

Ethical Considerations for Generative Artificial Intelligence in Plastic Surgery

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Summary: The integration of artificial intelligence (AI) into surgical care is rapidly transforming healthcare by enhancing efficiency, clinical decision-making, and patient outcomes. Generative AI (genAI), a subfield using large language models such as ChatGPT, Bard, and Midjourney, holds significant promise in automating tasks such as surgical planning and discharge summaries. However, it raises concerns about misinformation, data breaches, biases, and misuse. No genAI technology has yet received Food and Drug Administration approval for surgical use, emphasizing the need for thorough regulatory evaluation. This article proposed 5 ethical principles, adapted from World Health Organization recommendations, to guide the adoption and governance of genAI in plastic surgery. These principles include ensuring data transparency, maintaining patient autonomy, prioritizing safety and accountability, promoting equity, and investing in sustainability. Each principle is illustrated with a hypothetical case to highlight potential ethical breaches and the importance of rigorous testing, clear communication, and continuous monitoring. By adhering to these guidelines, stakeholders can ensure that genAI serves to enhance patient care and uphold the highest standards of ethical practice in surgical settings. (*Plast Reconstr Surg Glob Open* 2025;13:e6825; doi: [10.1097/GOX.00000000000006825](https://doi.org/10.1097/GOX.00000000000006825); Published online 2 June 2025.)

INTRODUCTION

Artificial intelligence (AI) is quickly redefining surgical care by using technologies that complement human intelligence to improve healthcare efficiency; clinical decision-making; and, most importantly, patient outcomes. Generative AI (genAI) is a subfield of AI that uses large language models (LLMs) to generate realistic images, text, and videos that can ultimately assist in automating writing tasks such as discharge summaries or surgical planning.^{1,2} The potential applications of LLMs such as ChatGPT, Bard, Llama, Gemini, and Midjourney in the field of surgery are significant, as they possess the ability to efficiently handle complex concepts and provide multimodal responses to a wide array of inquiries and prompts.^{3,4} Their initial appeal is also met with legitimate concerns regarding the propagation of misinformation, clinical efficacy, patient data breaches, racial biases originating from

training data, and the potential for misuse.² To date, no genAI technology has undergone review and approval by the US Food and Drug Administration (FDA) for any surgical domain, highlighting the need for thorough regulatory evaluation in healthcare. In this article, we propose 5 ethical principles, adapted from World Health Organization (WHO) recommendations for AI integration into healthcare, to guide effective genAI adoption and governance in plastic surgery^{5,6} (Table 1). The WHO guidelines provide ethical principles to ensure the safe, effective, and equitable integration of AI into healthcare, addressing challenges such as bias, privacy, transparency, and accountability.^{5,6} Although these guidelines address ethical challenges such as bias, privacy, and misuse in AI broadly, they do not account for the unique implications of genAI, such as direct messaging with patients using chatbots or undermining patient autonomy during patient consultations.

Our framework builds on the WHO's principles by creating specific guidelines tailored to plastic surgery, focusing on patient trust, safety, and informed consent. We provide a specialized code of conduct and use hypothetical scenarios to demonstrate how these adapted principles can guide ethical genAI adoption in clinical practice, offering a novel approach that aligns with, but extends beyond, existing WHO recommendations. We begin discussions of each ethical tenet by presenting a hypothetical

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case and outlining a code of conduct that plastic surgeons should follow when integrating these technologies into their practices.

Ensuring Data Transparency

Case 1

An aesthetic surgery clinic deployed a genAI tool to predict postoperative outcomes for rhinoplasty, intended to assist surgeons in clinical decision-making and to guide patient expectations.⁷⁻¹¹ The AI tool generated visual simulations based on past procedures but lacked transparency about data sources, including patient demographics, surgical techniques, and outcomes. It provided no documentation on data provenance, and routine audits or validation were absent. Ethical concerns arose when AI predictions differed significantly from actual results, leading to patient dissatisfaction despite no clinical errors. The lack of transparency and systematic review hindered model improvement, and procedural risks were discussed without addressing the tool's accuracy or reliability.

