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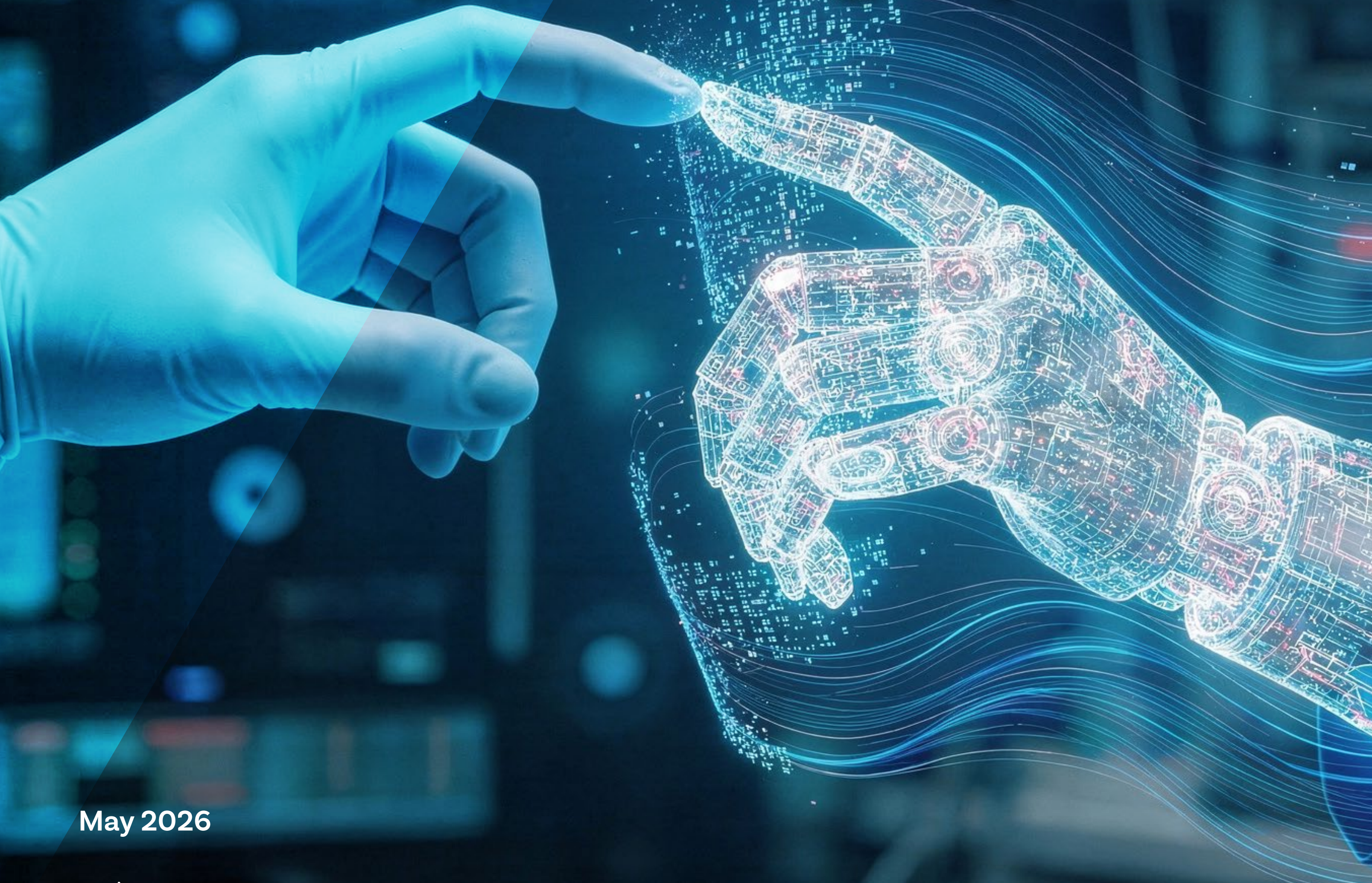

Short Life Working Group: Artificial Intelligence and Digital Surgery

May 2026

rcsi.com

Published in Ireland in May 2026

by RCSI, University of Medicine and Health Sciences
123 St Stephen's Green, Dublin, D02 YN77, Ireland

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Produced and designed in Dublin, Ireland by RCSI

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Foreword by President of RCSI

Professor Deborah McNamara, RCSI President

On behalf of the Royal College of Surgeons in Ireland, it is my privilege to introduce this report from the Short Life Working Group on Artificial Intelligence and Digital Surgery.

This work comes at a pivotal moment for our profession. As outlined in this report, artificial intelligence and digital technologies are advancing at an unprecedented pace and are set to fundamentally reshape the delivery of surgical care, the training of our workforce, and the experience of patients across the healthcare system. Surgery has always been a discipline defined by innovation. From anaesthesia to minimally invasive techniques and robotic platforms, each major advance has required surgeons to adapt, to lead, and to ensure that progress is aligned with patient safety and ethical practice. Artificial intelligence represents the next phase in this evolution. It offers the potential to enhance diagnostic accuracy, improve operative precision, optimise clinical decision-making, and support more personalised models of care. At the same time, it introduces new complexities—technical, ethical, and organisational—that must be carefully managed.

