.nih.gov/</a> (accessed 2 March 2025) |
|                               | Embase   | A database for biomedical and pharmacological literature aiding regulatory compliance for licensed drugs. | <a href="https://www.embase.com/">https://www.embase.com/</a> (accessed 2 March 2025)                   |
| Video generation              | Sora     | OpenAI's upcoming AI model specializes in generating videos from text inputs.                             | <a href="https://openai.com/index/sora/">https://openai.com/index/sora/</a> (accessed 2 March 2025)     |

**Table 2.** Comparative table assessing each tool's strengths and weaknesses.

| Tool Name                | Primary Function                 | Key Strengths                                                              | Known Limitations/Evidence Gaps                                                        |
|--------------------------|----------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Grammarly                | Writing improvement              | Robust grammar correction; tone suggestions; plagiarism checker.           | Limited domain-specific support; mostly non-medical; no formal academic validation.    |
| Quillbot                 | Paraphrasing, citations          | Useful for rephrasing and summarization; citation tools.                   | Paraphrasing may distort scientific meaning; no peer-reviewed assessment.              |
| Trinka                   | Grammar, spelling, and syntax    | Academic tone correction; includes technical vocabulary suggestions.       | Limited clinical/biomedical domain validation.                                         |
| ChatGPT                  | Content generation, Q&A          | Broad utility; conversational; custom prompts can generate lay summaries.  | Risk of hallucinations; no transparency on sources.                                    |
| Claude/Bard/Bing AI      | Similar to ChatGPT               | Integration with real-time search (Bing), enhanced safety (Claude).        | Lack of real-world performance evaluation in health-specific tasks.                    |
| Med-PaLM 2               | Medical Q&A                      | Specialized in healthcare; outperformed general LLMs in benchmarks.        | Not publicly available; independent peer-reviewed data lacking.                        |
| Elicit                   | Research Q&A with source filters | Extracts claims from papers; filters by population/intervention/outcome.   | Still experimental; no formal validation of claim extraction accuracy.                 |
| Scite.ai                 | Citation-based insights          | Differentiates supporting/contradicting citations; aids evidence tracking. | Performance varies across fields; citation sentiment can be ambiguous.                 |
| Connected Papers         | Citation mapping                 | Helps visualize related works in a citation graph.                         | Limited to Semantic Scholar database; not all connections are semantically meaningful. |
| DALL-E3/Midjourney       | Image generation from text       | High-quality image output; artistic or illustrative applications.          | Not clinically validated; inappropriate for medical images or diagnostic tasks.        |
| DermEngine/SkinVision    | Diagnostic imaging               | Lesion classification using image input; CE-marked in EU (SkinVision).     | Studies show variable accuracy <sup>4</sup> ; not meant to replace clinician judgment. |
| Scholarcy/ChatPDF        | PDF summarization                | Summarizes large texts; identifies key results and visuals.                | Can miss nuance; accuracy of automatic extraction unverified in the literature.        |
| Fireflies/PowerScribe360 | Audio transcription              | Accurate speech-to-text for meetings or reporting.                         | Limited biomedical validation; performance affected by accents and background noise.   |
| SciSpace                 | Publishing support               | Helps with formatting, peer review integration.                            | Little formal evaluation of its impact on publication quality or speed.                |
| Sora (OpenAI)            | Text-to-video generation         | Innovative multimedia generation from text prompts.                        | No clinical applications; use in science communication remains theoretical.            |

### 3. Results

#### 3.1. Writing Enhancement Tools

Writing enhancement technologies such as Trinka and Jenni, refine syntax and style, in addition to rectifying spelling mistakes [9]. They do so by proposing succinct structures for convoluted sentences, creating a more engaging and accessible article. They are especially beneficial for non-native English-speaking researchers by ameliorating various linguistic aspects of their work [10]. Osteosynthesis, a writing instrument by PubMed, is distinguished by its ability to generate in-depth literature reviews, systematic reviews, and exam questions tailored to specific user requests. If similar functionalities were incorporated into LLMs like ChatGPT, using databases such as Scopus and Cochrane, the process of conducting literature searches and generating systematic reviews could be remarkably expedited. Such a technological upgrade could catalyze faster breakthroughs and advancements. While these tools are beneficial, they should not supersede manual review due to potential limitations in discerning complex terminology or context-dependent phrasing.