Many early genAI applications in healthcare exist in an ostensible black box, with opaque decisions and unintelligible logic. Discourse in clinical literature has called for explainable AI, where augmented clinical decision-making can be justified. Moreover, the EU General Data Protection Regulation has called for all technology companies, beyond healthcare, to be mindful of their practices and provide “meaningful information about the logic behind automated decisions using their data.”¹²⁻¹⁴

The desire for explainability stems from a drive to ensure physician-patient trust and safety and inform surgeons of the steps behind AI decision-making.¹³ This explainability generally takes 2 forms: inherent explainability and post hoc explainability.¹³ Inherent explainability pertains to models with clear input-output data where relationships between independent and dependent variables can be quantified.¹⁵⁻¹⁸ For example, the relationship between the independent and dependent variables can be teased out in a predictive linear regression that estimates the risk of postsurgical complications following breast reconstruction based on patient comorbidities.^{19,20}

However, complex AI models capable of image or text analysis and production lack simple input-output relationships. In such cases, post hoc explainability is used, aiming to dissect the model's decision-making process using a confluence of decision variables.^{13,18,21} In the scenario of an algorithm that predicts the postsurgical appearance following rhinoplasty, researchers can try to work backward to reverse-engineer the generative model's output decision (Fig. 1).

The additional goal of explainability is to detect biases; however, given that many sociological and demographic biases are encoded in AI training data that have been collected years prior, localized justifications regarding model decision-making will do little to mitigate global concerns about the model's generalizability.^{13,22-27} The integration of explainable AI should be complemented with commitments to collect more robust and diverse training data so that surgeons seeking genAI support are adequately informed, and disparities in plastic surgery care are not

Takeaways

Question: How can generative AI (genAI) be ethically integrated into plastic surgery to enhance patient care while minimizing risks such as misinformation, data breaches, biases, and misuse?

Findings: This study proposed 5 ethical principles adapted from World Health Organization guidelines—data transparency, patient autonomy, safety and accountability, equity, and sustainability—to guide the use of genAI in plastic surgery. Using hypothetical cases, it illustrates potential ethical challenges and offers a code of conduct for clinical practice.

Meaning: Adhering to these ethical principles ensures that genAI in plastic surgery improves patient outcomes while maintaining trust, safety, and equity in healthcare.

perpetuated.²⁸⁻³² Moreover, given the inherent complexity of many genAI technologies, there exists a trade-off between full explainability and accuracy: in achieving full explainability, researchers could inadvertently oversimplify the model, in turn, resulting in a loss of accuracy as the model's capabilities are compromised in favor of transparency.¹⁵ Explainability is not always a prerequisite for efficacy, as evidenced by the case of acetaminophen: despite its extensive use, the precise mechanisms underlying its therapeutic effects remain unclear.³³

Although explainability in healthcare AI is limited, all genAI models should undergo rigorous, plastic surgery-specific testing before clinical use. This should follow established guidelines, include simulated surgical scenarios, and use standard evaluation metrics typically assessed for other medical devices. Validation must assess the AI's assumptions and health insurance portability and accountability act compliance. Independent review boards with multidisciplinary experts should audit these models for validity.

Maintaining Patient Autonomy

Case 2

During a preoperative breast reconstruction consultation, a patient receives an AI-assisted surgical recommendation without clear disclosure of the AI's role or non-AI alternatives. The tool operates discreetly, refining its predictions with patient data. This opacity risks influencing surgical decisions misaligned with patient preferences. When patients later learn of the AI's involvement and data use without explicit consent, trust and privacy concerns arise. This case underscores the need for transparency to ensure that AI supports clinical judgment while upholding patient autonomy and informed consent.

Informed consent and autonomy serve as central tenets of medical ethics.^{34,35} These principles require healthcare providers to collect informed, educated, and voluntary consent from patients before any surgical, research-related, or clinical procedure.³⁶⁻³⁹ Integrating genAI into surgical consultations must prioritize patient autonomy, keeping human decision-making central. Surgeons should ensure informed consent and prevent overreliance on AI. Rather