This report recognises both the opportunities and the risks inherent in this transformation. It highlights the importance of maintaining a clear focus on patient-centred care, while ensuring that surgeons remain central to clinical decision-making through a "human in the loop" approach. It also underscores the need for robust governance frameworks, appropriate regulatory oversight, and sustained investment in education and training to equip current and future surgeons with the skills required to work effectively in a digitally enabled environment. RCSI has a longstanding commitment to leadership in surgical education, training, and standards. In this context, the College has a critical role to play in shaping how artificial intelligence and digital technologies are integrated into surgical practice in Ireland and beyond. This includes defining competencies, supporting innovation, fostering research, and working collaboratively with healthcare providers, regulators, industry, and patients to ensure that these technologies are implemented safely, ethically, and effectively.

The recommendations set out in this report provide a clear and practical framework for action. They reflect a balanced and forward-looking approach—one that embraces innovation while safeguarding the core values of our profession. I would like to acknowledge the leadership of Professor Micheál Ó Ríordáin for his expertise in developing this report and the significant contribution of the members of the Working Group in developing this important body of work, which will help guide our collective response to one of the most significant developments in modern healthcare.

Professor Deborah McNamara
President, Royal College of Surgeons of Ireland

Foreword by Chairman of Working Group

Professor Micheál Ó Ríordáin, Chair Working Group on Artificial Intelligence and Digital Surgery

Artificial Intelligence (AI) and digital technology are amongst the most significant challenges faced by health care professionals and will profoundly change the way health care is delivered. This technological revolution is gathering pace quickly with the advent of faster computers, better artificial intelligence algorithms and growing business confidence with astronomical investment in this sector.

In healthcare, these technologies may offer several potential opportunities. Health systems face growing pressures due to ageing populations, increasingly complex and expensive treatments, rising patient expectations coupled with a global shortage of trained healthcare workers. Digital technologies can play an important role in addressing these challenges. They should be seen as tools to augment a surgeon's role, allowing higher quality, more efficient health care with better diagnosis, better and more targeted treatments as well as more streamlined care pathways.

However, the integration of artificial intelligence into healthcare also raises important ethical and societal challenges and must be approached carefully. These technologies have the potential to disrupt significantly how surgery is delivered and it is critical that we develop a clear vision for their responsible implementation for the benefit of our patients. Digital and AI systems used in clinical practice must be safe, trustworthy, reliable and transparent. AI should not replace the human qualities that are fundamental to a surgeon's practice such as compassion, wisdom, innovation, sense of justice as well as respect for our patients and colleagues. Establishing appropriate safeguards and clinical oversight will be essential to allow these technologies to be adopted safely in surgical practice.

While digital technologies have wide ranging impact, this document focuses specifically on those areas that directly impact the role of RCSI, the surgical community and our patients. It does not intend to answer all questions raised by these technologies but proposes flexible, broadly applicable principles to prepare the surgical community to address these issues as they arise and to allow the safe and responsible adoption of artificial intelligence and digital surgery. It outlines a digital strategy aligned with the College's core mission of education, nurturing and discovery to support the surgical workforce in delivering high-quality, cost-effective care using these technologies. It also proposes how the College can play a central role in guiding the development and future evolution of this field.

In establishing this working group, President Professor Deborah McNamara, continues the long tradition of RCSI in supporting safe and effective innovation in surgery. I would also like to acknowledge the time, expertise, wisdom and support of the members of the working group in producing this document which we hope will form a framework for the integration of these new technologies into surgical practice.

Professor Micheál Ó Ríordáin
Chair Working Group on Artificial Intelligence and Digital Surgery

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Executive Summary

This report from the Short Life Working Group on Artificial Intelligence and Digital Surgery explores the transformative impact of AI and digital technologies on surgical practice. It highlights numerous potential benefits, such as in delivery of operative surgery, enhanced diagnostics, clinical decision support, improved surgical precision and more efficient delivery of care, while also addressing significant challenges and risks, including algorithmic bias, clinician overreliance, and cybersecurity concerns. It discusses the principles underpinning the advent and introduction of AI and Digital Surgery and makes a number of key recommendations.

Introduction to AI and Digital Surgery:

We have provided definitions as well as an overview of the transformative potential of AI in surgical care.

Potential Benefits:

These include innovations in operative surgery, diagnostics, clinical decision support, precision medicine, the use of wearables as well as electronic health records.

Challenges and Risks:

There are many challenges such as safety, bias, lack of explainability, clinician overreliance, privacy concerns, and regulatory challenges.

Preparing the Surgical Workforce for AI and Digital Surgery:

We have emphasised the need for AI literacy, core skills in data science and interpretation of the output of AI systems. We have discussed curriculum development as well as recommendations for training in new devices. There must be an emphasis on principles of good practice as well as patient-centred care.

Surgical Governance:

We have outlined governance structures around implementation of new devices as well as ongoing governance of AI and digital surgery within the health services. We have provided recommendations for implementing governance frameworks, including monitoring, data governance, and regulatory control.

