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Is AI Changing Surgery, or the Surgeon?

"Will artificial intelligence improve surgery in the future and what are the implications?

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Introduction

Artificial intelligence (AI) in surgery is not a new concept, but in recent years has begun to evolve at a striking pace. In the near future, hospitals across Australia can expect to see AI becoming part of the surgical norm. Tools that analyse scans, draft operation notes, prioritise patients, and recommend management plans are already in use.[1,2] Their presence is growing not only in theatres, but in private clinics, emergency departments, and teaching hospitals, where clinicians under pressure welcome technologies to lighten cognitive and administrative load.[3] These systems have demonstrated speed, consistency, and accuracy, all while never tiring, missing key details, or slowing when the tough gets going.[1] But as they become more reliable, the deeper worry is not what they can do, but what they might replace. When surgeons stop composing their own notes, stop recalling steps from memory, or begin to defer decisions to AI, they may gradually lose the very habits their profession depends on. In aviation and nuclear engineering, this has long been recognised as “automation bias”, the tendency to over-trust a system once it begins to perform reliably.[4] In surgery, good outcomes often depend on sound judgement, so even small changes in how engaged a surgeon is in decision-making can carry lasting consequences.

While AI will undoubtedly improve surgery, its growing presence also carries implications we are only beginning to understand. The greatest risk is not replacement, but erosion, in that through repeated reliance, the surgeon’s ability to reflect, recall, and reason may begin to weaken.[5] Clinical judgement risks becoming the product of machines rather than that of the surgeon, as the act of deciding is gradually displaced by prediction and automation. If a generation of surgeons learns to operate with algorithmic guidance from day one, what will be left of their independent thinking by day one hundred? Will the skill of seeing nuance in the operating theatres slowly disappear? And perhaps most urgently, if a machine now assists in surgical thinking, what happens when it is wrong, and who is accountable? If responsibility still rests with the surgeon, as current medico-legal advice confirms, how do we regulate a system in which the decision-maker may no longer be fully in control?

Where AI Helps, and How

AI tools, particularly large language models (LLMs) such as ChatGPT, and Gemini, are increasingly being used in medicine to support clinical decision-making and medical education by providing rapid access to relevant knowledge. Unlike traditional search engines, LLMs can generate human-like responses in real-time and deliver personalised answers by adapting to the user’s prompts.[6] As a result, LLMs have become an attractive tool for streamlining clinical workflows and supporting decision-making across various levels of practice.[2] It is perhaps no surprise then, that AI has already found its place in many corners of patient care.

One of its most noticeable contributions is in medical imaging. Algorithms trained on large datasets can now identify intracranial haemorrhages and pulmonary nodules with accuracy matching that of experienced radiologists.[7,8] AI can also detect subtle anomalies in imaging that may help non-specialist clinicians triage urgent cases, particularly in smaller hospitals or after-hours settings where access to

radiologists is limited.[9] For surgical teams, this can mean earlier identification of operable pathology, more confident preoperative planning, and faster escalation to theatre where needed. This kind of early insight is especially valuable in trauma or acute care surgery, where delays in diagnosis can significantly affect outcomes.

In operating theatres, AI-integrated robotic systems are now offering real-time anatomical guidance and instrument tracking to support surgeons during technically demanding procedures.[10] These platforms are particularly valuable in microsurgery and reconstructive operations, where precision and stability are critical. Surgical robots such as the Symani Surgical System use motion scaling, tremor filtration, and articulated wrists to replicate human dexterity while extending movement beyond natural limits.[11] This allows for finer dissection and delicate handling of tissues in deep or narrow anatomical fields, reducing morbidity and improving patient outcomes.[11]

Additionally, the growing field of tele-operated robotics is beginning to show promise. With the right connectivity and technical infrastructure, surgeons have demonstrated the ability to operate across distances, as seen in a recent case where a surgeon in Rome remotely performed a robotic prostatectomy on a patient in Beijing using a 5G-powered robotic system.[12,13] Though still in their early stages, these technologies could eventually enable tertiary centres to provide remote support to smaller or remote hospitals, improving care coordination and outcomes without overwhelming referral systems.

Outside of theatres, LLMs are also easing the burden of administrative tasks that often take time away from surgical care. One recent study found that ChatGPT could produce structured, complete operative notes in under five seconds, compared to an average of seven minutes when written manually, while still meeting recognised standards for surgical documentation.[1] Even a few extra minutes saved in between cases can improve the overall workflow when the caseload is high and turnaround times are tight.

These tools are not only enhancing surgical precision but also reclaiming time which is arguably the scarcest resource in high-pressure clinical environments. By reducing delays, streamlining documentation, and enabling faster decision-making, AI is helping surgical teams stay focused on what matters most: patient care. But while technology is advancing rapidly, the human systems around it don’t always adapt as quickly. And when clinical skills go unused or unsupported, the cost can be much harder to recover.