Table 1. Ethical Principles and Guidance for GenAI Adoption in Plastic Surgery

Ethical Clause	Definition	Implementation Strategies	Regulatory Challenges	Case Examples
Data transparency and intelligibility	Ensure that the data used by AI are clear and accessible to users with clarity in the model's decision-making process	Clear labeling of clinical data sources with a commitment to regular audits and reports on performance and data integrity is essential. Independent expert review is used to validate existing algorithms with systems that allow for user feedback on AI decisions to improve model transparency	Compliance with data protection regulations and ensuring patient data anonymity	An algorithm is developed to predict postoperative rhinoplasty simulations. Data to train the model include pre- and postoperative images of patients' faces. These data are clearly labeled, and an independent plastic surgeon regularly audits the AI to validate its precision. Before using the AI, surgeons explain to patients how the system processes images and makes predictions. Patients are also allowed to provide feedback on the AI's suggestions. All personal data are anonymized and managed in compliance with privacy regulations to ensure patient confidentiality
Patient autonomy	Maintaining the patient's right to informed decision-making in care involving AI	Implement AI tools that supplement rather than replace surgeon consultations, and allow patients to opt in, rather than opt out, of AI-guided support to garner patient trust	Upholding informed consent regulations.	During a preoperative consultation, a patient is offered the use of a surgical planning AI tool, with the option to accept or refuse. The surgeon then presents an AI-guided recommendation for a reconstructive procedure, clearly outlining alternative options and the patient's right to decline
Safety and efficacy	Prioritizing the safety and effectiveness of AI tools for surgical application	Rigorous preimplementation testing fulfilling regulatory requirements, coupled with regular updates and audits of AI systems	Adherence to medical device and technology certification standards	A breast augmentation clinic uses an AI system to predict surgical outcomes. This AI undergoes extensive preimplementation testing, receives regulatory approval, and is regularly audited for accuracy and safety. It adheres to medical device/technology certification standards. Surgeons use predictions to discuss potential outcomes with patients, enhancing the consultation process
Accountability and responsibility	Assigning clear accountability for AI-driven decisions in clinical settings	Define legal responsibilities in the use of AI and develop protocols for error reporting and resolution	Legal implications of AI errors	An AI system that assists in evaluating candidates for liposuction mistakenly identifies a patient as an ideal candidate despite contraindications. The clinic has clear protocols in place: the error is immediately reported, the AI's decision is reviewed by a team of surgeons, and the patient is informed and offered alternative assessments. Legal responsibilities are predefined, ensuring the clinic remains compliant, and both the clinic and technology company are accountable for the AI's actions
Equity and inclusivity	Ensuring AI tools serve all demographic groups without reinforcing existing healthcare disparities	Design AI to handle diverse datasets reflecting different demographics while monitoring AI outputs for bias	Challenges in creating unbiased AI systems	A nonoperative tool recommends postoperative medications for patients who have undergone reconstructive surgery. Each recommendation is followed by prior authorization support from a large dataset of diverse health insurance plans to ensure coverage. The tool submits adequate medical justifications directly to insurers, streamlining approvals and ensuring patients receive necessary care promptly and equitably
Sustainability and adaptability	Focusing on the tool's long-term viability and flexibility to adapt to evolving medical knowledge	Regular updates to incorporate the latest surgical research with scalable solutions that are adaptable to various procedures	Managing continuous learning of AI systems without compromising current clinical standards	Preoperative breast reconstruction tools integrate the latest clinical research, data from clinical trials, and real-world evidence into their recommendations. Frequent updates ensure the system remains current with advancements in surgical techniques. Surgeons contribute to a feedback loop allowing the tool to refine its recommendations based on surgical outcomes maintaining high clinical standards and adaptability

than classifying AI as simply autonomous or nonautonomous, a graded system would better assess the varying risks of automation in healthcare.⁴⁰

Autonomous AI-based tools are capable of analyzing imaging data to provide diagnostic decisions,⁴¹ such as detecting large vessel occlusions in stroke patients and alerting specialists without the need for human radiologist interpretation.^{42,43} In ophthalmology, an autonomous AI system diagnoses diabetic retinopathy directly from

retinal images without requiring skilled operators.⁴⁴ Similarly, AI-powered systems for continuous glucose monitoring can independently adjust insulin delivery in real time based on glucose trends, minimizing the need for patient intervention and reducing the risk of hypo- or hyperglycemia.⁴⁵

Popular LLMs such as ChatGPT and Bard are nonautonomous agents that are prompted to serve as assistants for surgeons. Preliminary reports show that ChatGPT is