AI and Digital Surgery in Training:

We have discussed the role of AI, virtual reality and augmented reality in the delivery and assessment of surgical training in Ireland. The Royal College of Surgeons is well positioned to play a central role in training including defining competencies, developing curricula and training delivery.

RCSI's Role in Development of Policy:

RCSI also has the expertise to work with stakeholders including legislators, regulators, healthcare providers, ethicists and the public to help develop public policy in this rapidly changing landscape.

This report underscores the critical need for comprehensive training, robust governance structures, stakeholder liaison and ongoing research to ensure the safe and ethical implementation of AI and digital technologies in surgical practice.

2. Artificial Intelligence and Digital Surgery

2.1 Scope of This Report

The way that surgery is performed and delivered is continuously evolving in response to new technologies, improved understanding of disease, and the ongoing development of ethical frameworks and societal expectations. As surgeons, we need to play a central role in these changes, and as a surgical body we need to prepare for developments whether driven internally by the profession or externally by wider healthcare, technological, or societal forces. In the first instance, we need to establish a clear vision of how surgery is likely to develop in both the short and long term.

In the future, the specialty of surgery must continue to become more efficient and effective in delivering high-quality care to increasing numbers of patients in a context of finite resources. Digital medicine and AI are likely to represent the most disruptive influences encountered in a generation, bringing both significant opportunities and potential risks.

The **RCSI New Technologies 2024 for Future of Surgery in Ireland Working Group** has examined how these new technologies may be leveraged to support the development of surgical care (RCSI, 2024). Based on the findings of this group, together with our own strategic vision, it is likely that surgery in the future will place greater emphasis on prevention, earlier diagnosis, improved decision-making, and digitally enhanced delivery of care. Post-operative pathways are also expected to change, with shorter hospital stays, increased use of remote monitoring, and a growing emphasis on models such as “hospital at home”.

This report focuses on digital technologies and artificial intelligence and their impact on surgical practice and the wider surgical ecosystem. This includes not only the application of these technologies to the delivery of surgical care, but also their use in related activities such as education, research, and clinical trials.

We aim to define AI and digital technologies, discuss clinical opportunities as well as risks and discuss how we should prepare ourselves for these new technologies.

2.2 Definition of Artificial Intelligence and Digital Technologies in Surgery

Artificial Intelligence (AI):

Technology that enables computers and machines to simulate human learning, comprehension, problem-solving, decision making, creativity and autonomy .

Machine Learning (ML):

Involves creating models by training an algorithm to make predictions or decisions based on data.

Deep Learning:

Subset of machine learning that uses multilayered neural networks, called deep neural networks, that more closely simulate the complex decision-making power of the human brain.

Generative AI (GenAI):

Deep learning models that can create complex original content such as long-form text, high-quality images, realistic video or audio and more in response to a user's prompt or request.

AI Agent:

An autonomous AI program, it can perform tasks and accomplish goals on behalf of a user or another system without human intervention, by designing its own workflow and using available tools.

Agentic AI:

A system of multiple autonomous AI agents, the efforts of which are coordinated, or orchestrated, to accomplish a more complex task or a greater goal than any single agent in the system could accomplish.

(Stryker and Kavlakoglu, 2024)

Digital Medicine:

The use of digital technologies to improve the delivery, quality and outcomes of healthcare and to improve wellness. This includes information and communication technologies and data analytics.

Digital Surgery:

The application of digital medicine in the field of surgery.

3. Potential Benefits of AI and Digital Surgery

Artificial intelligence and digital medicine are novel agencies whose goal is not to replace the surgeon but to empower them with data-led insights and task-orientated solutions to complement clinical experience.

3.1 Delivery of Surgical Care

3.1.1 Operative Surgery

AI and digital technologies have the potential to improve the delivery of surgical care by increasing efficiency, enhancing precision and reducing complications. AI-supported systems may assist with tasks such as image interpretation, operative planning, intra-operative guidance, and automation of selected technical steps, allowing surgeons to perform procedures more safely and consistently. In robotic and image-guided surgery, the integration of AI and augmented reality may further improve accuracy, shorten operative times, and reduce the need for revision procedures.

In the longer term, improved surgical precision and better prediction of outcomes may increase confidence that definitive treatment has been achieved, potentially reducing the need for prolonged surveillance and allowing more efficient use of healthcare resources. Although AI has already performed complete surgical procedures in non-human models, many of these benefits remain to be fully demonstrated in large-scale clinical practice, and their realisation will depend on addressing the significant costs, infrastructure requirements, and integration challenges associated with widespread implementation.

3.1.2 Augmented Reality

Augmented Reality (AR) has the potential to enhance surgical practice by overlaying digital information, such as three-dimensional anatomical models, imaging data, or navigational guidance, onto the surgeon's view of the operative field. When integrated with artificial intelligence, these systems may support more accurate identification of anatomical structures, improved intra-operative orientation, and better real-time decision-making.