### 3.2. Large Language Models

LLMs such as ChatGPT, Gemini, and the recently released Chinese-developed Deepseek AI, facilitate the process of article creation, assess medical records and images, predict potential complications, offer management recommendations, and promote research on various topics, thereby advancing surgical practices [1–6,11]. LLMs are increasingly integrated into surgery, reducing administrative burdens and enhancing research efficiency as surgeons can leverage LLMs for drafting emails, refining documents, and even generating letters of recommendation [12]. In surgical research, LLMs help in writing literature reviews, study design, and manuscript drafting, with studies showing AI-generated abstracts can closely resemble those from high-impact journals [13,14]. Despite concerns over academic integrity and AI-generated text policies, specialized biomedical LLMs such as BioBERT and Med7 demonstrate strong potential in medicine [15–17]. LLMs also facilitate hypothesis generation and experimental design in surgical research [18,19]. By analyzing large datasets and recognizing patterns across diverse sources, LLMs can propose novel research questions, optimize study methodologies, and even predict potential outcomes based on existing evidence [18–20]. With ongoing advancements in natural language processing, LLMs have the potential to enhance access to high-quality scientific insights, empowering both established researchers and early-career academics to contribute meaningfully to the evolving landscape of surgical innovation.

### 3.3. Search Engine Optimization Tools

Search Engine Optimization (SEO) tools such as Consensus and Elicit increase the visibility of articles by optimizing keywords, titles, click-through rates, dwell time, and meta descriptions, using AI to understand user behavior and suggest improvements. These suggestions refine content to better meet user expectations, increasing readership and accelerating the spread of medical knowledge. Additionally, the link analysis function of SEOs can potentially serve as a digital counterpart to citation analysis in academic literature [21]. They can track the digital footprint of research articles by identifying web pages, institutional repositories, and social media platforms that link to a particular study or academic profile. This broadens the perspective on research influence beyond traditional citation metrics, uncovering new dissemination pathways. Furthermore, AI-driven analytics can assess engagement metrics, such as reader interactions and geographic reach, providing insights into how surgical research is being consumed and discussed globally. While these tools offer valuable enhancements to research visibility and impact assessment, their findings should complement traditional academic metrics to ensure a comprehensive evaluation of research significance.

### 3.4. Image Interpretation and Generation Tools

AI image generators such as Dall-E3 and DermEngine analyze numerous image datasets of dermatological conditions [22]. They are also capable of monitoring changes in skin conditions, thereby facilitating more accurate, early detection and management strategies. JasperAI functions differently, capable of generating images based on textual input. Its potential could be instrumental to plastic surgeons and patients who are planning reconstructive or cosmetic surgery by generating digital approximations of the final surgical outcome based on patient data. V7, on the other hand, allows users to upload medical images and videos, subsequently employing ML algorithms to interpret the information. After which, it can identify and annotate a variety of anatomical structures in X-Ray and Computed Tomography (CT) scans. This amalgamation of image recognition technology and medicine represents a future characterized by improved patient outcomes, optimized healthcare workflows, and preventative care becoming more effective and widely accessible.

### 3.5. Organization and Content Search

Organization tools aim to streamline article searches by capturing relevant articles and helping researchers better organize their work. Lateral allows users to quickly search keywords, organize findings on a dashboard, and navigate directly to relevant sections, speeding up searches. ResearchRabbit can track citations, summarize papers, and illustrate connections on a tree graph, enhancing understanding of research relationships. ConnectedPapers uses Semantic Scholar to find and distill thousands of related articles into the most relevant ones. Scite and Iris process keywords against databases to extract relevant articles, with Iris also generating a research map to visually organize articles into topical clusters [23]. Perplexity, founded in 2022 by Aravind Srinivas—a former researcher at OpenAI and DeepMind—is a conversational search engine that combines AI chatbot capabilities with real-time web search, providing users with natural language responses accompanied by cited sources. These tools help users find the most relevant scholarly works, enriching their research.