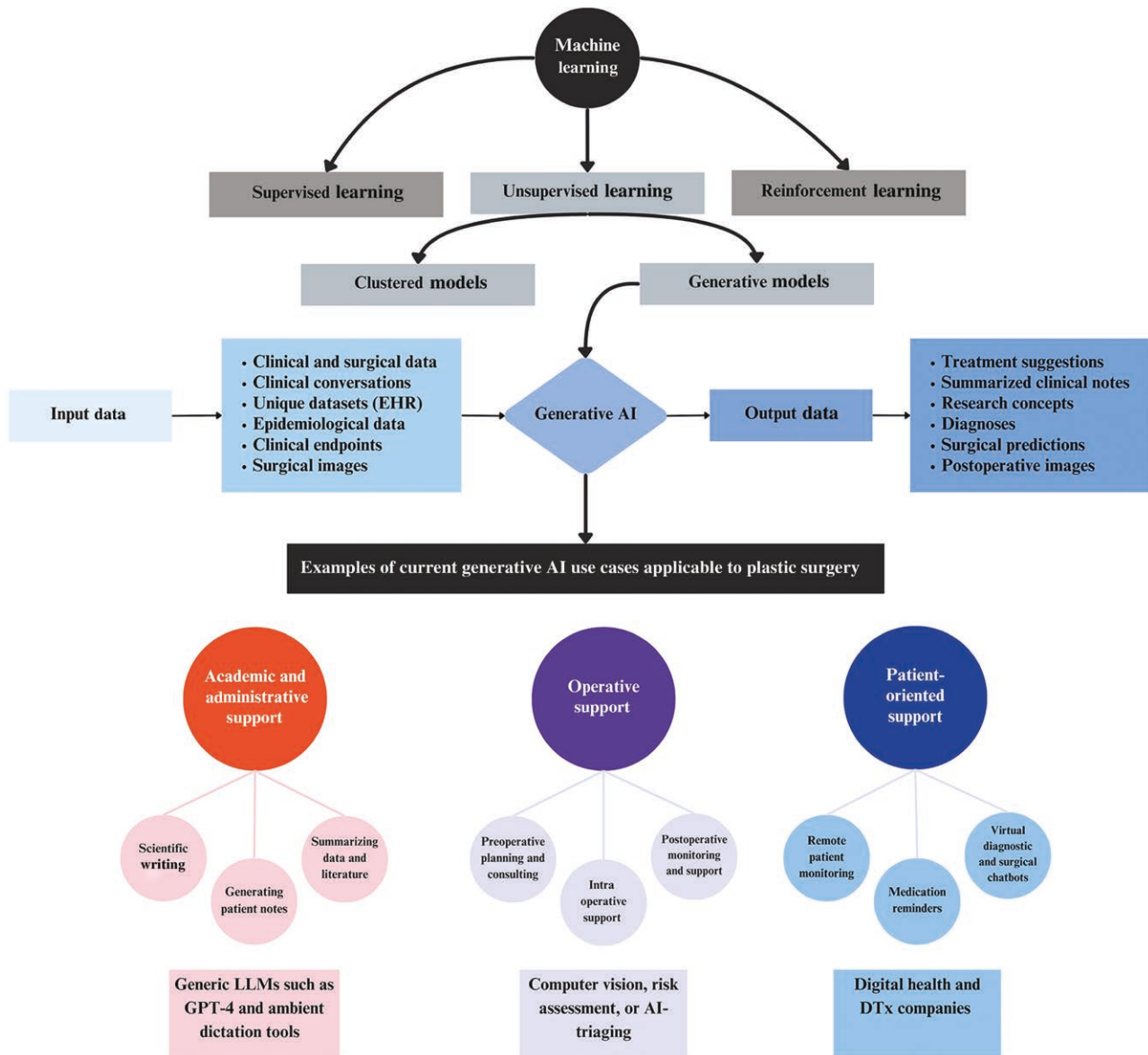


Fig. 1. Landscape of genAI in plastic surgery. This figure illustrates the integration of genAI within plastic surgery, from input data (clinical and surgical data, EHR, clinical endpoints) through to output data (treatment suggestions, diagnoses, postoperative images). Machine learning approaches (supervised, unsupervised, and reinforcement) lead to clustered and generative models, forming the core of genAI. The diagram highlights 3 application areas: academic and administrative support (scientific writing and generating patient notes with LLMs such as GPT-4), operative support (preoperative planning, intraoperative support with computer vision, and AI-triaging), and patient-oriented support (remote monitoring and virtual chatbots via digital health companies). DTx, digital therapeutics.

promising in oncology⁴⁶ and head and neck surgical decision-making,⁴⁷ and is equivalent to first-year residents on the plastic surgery in-service exam⁴⁸ (Table 2). ChatGPT supported multidisciplinary tumor boards by recommending neoadjuvant therapy, aligning with treatment guidelines, when the tumor board had opted for surgery alone.⁴⁶ Despite their initial appeal, ChatGPT has also been shown to produce inconsistent surgical advice⁵⁴ and a diagnostic error rate of 83% in some pediatric cases.⁵⁵ Especially in the nascent stages of genAI integration in surgery, where the reliability of these developing technologies is unclear, transparent communication

about AI's involvement is crucial for maintaining trust and adapting to the changing needs of both surgeons and patients.^{56,57} Decisions made by genAI systems should be reversible and designed to assist, not replace, surgeons.⁵⁸ Surgeons should disclose the use of genAI for surgical decision-making or any other purpose to their patients and in medical notes as they would for any other clinical intervention.