The Atrophy of Clinical Judgement

Clinical judgement isn’t innate, it’s built through repetition, reflection, and the slow, often uncomfortable process of learning what matters and when.[14] For surgical trainees, this often starts outside the operating theatre. It’s forged in those moments you notice a subtle shift in post-op vitals, hesitate between competing diagnoses, or argue with yourself over whether to wake the on-call consultant at 3 a.m. These aren’t routine decisions that AI can make, but choices that demand attention, reasoning,

and the willingness to act. This is how surgical judgement begins, not with certainty, but with the courage to weigh uncertainty.

In 1971, American surgeon Dr Robert Bartlett published *"The Teaching of Surgical Judgement"*, one of the earlier and insightful explorations of what surgical judgement truly involves.[15] He argued that judgement is not merely technical skill or clinical knowledge, but a reflective, evolving process grounded in six key faculties: knowledge, reasoning, individualisation, conscience, repentance, and the commitment to 'do no harm.'[15] It must be actively maintained through ethical introspection and continual self-assessment. To reinforce this, Bartlett introduced a self-evaluation tool for surgical residents, not to measure outcomes, but to cultivate awareness, confront mistakes, and reflect on decisions.[15] Interestingly, residents often rated themselves lowest not in technical ability, but in recognising and admitting errors. For Bartlett, this revealed that sound surgical thinking depends less on execution and more on the capacity for honest, moral self-correction, what he called a "self-correcting philosophy," the defining trait of a thoughtful, accountable surgeon.[15]

So, what happens when these small, formative decisions essential for developing one's judgement are increasingly made, or even just suggested, by an AI system? What happens when that early sense of doubt, the "gut feeling" that only comes from lived experience, is replaced by the soulless logic of an algorithm? In their 2022 thesis, Kosmyna et al[16] describe this phenomenon as cognitive offloading: the gradual reduction in mental effort as we lean more heavily on external systems for answers. They warn that such offloading may encourage passive information consumption, superficial engagement, and weakened critical thinking skills.[16] In learning contexts, it can reduce memory formation, undermine problem-solving habits, and discourage independent research.[16] These trends are especially concerning when applied to a discipline like surgery, where nuanced reasoning and active decision-making are non-negotiable.

What could our future surgical trainees look like if they grow up in systems saturated with AI? Practically speaking, over-reliance on intelligent systems may reshape how they gather information, tolerate ambiguity, and justify decisions.[17] Studies have shown that frequent interaction with AI tools, particularly among younger users, is associated with diminished critical thinking skills and a greater risk of cognitive atrophy through a process known as cognitive offloading.[16,17] A trainee might no longer engage in the mental discipline of using the surgical sieve to generate differential diagnoses, because the "system" has already suggested the most likely cause. They may accept outputs at face value rather than asking, *"but what else could this be?"*. Over time, the skill of interrogating uncertainty, a core habit of judgment, may atrophy. Even in high-stakes, or post-op complication reviews, the instinct to cross-check, question, or explore alternatives could be dulled by the perceived authority of the algorithm. What begins as clinical support may quietly become cognitive dependence. And in that shift, the space where surgical judgment used to be, critical thought, doubt, and the act of choosing, risks being automated away.

Ultimately, clinical judgement is more than a skill. It shapes how surgeons think, respond, and take responsibility. It is formed in moments where protocols fall short, and decisions must be reasoned rather than retrieved. While AI can improve efficiency and support decision-making, it cannot replace the habits of critical thinking such as asking the right questions, noticing when something doesn't fit, or taking ownership in uncertain situations. If training leans too heavily on systems that provide conclusions without the cognitive effort to reach them, there is a risk that these habits will fade. What is lost is not only the ability to decide, but the accountability that gives those decisions weight.

Trust, Transparency, and Accountability

AI systems, particularly those built on deep learning, are often described as "black boxes" because their decision-making processes are difficult to interpret, even for their creators.[18] In surgery, where decisions can be life-altering, this lack of transparency introduces serious ethical tension. When an AI system recommends a diagnosis, flags a complication, or selects an operative plan, it may not provide a clear explanation for how it arrived at that conclusion.[19] For the surgeon, this creates a dilemma: do they trust the output of a system they cannot fully understand, or rely on their own judgement and risk making the wrong call? The lack of interpretability doesn't just affect clinical confidence; it directly challenges the foundation of informed consent.[20] If a surgeon cannot explain how a decision was reached, how can they explain it to the patient? In surgery, where the stakes are high, this lack of transparency makes it harder to hold anyone accountable and puts strain on the therapeutic relationship between patients and surgeons.