### 3.6. Audio Analysis

AI tools present a transformative opportunity by harnessing ML algorithms to interpret audio data. Scribing tools like Fireflies and PowerScribe360 can understand human speech across a range of accents and transcribe them into text, which can streamline note-taking and facilitate team communication and rigorous data analysis. These tools ensure the preservation of critical dialog from medical interactions, maintaining accuracy in documentation which can be crucial for data collection. The resulting transcripts improve accessibility for those with hearing impairments or for whom English is not a primary language. More importantly, these tools support regulatory and ethical compliance through rigorous record-keeping in clinical research [24]. audeERING, another audio AI tool, innovatively diagnoses diseases like Parkinson's and COVID-19 by analyzing patient audio data. However, automated services may not achieve complete precision, especially with intricate medical jargon or in instances of pronounced accents or ambient noise [25]. Confidentiality and data security are also major concerns, especially with sensitive medical data and third-party cloud services. Researchers must ensure tools comply with regulations like the Australian Privacy Principles or the European Union's General Data Protection Regulation to safeguard participant confidentiality and data security.

### 3.7. Publication and Collaborative AI Tools

Publication and collaborative AI tools such as SciSpace provide a comprehensive platform to collaborate with other researchers, promote the dissemination of one's work, track the impact of published papers, and comment on other scholarly articles. They also provide an updated list of journals actively accepting submissions and help reformat the researcher's article according to their guidelines. This can reduce the time spent on formatting and journal selection, thereby streamlining the research process. AI-driven search platforms excel in systematically filtering through diverse scientific literature sources, ensuring comprehensive coverage and efficient data retrieval. AI tools and algorithms that can understand the contextual use of words significantly enhance the accuracy and relevance of search results [26]. Essential features, such as author name, query refinement, and automatic article indexing aid in generating concise summaries of pertinent studies. Notable examples of databases using such features include *PubMed* and *Embase* [27]. However, over-reliance on AI could result in the attrition of crucial research skills, underlining the importance of these tools as supplements to, rather than substitutes for, human expertise [28]. Data security and privacy concerns can also arise due to the extensive collection and storage of sensitive data.

### 3.8. Ontologies

Ontology-based AIs use structured representations of knowledge and relationships, provide a standardized vocabulary and capture relationships between concepts, allowing heterogeneous data to be unified [29,30]. This facilitates automated reasoning, enabling researchers to gain new insights from existing structured data. Ontologies also promote knowledge reuse and sharing across systems, reducing redundant effort [31]. They help organize guidelines, research findings, and terminology to support clinical decision-making [32]. They also allow linkage of diverse biomedical data to generate new hypotheses. Ontologies augment scientific research by making knowledge computable so that information systems can be interconnected and advanced analytics can be performed to accelerate discoveries, positioning them as a core enabling technology for augmenting scientific research across many domains [33].

### 3.9. Video Generation

The Sora model, a new video generator AI created by OpenAI, utilizes transformer architectures and unified visual data representations to interpret text instructions and generate detailed, accurate visual content [34]. It could allow researchers to create sophisticated visual representations of data and concepts, potentially revolutionizing how studies are communicated and understood. By facilitating the visualization of complex medical scenarios and research findings, Sora has the potential to enhance data presentation, communication, and explain research ideas more easily. Despite challenges such as potential inaccuracies due to the model's text interpretation limitations, Sora's ability to produce high-quality visual outputs from textual prompts offers promising avenues for advancing medical research capabilities [34]. Further exploration is needed to fully explore and optimize Sora's impact in this critical domain.