Unlike traditional healthcare technologies, genAI evolves from new data, which can lead to the reuse of patient information in ways not originally consented to or expected.⁵⁹ This evolving nature of AI complicates how

Table 2. Use Cases of GenAI and LLMs for Plastic and Aesthetic Surgeons and Patients

	Use Case	Primary Users	Availability of Technology*	Examples of Potential Applications in Plastic Surgery
Academic and administrative support	Research support	Academic plastic surgeons, researchers, and medical students	5	Automating data collection for systematic reviews and meta-analyses, assisting in identifying research gaps in the literature and writing academic reports, and summarizing findings from published articles
	Generating, summarizing, translating, and interpreting of discharge notes	Plastic surgeons, physician assistants, nurses, and patients	3	Efficiently condense postoperative care instructions, highlighting critical elements such as wound management and activity restrictions, and create standardized operative reports and patient progress notes to ensure comprehensive documentation in line with institution-specific protocols. Additionally, instantly translate postoperative instructions into multiple languages or plain language to improve patient comprehension and adherence across diverse populations
	Prior authorization support	Plastic surgeons, physician assistants, and nurses	2	Streamlines the compilation and submission of detailed justifications for procedures or medications to insurance companies, enhancing preauthorization efficiency
	Advertising and marketing	Surgeon-entrepreneurs, aesthetic surgery clinic owners, and investors	5	Leverage AI tools such as Midjourney and DALL-E to create high-quality, realistic images for marketing campaigns. These tools can showcase surgical outcomes, clinic environments, and patient testimonials, enhancing online presence and attracting clients. This approach streamlines content creation and ensures marketing materials are innovative, engaging, and visually appealing ^{49,50}
Operative support	Generation of predictive images of postoperative results	Plastic surgeons and patients	1	Generating photorealistic renderings of predicted postoperative results in cosmetic procedures such as rhinoplasty or reconstructive procedures such as breast reconstruction, which can be presented using AR/VR ^{51,52}
	Visual assessment of postoperative aesthetic outcomes	Plastic surgeons and patients	1	Objective assessment of postsurgical outcomes using predefined aesthetic criteria such as facial symmetry on an informed image-to-text model
	Clinical decision support and diagnostic assistance	Plastic surgeons, physician assistants, and nurses	2	Integration with institution-specific databases including longitudinal data on procedural success and complications to suggest procedural strategies
	Triage of postoperative complications and emergencies	Plastic surgeons, physician assistants, and nurses	1	Monitor signs of postoperative complications, such as sepsis, prioritizing cases for rapid response to prevent adverse outcomes ^{49,20}
Patient-oriented support	Rehabilitation guidance	Patients	2	Tailored rehabilitation plans are presented in accessible text for patients. Plans are based on recovery trajectories to optimize recovery in reconstructive patients
	Postoperative remote patient monitoring	Plastic surgeons, physician assistants, nurses, and patients	3	Analyze data from wearable technology and/or well-being chatbots to monitor recovery, allowing for early intervention through real-time alerts to healthcare providers
	Medication reminders	Patients	4	Implement automated reminders for postoperative medication schedules, ensuring compliance with pain management or antibiotic prophylaxis
	Pre- and postoperative chatbot	Patients	2	Provide 24/7 virtual support, delivering preoperative advice and postoperative care information to enhance patient engagement and satisfaction, and monitor well-being

The analysis presented was conducted based on the information and technological resources available up to and including May 1, 2024. It is important to acknowledge that the field of AI is rapidly evolving. Future advancements in technology may lead to modifications in the applications of these tools, potentially expanding their utility beyond the current uses outlined in this article. As such, the findings and applications discussed should be considered within the context of the state of technology at the time of analysis. Readers are encouraged to consider these dynamic aspects when applying or referencing this work in future research or clinical practice. This table was adapted from Meskó and Topol.⁷¹