Trust is central to surgical care, rooted in the human relationship between patient and surgeon. Patients do not place their faith in AI tools or systems, they place it in the judgement, presence, and accountability of a person in the room. As AI becomes more integrated into surgical workflows, there is a growing risk that this relationship could be weakened. The Australian Values and Attitudes toward AI (AVA-AI) national study found that while over 60% of Australians are comfortable with AI assisting in diagnosis, support plummets to just 27% when AI makes decisions autonomously.[21] Further, a global scoping review of patient perspectives found that while there is cautious support for AI in healthcare, it is strongly conditional on human oversight, transparency, and accountability.[22] Patients may accept that AI plays a background role, but they still expect that a surgeon, not a machine, is ultimately responsible for choices made on their behalf. They consistently value human interaction, clarity in decision-making, and control over how their data is used. In this context, informed consent must evolve beyond procedural approval; it must include transparent communication about the role, limitations, and influence of AI systems involved in their care.[20]

The integration of AI into surgical decision-making raises urgent questions about accountability. If an AI system recommends a course of action that results in harm, who bears responsibility, the system's developer, the hospital, or the surgeon who accepted its advice? Legally and ethically, the answer remains murky, and as AI systems become more sophisticated and autonomous, the lines of responsibility risk becoming blurred and increasingly difficult to navigate. Surgeons may end up finding

themselves accountable for decisions they did not fully make. This concern is not hypothetical, Kovoor et al[23] note that existing malpractice and regulatory frameworks are “unlikely to adequately consider the complexities introduced by AI,” leaving clinicians exposed to liability even when they have little insight into how a decision was derived. Automation bias further complicates this picture, as clinicians may defer to machine outputs, especially under time pressure or institutional expectation. If an adverse outcome occurs, the legal system still looks to the surgeon, even when the source of error lies in a model that cannot be examined or cross-examined. Until regulatory structures evolve to reflect these shared dynamics, the ethical burden will continue to fall on individuals navigating decisions without full visibility or control.

Finally, concerns about data privacy and breaches cannot be ignored. In one high-profile case, Clearview AI faced global scrutiny for scraping billions of facial images without consent, raising serious questions about how AI systems acquire and use personal data.[24] In healthcare, these concerns are compounded by the vast volumes of sensitive information required to train medical AI systems. At the same time, the role of AI in medical research is expanding significantly; a recent bibliometric analysis found that the proportion of biomedical abstracts likely containing AI-generated content increased by nearly 70% between 2020 and 2023.[25] This rapid expansion raises serious concerns about the accuracy of AI-generated research. LLMs are known to "hallucinate", producing content that appears credible but is factually incorrect or fabricated, which can introduce undetected errors if AI tools misinterpret data or fail to recognise underlying biases.[26,27] These flawed findings may then influence clinical practice, as other healthcare professionals might rely on them when making decisions. As AI becomes more integrated into the medical literature, it is essential to establish strong safeguards to protect research quality, including frameworks now being developed to assess clinical risks and reduce AI-induced errors in healthcare contexts.[27]

Educating and Regulating the Future Surgeon

Surgical education has long prioritised technical excellence, but the role of the surgeon is changing. As AI becomes more embedded in surgical care, surgeons must now interpret, question, and at times override algorithmic recommendations. Used well, AI can also help develop surgical judgement. Simulation tools now provide feedback not only on technical skills, but also on decision-making processes.[28] Virtual patients and AI-guided rehearsal systems allow trainees to practise reasoning in realistic, risk-free scenarios.[29] Some platforms even map intraoperative decisions for structured reflection, using tools like the Visual Concordance Test to train cognitive surgical skills outside the operating theatre.[30] Rather than replacing judgement, these tools may help cultivate the habits of reflection that good surgical decisions depend on

Additionally, The Royal Australasian College of Surgeons (RACS) has shown swift national leadership in recognising these emerging demands. In recent submissions, RACS has called for clearer legal frameworks, stronger oversight of clinical software, and a commitment to surgeon-focused reform.[31,32] Crucially, RACS has also highlighted the need for formal education in digital decision-making, so that

surgeons remain not just competent with new tools, but confident in exercising their own clinical judgement.[31]

These proposals align closely with RACS's own Surgical Competence and Performance Framework, which defines decision-making, judgement, and professionalism as core surgical competencies.[33] As digital systems become more present in clinical life, these attributes will only grow in importance. This is not about resisting change. It is about safeguarding the values that define surgical practice. In continuing to champion ethical, accountable innovation, RACS sets an example for how surgical regulation should evolve, by focusing not just on the tools, but on the people trusted to use them. AI can support training, but it cannot replace empathy, judgement, or ethical decision-making.

Conclusion

There is no doubt that the rise of intelligent systems has brought genuine progress to surgical care: fewer errors, faster decisions, improved outcomes. But outsourcing parts of the cognitive process may as well be outsourcing parts of what makes surgical practice meaningful. When reflection is no longer necessary, it becomes unfamiliar. When independent reasoning goes unexercised, like a muscle, it begins to weaken. The shift is not dramatic, but gradual and easy to miss. Without conscious effort, we may train a generation of surgeons who are highly equipped, yet unable to act without guidance.

I once read a phrase, "AI will not replace people, but people who use AI will replace those who don't." It made me wonder how different that really is from saying *surgeons who use AI will replace those who don't*. Alas, in the pursuit of efficiency, we must not forget the very skills that make a good surgeon. Clinical judgement is not optional, nor can it be programmed or outsourced. It is what makes surgery human.

The challenge ahead lies not in resisting AI, but in learning to integrate it without forgetting the habits that shape surgical judgement, the ability to notice, to reflect, and to decide when not to act. Because a surgeon's most powerful tool has never been the scalpel, it's been knowing when not to use it.

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