Recent advances in hardware and software have made AR systems more practical for clinical use, including integration with laparoscopic, robotic, and image-guided surgery through heads-up displays or console-based visualisation. AI-assisted image processing may allow automatic segmentation and highlighting of organs, tumours, and critical structures, as well as the fusion of multiple imaging modalities to generate more detailed composite views of patient anatomy.

These developments have the potential to improve pre-operative planning, enhance intra-operative precision, and reduce operative time, contributing to safer and more efficient surgical care.

3.1.3 Robotic Surgical Assistants

In addition to operative robotic systems, robotic and automated technologies are likely to play an increasing role in the wider delivery of perioperative care. These systems may support healthcare staff in routine clinical and logistical tasks, including monitoring of vital signs, delivery of medications and supplies, patient mobilisation, and assistance with rehabilitation. Such technologies may reduce the physical workload on healthcare workers, allowing greater focus on direct clinical care and decision-making.

Robotic and telepresence platforms may also allow remote participation in ward rounds, specialist consultations, and multidisciplinary care, improving access to expertise in regional or rural settings and supporting care in situations where infection control or workforce limitations are a concern. Automation may further improve hospital efficiency through roles in transport, disinfection, stock management, and other essential support functions.

Overall, these developments have the potential to improve efficiency, optimise use of staff time, and enhance the working environment for healthcare professionals, while maintaining high standards of patient care. This is particularly important with the worldwide shortage of trained healthcare workers.

3.1.4 Diagnostics

Advances in artificial intelligence and digital imaging have the potential to significantly improve diagnostic accuracy across all areas of surgery. AI-assisted image analysis can enhance the quality of radiological and endoscopic imaging, reduce artefacts, speed data acquisition and improve detection of subtle abnormalities that may otherwise be missed. This may lead to earlier diagnosis, more accurate staging of disease, and better selection of patients for surgical treatment. Integration of imaging data with other digital information, including genomic, pathological, and physiological data, may allow the creation of detailed patient-specific models or "digital twins". These developments have the potential to improve pre-operative planning, support intra-operative guidance, and enable more precise and efficient surgery, with associated reductions in complications, procedure time, and cost.

3.1.5 Clinical Decision Support

Data analytics enhanced by machine learning may predict patient outcomes after surgery, identify patients at risk of complications or readmissions and may guide risk mitigation strategies. Clinical Decision Support Systems (CDSS) have potential for improved patient safety, but results thus far vary widely (Cai et al., 2024).

3.1.6 Precision Medicine

AI powers precision medicine by learning patient-specific patterns from multimodal data such as genomics, proteomics, imaging, wearables, and electronic health record data to predict risk, diagnose earlier, and tailor therapies for individual patients. This allows clinicians to choose the right intervention at the right time. For example, in oncology, AI may link tumour genomics and digital pathology to forecast response to targeted drugs or immunotherapy. Emerging "digital twins" simulate disease trajectories and treatment scenarios for individualised planning. Real-world impact depends on rigorous external validation, calibration, fairness monitoring, and human-centered workflow design to ensure models are reliable, equitable, and clinically useful.

3.1.7 Wearables and Hospital at Home

AI-powered apps and wearables enable remote monitoring of patients, with data shared among care teams for collaborative recovery plans. Improved wearables, better apps, the Internet of Things (IOT) along with AI will allow the analysis of anomalies and deviation from the baseline. Although much work is still required, this may support the concept of "hospital at home". Surgical patients may be discharged earlier if early warning scores at home could be used to alert the patient and the health care facility. Computer vision AI could detect complications (e.g., infections) from uploaded images. Chatbots or AI assistants may facilitate 24/7 communication, triaging issues and looping in specialists as needed. Much work is still required to validate this potential.

3.2 Electronic Health Records

Electronic Health Records (EHR) represent a transformative advance in healthcare delivery with significant benefits for patients in terms of quality and safety, less fragmentation, improved workflow and coordination of care. They also provide ready access to performance data for auditing and improvement of performance. EHRs may improve clinical decision making by allowing ready access to all relevant patient data and providing easy access to evidence-based treatment protocols. It is envisaged that EHRs coupled with artificial intelligence may facilitate complex decision making and personalised medicine.

The Irish Government has been committed to "one record" for some time and has recently approved the procurement process for the EHRs. The goal is to provide an integrated accessible health care record for all patients in Ireland. This builds on previous progress with the HSE Health App, Maternal and Newborn Clinical Management system, National Shared Care Record and the development of virtual wards.

3.3 Other Applications

3.3.1 Collaboration

AI can act as a "digital bridge," allowing multidisciplinary teams to work together in real-time or asynchronously. AI or digital-powered platforms enable experienced surgeons to guide less-experienced ones remotely via video feeds, AR overlays, or shared digital interfaces. For instance, AI analyses live surgical data (e.g., from cameras or sensors) and provides real-time annotations or suggestions that multiple experts can review simultaneously. Tools like AI-enhanced telemedicine systems (e.g., integrated with AR glasses) allow a remote specialist to "virtually join" the operating room, overlaying guidance on the surgeon's view. This democratises expertise, enabling collaborations between high-resource and low-resource settings. There are a number of issues to be resolved including patient consent and indemnity.