*Assessment of “availability of technology” was based on predefined criteria: Readily available (category 1): technologies fully operational and in active clinical use, such as AI-based imaging tools for preoperative planning and postoperative monitoring integrated into EHRs. Criteria: peer-reviewed clinical studies demonstrating widespread use, commercial products available to multiple healthcare facilities, and inclusion in standard guidelines. Limited availability (category 2): technologies available but limited by region, cost, or integration challenges, such as specialized imaging tools requiring specific equipment. Criteria: found in select clinical settings or regions, with some publications indicating limited adoption due to access barriers or costs. In development (category 3): technologies in active development, clinical trials, or reaching product-market fit, such as AI-driven preoperative optimization systems. Criteria: premarket studies, clinical trials, or investor-backed start-ups working toward product-market alignment. Conceptual research (category 4): Technologies proposed or undergoing initial research without clinical validation, including theoretical applications in facial reconstruction algorithms. Criteria: published in peer-reviewed journals, but with limited experimental validation or predominantly laboratory-based research studies. Speculative future (category 5): technologies still in the preresearch phase, not actively developed or tested, such as advanced generative models for automated robotic surgery. Criteria: speculative proposals in review papers, academic talks, or grant proposals without ongoing research or prototypes.

AR, augmented reality; VR, virtual reality.

informed consent is managed, as patients may not be fully aware of how their data could be used as AI capabilities expand.^{60,61} To uphold patient autonomy, healthcare providers must prioritize transparency and regular communication about AI's role and ensure patients understand how their data might be (re)used over time.

Finally, respecting patient autonomy extends to safeguarding privacy, confidentiality, and informed consent for data usage. One recent study demonstrated the potential for users to circumvent security measures in ChatGPT and access confidential, personally identifiable information using a technique known as the Janus Interface, which involves a modification of the LLM.^{62–64} The integration of personal identifiable information into chatbots poses privacy risks: healthcare professionals may unintentionally expose patient data, whereas malicious users may exploit weak cybersecurity. Despite safeguards, trained cybercriminals could circumvent security measures. Sharing surgical data for AI model refinement without explicit consent heightens reidentification risks, violating patient trust and informed consent principles.⁶⁵ Existing government legal frameworks, which ensure patient control over their data, including access and sharing options^{66–69} while a good start, must be continuously updated for the imminent and specific risks.

During preoperative consultations, it is crucial to maintain patient autonomy by providing clear information about AI use in surgical planning. Patients should be given AI-generated recommendations and alternative options, ensuring they understand their right to accept or decline AI tools. Surgeons must transparently discuss the AI's benefits and limitations, emphasizing that the final decision is always the patients'.

Prioritizing Safety

Case 3

An outpatient clinic's AI tool summarizes electronic health record (EHR) data to assess liposuction eligibility but overlooks critical comorbidities. Relying on this incomplete report, the surgeon proceeds without fully reviewing the medical chart, resulting in severe complications. Investigations reveal outdated AI guidelines and reactive error protocols. The patient sues for negligence and lack of informed consent regarding AI involvement.

The introduction of novel technologies in healthcare is often met with initial technological difficulties and complications.⁷⁰ For example, the adoption of robotic-assisted tools for minimally invasive procedures, though seemingly infallible, has a nonzero number of adverse events⁷¹ and was initially met with considerable skepticism and underwent decades of review before approval.^{51,72,73}

Both surgeons and healthcare administrators adopting genAI must prioritize safety, accountability, and responsibility to mitigate the initial risk of complications.⁷⁴ This involves ensuring that genAI technologies align with regulatory standards for safety, accuracy, and efficacy, particularly for specific, well-defined surgical use cases.^{53,75} Before deployment, these technologies must undergo rigorous testing, similar to any medical

device, to ensure patient safety. Unlike static medical tools, genAI models evolve over time, requiring continuous monitoring by developers, investors, and surgeons to maintain quality, implement improvements, and assess potential adverse effects.⁵³ Preventing harm is crucial; genAI technologies, especially those that answer patient questions or provide diagnoses, must be carefully managed to avoid scenarios where patients are misinformed, or where these models perpetuate unrealistic surgical expectations.^{51,49}

The FDA regulates all medical products, including AI-based technologies, under its broader framework for ensuring safety and quality.^{53,76,77} For AI and machine learning technologies, which fall under the category of software as a medical device, the FDA has developed a tailored regulatory strategy that focuses on continuous monitoring and evaluation of real-world performance.^{53,78} To date, 6 AI medical products, labeled by the FDA as plastic surgery devices, have been approved by the FDA.⁷⁷ Despite these developments, no genAI device or LLM in any specialty has been approved, and challenges remain in regulating adaptive AI algorithms that evolve over time, which will require refinement of regulatory standards.