## 4. Discussion

AI tools have augmented medical research, driving efficiency, accuracy, and innovation [35]. They can process vast amounts of data more efficiently than humans, identify patterns and predict outcomes that exceed human capabilities, accelerating data analysis and revealing hidden insights that are otherwise laborious to uncover [36,37]. AI tools can conduct literature reviews, saving researchers a significant amount of time by sieving through thousands of relevant studies [38]. Audio analysis is also progressively influenced by AI. Transcribing tools like *FireFly* enable radiologists to produce radiographic reports faster, and *audEERING* spearheads innovative approaches to diagnosing pathologies based on auditory data, potentially advancing scientific research, fostering innovation, and enhancing communication.

LLMs such as ChatGPT have demonstrated potential in improving writing efficiency, with studies showing that AI-assisted abstracts and lay summaries are often rated as comparable in quality to those written by human researchers, particularly for first drafts or non-native English speakers [39–41]. In comparative studies, tools like Elicit and Scite have outperformed traditional search engines in generating relevant literature suggestions, aiding hypothesis formation, and streamlining systematic review protocols [42,43]. While these cases reflect growing interest and early success, robust empirical studies using standardized outcome measures remain essential to formally evaluate long-term efficacy, reproducibility, and integration into surgical research practice.

However, AI tools face potential barriers to integration such as patient privacy, data security, accuracy, reliability, and potential biases in training data. Addressing these is crucial for their ethical and effective use as many AI tools rely on ML and Deep Learning, requiring access to extensive datasets. However, institutions hesitate to share confidential

patient records due to security, privacy concerns, and insufficient patient consent [44–46], limiting accessibility for ML and DL training. Certain AI tools such as *ChatGPT* lack access to the internet limiting them to a fixed database for responses and this can result in less relevant answers, necessitating database updates [46]. Therefore, a critical need exists for innovative solutions that uphold data privacy without inhibiting the progression of AI [47].

Another concern involves inadequate data from marginalized or misrepresented populations for training AI tools using ML and DL, which can lead to inaccurate health predictions and epidemiological trends [48–55]. For example, tools trained primarily on data from one geographic or ethnic group may not accurately reflect disease patterns or health conditions in other populations. These disparities can inadvertently bias research findings and medical hypotheses. Without careful dataset selection, AI systems could reinforce historical biases, similar to those in 1900 San Francisco's Chinatown or apartheid-era South Africa [56]. The “Black Box” problem, where AI algorithms are opaque, can worsen this issue [57–59]. Using diverse, generalizable training datasets and developing stereotype-resistant neural networks could alleviate this issue, but their effectiveness is still unproven [60].

Plagiarism remains a significant concern as LLMs may reproduce content from training data without proper citation [61]. This is compounded by difficulties in tracing the origins of AI-generated content. It underscores the need for robust strategies to monitor and mitigate plagiarism risks in scientific writing and research when using AI tools. Additionally, inaccuracies such as generating non-existent references, termed “AI Hallucination”, can compromise the validity of outputs [61]. For instance, ChatGPT-4, PaLM 2, and Llama 2 generated blogs with false health claims, such as sunscreen causing skin cancer and the alkaline diet curing cancer [62]. Consequently, when AI is used to summarize evidence, they are still prone to errors. To address content suspected of being inaccurate, consultation with experts or their work is often necessary [63]. If an AI-generated hallucination is included in a published article, and subsequent articles continue to cite that original source, it can create a “snowball” effect that is difficult to correct. This therefore raises the question of who or what sources should be consulted if the experts and authoritative resources were educated using the same AI algorithms.