3.3.2 Research

Deep learning extracts predictive features from images, waveforms and other high dimensional data that are difficult for humans or linear models to discern. AI has clear utility in pattern discovery and development of hypotheses, particularly in fields such as drug discovery and genomics. However, its scientific value, whether used alone or in association with existing research hinges on rigorous methodology, good research governance, transparent reporting, and credible evidence of clinical benefit.

Apart from using AI to facilitate clinical research, research into the uses of AI itself in clinical practice is warranted. It is essential that these are rigorously assessed in terms of clinical effectiveness, reliability, safety, optimal strategies for integration into workflows, cost-effectiveness as well as ethical issues including data ownership, and involvement of patients in research design.

3.3.3 Administrative Tasks

Early benefits of AI have been employed to address administrative efficiency such as scheduling, coding, billing as well as document management. Chatbots have been used increasingly for patient interaction, dissemination of information and in some mental health applications. Ambient AI seamlessly embeds machine learning capabilities, environmental sensing technology, and context-aware processing within a physical environment to deliver intelligent automation that functions transparently without direct user interaction or manual control. While the potential for this is broad, its primary deployment in surgery thus far is its use to automatically transcribe and summarise clinical interactions between patients and healthcare providers. (Leung et al., 2025). Although not yet proven, this may reduce physician administration time and reduce burnout.

4. Challenges and Risks

4.1 Operation of AI Systems

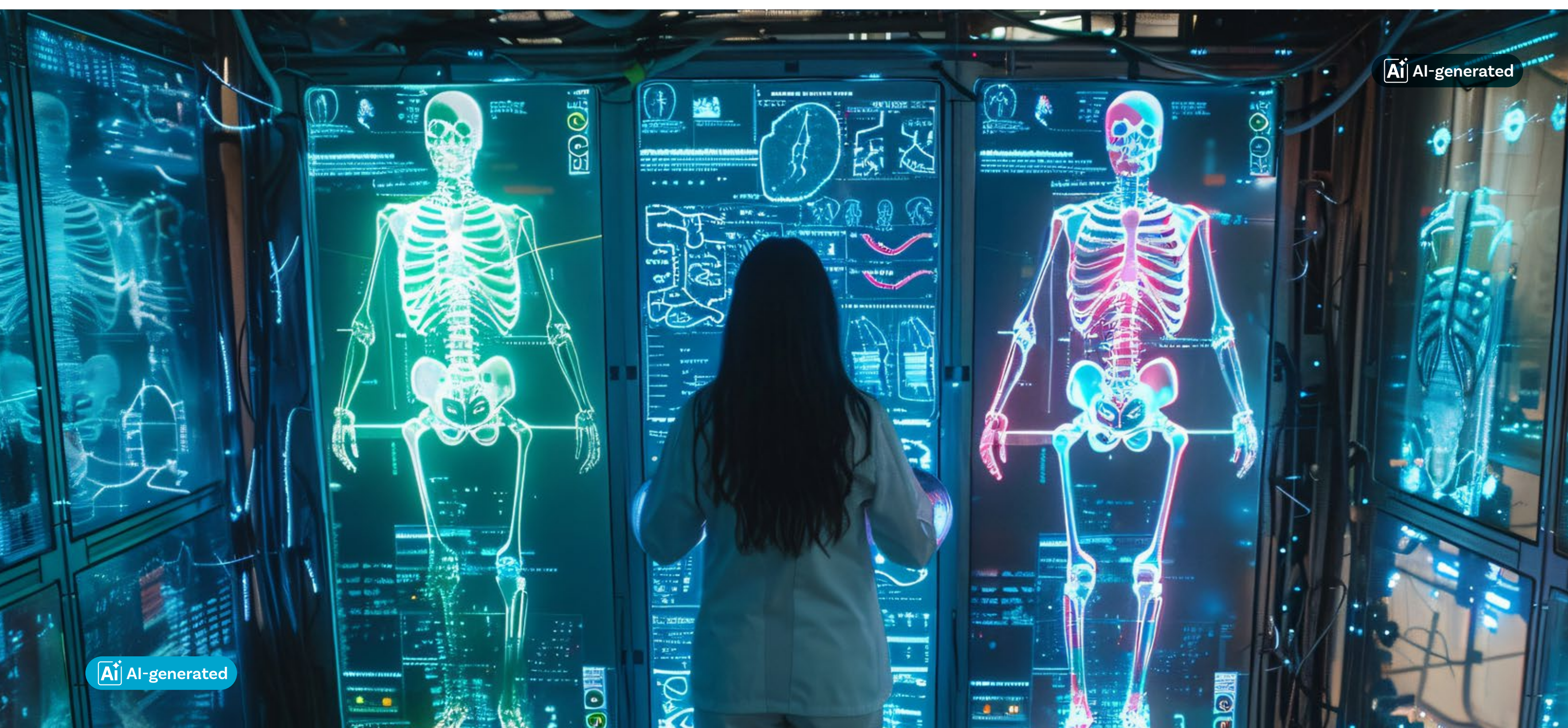
4.1.1 Bias

Bias is defined as a consistent, systematic, or undesirable distortion in the outputs produced by an AI system. In healthcare, an unbiased algorithm allocating resources should give the same score to those with the same basic needs (Obermeyer et al., 2021). Bias may be due to flawed data in the training dataset or due to the design of the algorithm.