In initial studies, genAI interfaces have been shown to enhance informed consent documentation for surgery,⁷⁹ generate accurate information to answer medical queries,⁸⁰ and provide comprehensive responses to commonly asked plastic surgery questions.⁸¹ Although these initial use cases are exciting, they have been met with limitations including fluctuating clinical accuracy and impersonalized medical advice,^{81–83} which can lead to dangerous consequences if used without oversight. Currently, there is little transparency regarding the quality and robustness of the surgical data that are fed into these preliminary models.

One consideration includes direct-to-patient AI communications, such as preoperative consultations or answering postoperative questions via chatbots, which offer exciting potential but also come with significant risks. Early studies suggest that AI-generated advice can save clinicians time, is often accurate and concise,⁸⁴ and is sometimes even preferred over surgeon-drafted responses.^{85,86} However, these AI systems often lack the nuance and personalization a clinician provides, failing to consider unique patient needs, varying health literacy, or unexpected complications.⁵⁰ This can result in patients misunderstanding instructions, following incorrect advice, or missing essential recovery steps, especially if they are unaware that their guidance is AI-driven rather than from a surgeon. To prevent potential harm, it is crucial to have strict oversight, ensuring that AI communications are accurate, clear, and supplemented by human supervision.⁸⁶

Another well-documented philosophical consideration is AI hallucination,⁸⁷ a dangerous symptom of chatbots, which involves the production of logical, well-defined, and plausible incorrect responses. LLMs such as ChatGPT sometimes produce counterfactual outputs that are articulated with confidence, which may result in

inflated surgical trust in the technology leading to catastrophic consequences.⁵³

It remains unclear who would be held liable for ill-informed genAI-augmented clinical decision-making. This is especially pertinent in the field of genAI, which uses unsupervised learning to inform their outputs; unlike other software, individual computational decisions are not coded by a team of software engineers.^{88,89} This may create a “responsibility gap,” placing the burden of genAI-related harm on surgeons or healthcare workers who did not develop the technology itself.^{2,88–91} Holding surgeons solely responsible for genAI-related harm is impractical, as many LLMs are black-box models, and surgeons may not fully understand the logic behind their recommendations.⁸⁹ Nonetheless, surgeons must be cautious in leveraging AI for surgical advice, recognizing the liability and ethical risks involved.² Surgeons should not be fully exempt from AI-related errors, especially when genAI tools suggest care options rather than definitive diagnoses. AI should supplement, not replace, surgeon judgment, providing additional insights where beneficial.

Promoting Equity

Case 4

An academic hospital’s AI tool recommends postoperative medications for reconstructive surgery but overlooks social determinants of health and reflects biases from overrepresented demographic groups in its training data. As a result, underrepresented patients receive inaccessible prescriptions or face insurance delays, increasing recovery time and complication risks. In response, the hospital reassesses the tool to integrate pricing, social factors, and more inclusive data, aiming for equitable healthcare delivery.

Well-documented concerns within our healthcare system revolve around persisting health disparities, even when new healthcare technologies are introduced to enhance patient care. This situation gives rise to what can be described as a “technological divide,” where population inequities in care are exacerbated by advancements in medical technology.⁹² Plastic surgery, already grappling with existing concerns regarding diversity and inclusion, must make considerations regarding the price and availability of genAI technologies such that its integration advances and does not hinder health equity.^{93,94}

Of particular concern when using LLMs is the perpetuation of bias, which can impact clinical decision-making and surgical equity.^{53,95} Healthcare AI bias can arise from training data that underrepresent diverse and vulnerable groups, leading to models that perpetuate social stereotypes. Some studies have shown that text-to-generative AI models tend to underrepresent sex and ethnic minority groups when generating images of physicians⁹⁶ and surgeons.⁹⁷ Other studies have documented GPT-4 in exhibiting racial and gender bias in medical recommendations, patient assessments, and medical education.^{94,98} GPT-4 exaggerated disease prevalence disparities and amplified societal stereotypes, highlighting serious concerns about using genAI for large-scale surgical adoption.^{98,99}

Ensuring equity in surgical genAI requires commitment throughout the so-called algorithm life cycle, starting with diverse and representative data collection.⁹⁹ Development, trials, and validation should incorporate input from varied backgrounds to enhance transparency in intended use, population limits, and generalizability. AI developers must proactively address biases to prevent widening health disparities.

AI Sustainability

Case 5

A surgery center uses a preoperative AI tool for breast reconstruction. This tool is programmed to integrate the latest clinical research data from clinical trials and real-world evidence into its recommendations. Regular updates are applied to the system to ensure it remains aligned with the evolving nature of surgical techniques. Surgeons actively contribute to the model’s feedback loop, ensuring that the AI tool’s continuous learning process allows the model to adapt its recommendations in real time with contemporary surgical practice (Table 3).