Image generation is becoming a popular topic for medical applications. *Sora*, an upcoming video generation software by OpenAI, exemplifies the immense potential of such AI tools in augmenting clinical practice and academic research [34]. However, many barriers remain, particularly concerning the potential for misinformation. AI-generated videos can be exploited by malicious actors, confusing patients, undermining trust in medical professionals, and leading to harmful treatment decisions. Such misinformation can compromise medical research by introducing false data and misleading results [56]. Despite *OpenAI's* efforts to mitigate misuse by employing a text classifier to check text prompts and developing tools to detect AI-generated videos, such as the inclusion of C2PA metadata, these measures have limitations. Metadata can be easily removed, and most social media platforms automatically strip metadata, rendering these protections ineffective against misinformation [64]. Therefore, combating potential health misinformation from *Sora*-generated videos will require a multifaceted approach, including robust verification mechanisms, government regulation, and patient education. Waisberg et al.'s letter to the editor underscores this risk by highlighting that during the COVID-19 pandemic, misleading or inaccurate information was found in nearly one in four of the most popular COVID-19 YouTube videos [64].

Despite their sophistication, AI tools may have difficulty distinguishing relevant data from irrelevant data. To ensure data validity, information generated by models should be subjected to rigorous validation by experienced surgeons and researchers. Ethical consider-

ations are crucial when using AI tools like ChatGPT for research content creation, necessitating disclosure of using AI during submission. Furthermore, the validity of information from AI tools can be outdated, requiring users to verify ChatGPT's recommendations against current and reliable guidelines for up-to-date and relevant advice.

#### 4.1. Limitations

This study has several limitations: a lack of systematic literature search methodology may introduce selection bias, and the absence of quality assessment for included studies could lead to overgeneralization from a small sample size. Additionally, there is no quantitative evaluation of AI tools using metrics like “effectiveness” and “efficacy” in data analysis. These terms are primarily conceptualized here in terms of speed and precision, but broader factors like purpose, rigor, reproducibility, and impact were not rigorously assessed, potentially hindering replication.

Given that this review examined AI tools rather than primary research studies, formal quality appraisal frameworks were not applicable. Nonetheless, we sought to provide a structured assessment by outlining each tool's function and accessibility (Table 1), thereby offering insight into their potential utility and limitations in surgical research. Future studies should aim to quantitatively evaluate these tools using standardized metrics to more rigorously determine their impact on research quality and outcomes.

Despite these limitations, this study lays a foundational understanding of AI tools in medical research, paving the way for future comprehensive reviews.

#### 4.2. The Future of AI in Medical Research

Despite their drawbacks, AI is poised to advance surgical research. They can analyze vast datasets using ML and DL to detect trends and patterns, thereby facilitating accurate predictions and revealing new disease insights. This capability extends to biopharmaceuticals where AI models utilize convolutional neural networks to predict drug binding affinity, accelerating more effective research into medications [65–68]. Additionally, AI can develop personalized treatments by analyzing patients' medical history and relevant data, enhancing treatment success, and minimizing complications [65–68]. Their increasing proficiency in utilizing visual and auditory data positions them as ideal supplementary tools for clinicians, researchers, and patients alike.

Ethical concerns in AI use are essential. Frameworks like the Development Plan for the New Generation of Artificial Intelligence should be created and applied for oversight [69]. New regulations are crucial for ensuring that AI systems are technically robust, private, and safe, with harmonized safeguards. Human oversight is still needed to maintain meaningful involvement and prevent bias, while transparency is vital for trust and reproducibility [70,71]. Diverse datasets are necessary to avoid discrimination, and accountability mechanisms must be established [72]. We must also consider the practical and ethical risks of using limited AI tools to avoid generating discriminatory or harmful outputs [73,74]. Rashidian et al. found that AI holds significant promise for enhancing outcomes in Hepato-Pancreato-Biliary (HPB) surgery, yet ethical considerations and the technology's reliability remain underexplored, as highlighted by an E-AHPBA survey showing high overall agreement on regulatory needs but mixed views on addressing bias and promoting equity [75]. These findings suggest that while HPB surgeons recognize the importance of oversight, greater clarity and consensus are needed around AI's role in ensuring fairness in surgical care [75].

The integration of AI into surgery offers tremendous potential but raises complex medico-legal and ethical challenges. Treger et al. postulates that surgeons must continue to meet evolving standards of care, carefully document AI involvement in clinical decisions, and maintain transparency regarding their rationale for accepting or rejecting AI advice [76].