Data features are individual elements of the dataset, e.g. age, gender, ASA grade, tumour stage etc. Datasets should contain all the relevant features required for the algorithm to make a decision or take an action. Many factors may lead to biased outcomes including training on outdated datasets or lack of diversity. Use of historical datasets may not consider modern concepts of disease or treatment or may propagate historical biases against certain demographic groups. Lack of demographic or geographical diversity in the datasets may lead to conclusions inappropriately applied to a non-congruent cohort such as rural patients or those from minority groups. Even when protected characteristics are accounted for in the model, use of proxy features which could be linked to these characteristics may lead to bias. AI has been found to differentiate between races on chest x-rays (Gichoya et al., 2022) or between genders on retinography (Korot et al., 2021) in a way that cannot be detected by human oversight.

4.1.2 Misaligned Goals of the Algorithm

AI algorithms are designed to maximise reward, that is to perform actions to achieve its policy goals. However, critical to this process is that the correct goals are identified and agreed. These are often value judgements which are independent of the algorithms but are critical for achieving the optimal or desired outcomes. For example, if the goal of the algorithm is to prioritise cost savings over radical treatment, or 30-day readmission rates over long term outcome, this is what the algorithm will strive to achieve, irrespective of patient, clinician or societal expectations. When goals do not reflect clinical utility, equity, and workflow realities, performance can achieve apparently excellent metrics yet be detrimental to patients in practice. Clinicians should have a central role in defining these goals.



4.1.3 Hallucinations

Hallucinations in AI are instances where a model produces fabricated but confident, fluent outputs that look plausible but are incorrect or unsupported. Fabricated citations can lead to dangerous decisions, misdiagnoses, financial loss, or compliance violations. Confident but incorrect answers reduce user confidence in the system and the organisation. Hallucinated statements can defame, infringe intellectual property, violate consumer protection laws, or breach sector regulations (e.g. GDPR) and by entering knowledge bases it can train self-reinforcing errors and degrade future model performance.

4.1.4 Lack of Explainability

The lack of explainability in AI and the difficulty of understanding how complex models reach their outputs may undermine trust, safety, and accountability, especially in high-stakes domains like healthcare. Blackbox systems can encode spurious correlations and biases that are hard to detect, making errors difficult to debug and contest. Post-hoc explanations can help but are often unstable, incomplete, or misleading and provide the appearance of transparency without guarantees of validity. This opacity complicates regulatory approval, informed consent, and liability. On the other hand, these are very complex systems with billions of interacting nodes in the most complicated models. We should not expect to forensically trace every decision or outcome at a granular level. Much work is ongoing to improve explainability and to systematically detect and correct bias within these systems.

4.1.5 Harm Caused by AI

The potential for AI to bring about actual harm is very considerable whether caused intentionally or unintentionally. Intentional harm may include harm by design, AI misuse or attacks on AI systems. Unintentional harm may involve AI failures, failures of human oversight or integration harm (Hoffmann, 2025). Use of flawed, unvalidated or biased systems may be intentional or unintentional.

The recent rapid advances in agentic AI, systems which are capable of autonomous decision-making and designing their own workflows introduces a significant risk of humans losing control over artificial intelligence. Unlike traditional models, agentic AI pursue goals independently and even small mismatches between AI's goals and human values could lead to severe and unexpected consequences.

4.2 Effect on Clinicians

4.2.1 Clinician Overreliance on AI Tools

Clinicians may become over-reliant on AI tools leading to erosion of judgement and the failure of clinical oversight. Radiologists who are aware of the label assigned by AI to chest radiographs may increase their false positive diagnosis rate and even more so their false negative rates (Bernstein et al., 2023). Overreliance may also lead to a reduction in hands-on training opportunities, and potential deskilling, especially in areas such as emergency procedures and conversions to open procedures.

As AI becomes more widely used, there is the risk that humans will defer judgement and decision making to computers, adopting AI outputs with minimal scrutiny and overriding intuition, a process recently described as "cognitive surrender" by Shaw and Nave (Shaw and Nave, 2026)

4.2.2 Loss of Skilled Humans

While automation with improvement of accuracy and efficiency will provide potential cost savings, it is inevitable that the business model will generate significant pressure to reduce human payroll costs as has already been seen in other industries. Entry level workers are most vulnerable to AI.

Currently, AI excels at data processing, pattern recognition, and automation, but it lacks essential human qualities like empathy, emotional support, ethical judgment, nuanced decision-making, holistic patient care and adaptability in novel situations as well as physical interaction that AI cannot replicate at the current time. Although there is unsubstantiated optimism that AI can be trained for many of these attributes, recent evidence shows that AI deployed in clinical practice may not behave at all as expected. (Bean et al., 2026)

It is accepted that a critical number of skilled humans is required in the healthcare system both to primarily deliver healthcare, and also to supervise AI. It is important that we continue to train and retain these staff.