Integrating genAI technologies into surgery necessitates a careful balance between enhancing efficiency and preventing the aggravation of technology burdens for surgeons. Although AI holds great promise in optimizing healthcare practices, poor integration can lead to unintended complications. In addition, the inherent nature of surgical practice necessitates a very close relationship between surgeons and AI training models to ensure proper interoperability between the operating room and the algorithms.

It is also important to highlight the importance of ensuring that genAI-driven healthcare technologies, including AI-integrated EHR systems, are designed with user-friendliness in mind to prevent additional workload and stress on healthcare providers. Incorporating genAI into surgery should prioritize usability and seamless integration, with minimal yet comprehensive tutorials and onboarding for effective large-scale adoption. Unlike EHRs, where hospitals invest heavily in technician support, initial genAI applications should provide scalable support to ensure consistency. Surgeons should collaborate with start-ups to provide iterative feedback, ensuring effective and sustainable technology uptake.

CONCLUSIONS

The integration of genAI into surgery enhances patient care and decision-making but must follow ethical principles for responsible implementation. This article outlined 5 key principles: data transparency, patient autonomy and safety, accountability, equity, and adaptability.

These principles safeguard patient safety, uphold human agency, mitigate bias, and ensure equitable AI access. As AI evolves, collaboration among providers, policymakers, developers, and patients is crucial to addressing ethical challenges. Adhering to these principles ensures that AI complements human intelligence, advancing surgical practice and healthcare delivery.

Table 3. Examples of Ethical Considerations Associated With Current GenAI Technologies

Technological Category	Example of Existing Technology in Healthcare	Summary of Ethical Concerns	Examples of Harmful Consequences
Academic research support	GPT-4	Ethical concerns include data privacy violations and bias in training datasets. GenAI models are also prone to hallucination in which they convincingly articulate a misguided or inaccurate fact. Research support tools may also inadvertently plagiarize from existing literature available in the model's training dataset	GenAI models mining patient data from EHRs to support postoperative outcomes research may inadvertently expose sensitive information or perpetuate biases if the training data lack diversity
Administrative task support	Abridge healthcare	Ethical issues include data privacy, accuracy in AI-generated documentation, and overreliance on automated systems. Inaccurate translations of clinical notes or prior authorization requests may result in inappropriate care or unnecessary insurance denials	AI-driven clinical note-generation tools produce incomplete or incorrect prior authorization documents, leading to unjustified denials and delayed access to critical treatments
Preoperative support	AEDIT	Ethical concerns include reinforcing societal biases in beauty standards and creating unrealistic patient expectations. GenAI predicting postoperative outcomes may standardize results based on prevalent aesthetic norms, disadvantaging patients from diverse ethnic backgrounds. Additionally, AI tools analyzing before-and-after photographs risk compromising patient confidentiality if images are not properly anonymized or used without informed consent	AI tools suggesting standardized rhinoplasty outcomes could fail to reflect a patient's cultural or personal preferences, leading to dissatisfaction and the perpetuation of narrow beauty ideals
Clinical decision support	Glass Health	Clinical decision support, diagnostic assistance, and triage systems can present risks of diagnostic errors and overreliance on AI recommendations. Surgeons may overlook their clinical judgment, increasing the potential for patient harm if AI misclassifies conditions	AI systems misidentifying a postoperative infection as benign could delay urgent treatment, compromising patient outcomes and increasing healthcare costs due to prolonged hospital stays or further complications
Patient-facing virtual diagnostic support	Corti	Virtual chatbots pose ethical challenges related to patient privacy, data security, and the potential dissemination of misinformation. Patients may disclose sensitive health information to chatbots without understanding how their data will be used or stored. Chatbots might provide incorrect medical advice or hallucinate due to limited context or inadequate training	Preoperative chatbots that offer erroneous preparation guidelines can compromise patient safety and increase the risk of surgical complications
Patient-facing postoperative support	EveryDose	Postoperative support technologies such as medication reminders or rehabilitation guidance must ensure accurate and personalized recommendations. Errors or inadequate personalization can lead to suboptimal recovery and adverse drug events	Rehabilitation chatbots providing generic exercise instructions without considering a patient's specific surgical history may result in injury or prolonged recovery, highlighting the need for individualized, evidence-based guidance in postoperative care

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of ChatGPT were thoroughly reviewed and, where appropriate, revised by the article's authors to ensure they accurately reflected the intended meaning and maintained the originality of the research.

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