Similarly, developers must ensure the safety and reliability of their tools, including the communication of uncertainty in AI-generated recommendations. Without clear standards, there is a risk of malpractice claims and erosion of trust in AI applications. Early legislative efforts in the United States, such as the proposed but unsuccessful Healthy Technology Act of 2023 and President Biden's Executive Order #14110, reflect growing federal attention to AI governance, emphasizing privacy, equity, and human oversight [77]. Recent guidance from the Centers for Medicare and Medicaid Services mandates human review in key clinical decisions, signaling an increasingly cautious regulatory approach to AI in healthcare [78].

Capelli et al. also discussed the growing role of AI and AI-powered robotics in surgery, emphasizing the need for trust and rigorous assessment to ensure patient safety [79]. They highlight the challenge of data security and privacy, especially with the increasing digitalization of healthcare data and the complexities of AI's access to vast datasets. They stress the importance of minimizing bias in AI systems, which can unintentionally perpetuate societal inequalities [80,81]. The authors also address the transparency issues in AI algorithms, particularly the "black box" effect, and the need for clear explanations of AI-driven decisions [82,83]. Lastly, they suggest that AI can help address disparities in surgical training and healthcare accessibility, particularly in under-resourced regions.

Advancements in AI are transforming medical writing by improving natural language processing accuracy, enabling real-time data integration, and increasing transparency through explainable AI [84]. While AI enhances efficiency and reduces costs in data processing, thorough economic evaluations are necessary to determine its broader impact. With AI managing routine tasks, medical writers will focus more on strategic decision-making, ethical considerations, and advanced editing, making it essential to maintain a balance through training and well-defined intervention strategies [85]. Key best practices involve integrating AI within ethical frameworks, utilizing it for literature synthesis, and fostering collaboration between human expertise and AI capabilities. AI tools in surgical research are increasingly supporting robotic surgery and real-time intraoperative decision-making by integrating multimodal data analysis [86,87]. During surgery, AI could analyze real-time patient data, such as vital signs and imaging, to provide immediate feedback and suggest optimal approaches by conducting immediate literature searches on the latest evidence. Pre-operatively, AI can scan the latest literature and clinical guidelines to recommend the most effective treatment strategies, ensuring that the surgical team is equipped with the best possible approach before entering the operating room. This continuous integration of real-time data and evidence enhances decision-making and overall surgical outcomes.

By streamlining literature reviews and draft creation, AI supports medical writers in producing high-quality, patient-focused content while ensuring that critical analysis and ethical judgment remain firmly in human hands, ultimately strengthening healthcare communication and research [85].

## 5. Conclusions

AI tools are transforming surgical academia by enhancing efficiency, accuracy, and innovation in medical research, with future advancements expected in natural language processing, predictive modeling, and multimodal data analysis. These tools hold promise for automating literature reviews, analyzing large-scale clinical datasets, generating hypothesis-driven insights, and streamlining manuscript preparation. However, addressing challenges like data privacy, bias, and ethical concerns is crucial, requiring rigorous frameworks to ensure responsible AI integration while preserving human oversight in scientific discovery and healthcare communication.

**Author Contributions:** Conceptualization, B.L., I.S., F.S., R.C., and W.M.R.; methodology, B.L., I.S., F.S., R.C., and W.M.R.; formal analysis, B.L., I.S., and J.C.; investigation, B.L. and I.S.; data curation, B.L. and I.S.; writing—original draft preparation, B.L., I.S., J.C., and X.M.; writing—review and editing, B.L., I.S., J.C., X.M., F.S., R.C., and W.M.R.; supervision, F.S., R.C. and W.M.R.; project administration, B.L. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** All available data is present in this manuscript.

**Conflicts of Interest:** The authors declare no conflicts of interest.

## Abbreviations

|          |                            |
|----------|----------------------------|
| AI       | Artificial Intelligence    |
| COVID-19 | Coronavirus Disease 2019   |
| LLM      | Large language model       |
| SEO      | Search Engine Optimization |

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