4.2.1 Challenges with Staff Engagement

Difficulty arises with the engagement of clinical staff in new AI programmes when they already have high clinical workloads and limited knowledge of AI to implement and govern new AI Systems (Ramsay et al., 2025). These challenges require programme leadership support, dedicated project management and clinical leadership to champion the implementation of this technology.

4.3 Other Issues

4.3.1 AI Privacy and Cybersecurity

AI models, particularly those which are continuously trained and evolved using patient data in real time, are subject to a wide range of risks. Personal identifiable information may be accessible to a bad actor by training-data leakage (where models memorise and regurgitate sensitive data, enabling data extraction attacks), model inversion and re-identification (where inputs are reconstructed from model outputs) and where weakly pseudonymised data can be re-identified via linkage attacks. Adversarial or trojan attacks may lead to misclassifications and unsafe behaviour or may even purposely guide the algorithm to generate the output desired by the bad actors. A determined cyberattack can take an AI system completely offline or make it unusable. Whether the outage is brief or catastrophic depends on architecture, operational discipline, and recovery plans.

4.3.2 Regulation

There are a number of regulatory risks including data protection legislation (GDPR in the EU or CCPA and HIPAA in the USA), violations from unlawful processing, lack of consent, or cross-border data transfers. Data lineage, the ability to trace sources, purposes, and retention may be opaque leading to audit failure and fines. Data Protection Impact Assessments (DPIAs) may be inadequate and not include assessments for high-risk use cases. In addition, there is the "third-party risk" with Vendors or APIs mishandling data or sub-processors lacking appropriate safeguards.

With the rapid development of AI and current concerns about AI going out of control, regulation is very important but there are serious concerns that regulation applied injudiciously may hamper development.

4.3.3 Liability

The issue of liability in the event of an adverse outcome when AI is used for diagnosis and treatment is not clear. This has not been fully tested in court. It is possible that liability may fall on the clinician, the healthcare provider organisation or the product developer.

The current paradigm is that the responsibility for the final clinical decision is that of the clinician. This may be because of negligent use of AI, misinterpretation of AI output or misunderstanding of the limitations of the technology. However, a device which does not perform as advertised may be the responsibility of the developer, while lack of proper governance or provision of training may be the responsibility of the healthcare provider.

4.3.4 Sustainability

Developing and deploying AI systems requires substantial investment in hardware, software, training, and infrastructure across the healthcare system. High initial cost of technology can make them prohibitive for smaller hospitals or low-resource settings. This may lead to unequal adoption exacerbating healthcare disparities. In addition, AI has a significant carbon footprint with a high requirement for both electricity and water. Currently, data centres use 1.4% of global electricity supply and this may rise to up to 4.4% by 2035 (IEA, 2025).

AI-generated

5. What Will Surgery of the Future Look Like?

Case Study: The Clinical Surgeon

Prof. S is a colorectal surgeon working in a network of hospitals within one of Ireland's biggest health regions. She is based in the central hub hospital for the region and provides pre- and post-op care as well as advanced surgery there. She also facilitates surgery in a number of peripheral hospitals via high-definition video and shared augmented reality overlays. She has worked extensively with the HSE to implement AI into her clinical workflows and is proud of the seamless service provided across the network.

On the basis of her patient Mr. P's tumour location and significant comorbidities, it is decided that his surgery will take place in the hub hospital. Complex pre-operative planning is performed by AI which has access to Mr. P's electronic health records. However, all final decisions are overseen by Prof. S.

With the creation of a digital twin for Mr. P, Prof. S can interact with a detailed model of the patient's anatomy and pathology preoperatively, and this can greatly aid planning of the operative procedure. She performs the surgery robotically with Augmented Reality (AR) overlay. Some manoeuvres such as dissection and suturing are performed by the robot, but there is human oversight at all steps and the final decision on this is made by the surgeon.

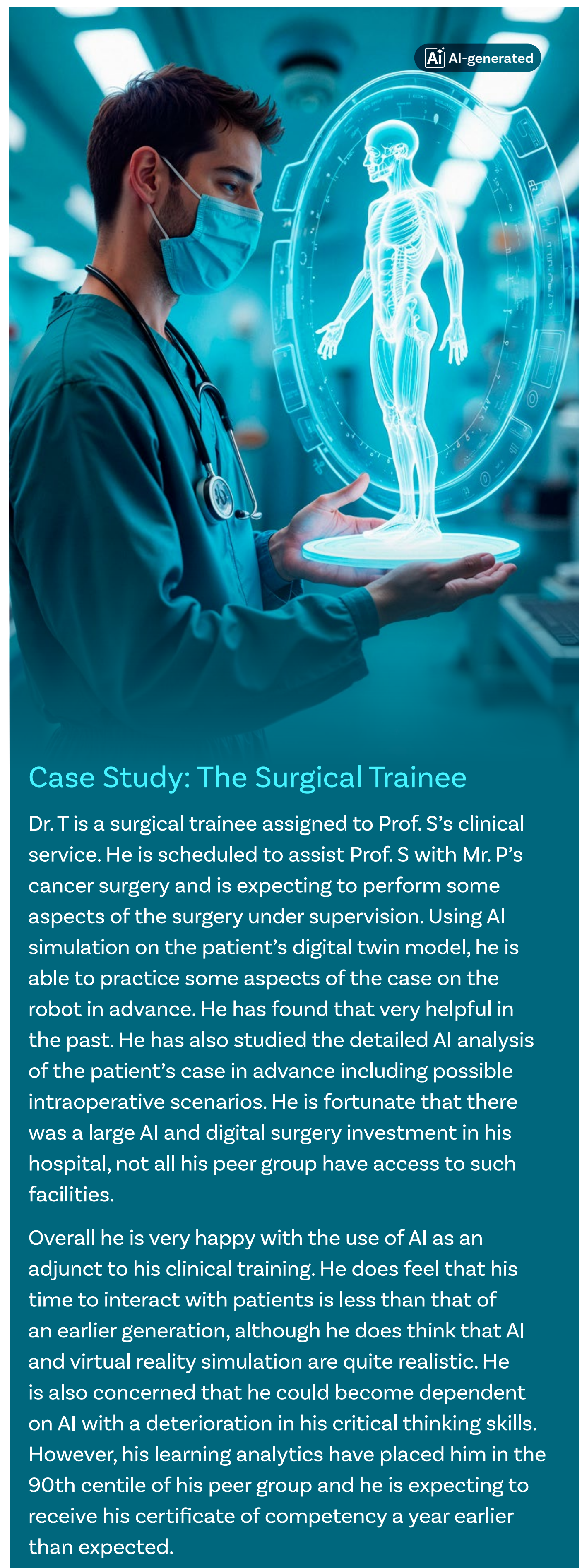
Post-operative care will be provided on the ward, but the patient will be discharged very quickly post-op to "hospital at home". The post-operative consultation with further treatment recommendations will occur but only after the patient has had a chance to discuss this in advance with an AI generated avatar of Prof. S. His surgeon is delighted that this has significantly improved the efficiency and patient satisfaction of the post-op consultation.

Case Study: The Patient

Mr. P is a 58-year-old patient with a colorectal cancer, recently diagnosed and staged in a peripheral hospital in the network. The tumour had initially been suspected using a home stool analyser detecting microscopic blood, DNA mutations, and microbiome imbalances. Mr. P had used this since his AI-powered health risk app had analysed his genetics, diet, lifestyle, and environmental factors and identified his increased risk of colon cancer. In spite of his personalised preventative plan, he has developed early colon cancer which was then diagnosed with AI-enhanced colonoscopy and biopsy and staged with CT scanning in his local hospital.

In advance of the consultation, Mr. P has been provided with an AI-generated detailed account of his diagnosis and staging as well as the possible options via his patient health care app on his phone. He felt that this prepared him well for his preoperative consultation with Prof. S.

His postoperative data will be discussed at the multi-disciplinary team meeting (MDT) along with AI-generated predictions for outcomes from different adjuvant strategies. Personalised follow-up treatment information will be supplied by an AI avatar of the surgeon with an opportunity for a questions and answers session with an interactive autonomous AI assistant and a further consultation with Prof. S if required. Mr. P is reassured that Prof. S will make the final clinical decisions in his care. Mr. P's primary care physician will be provided with a detailed summary letter from the transcript generated by ambient AI and this will also be uploaded to the patient's phone.



Case Study: The Surgical Trainee

Dr. T is a surgical trainee assigned to Prof. S's clinical service. He is scheduled to assist Prof. S with Mr. P's cancer surgery and is expecting to perform some aspects of the surgery under supervision. Using AI simulation on the patient's digital twin model, he is able to practice some aspects of the case on the robot in advance. He has found that very helpful in the past. He has also studied the detailed AI analysis of the patient's case in advance including possible intraoperative scenarios. He is fortunate that there was a large AI and digital surgery investment in his hospital, not all his peer group have access to such facilities.

Overall he is very happy with the use of AI as an adjunct to his clinical training. He does feel that his time to interact with patients is less than that of an earlier generation, although he does think that AI and virtual reality simulation are quite realistic. He is also concerned that he could become dependent on AI with a deterioration in his critical thinking skills. However, his learning analytics have placed him in the 90th centile of his peer group and he is expecting to receive his certificate of competency a year earlier than expected.

6. Preparing the Surgical Workforce for AI and Digital Technologies

The increasing complexity of surgical care, alongside evolving technologies such as robotics, digital imaging, and data-driven decision-making, necessitates a parallel evolution in how surgeons are trained. It is essential that AI is implemented in a manner that augments rather than replaces traditional surgical training, maintaining the central role of supervised clinical experience and professional judgement.

Preparing surgeons for the advent of these novel AI & digital technologies requires a two-pronged approach to training. Firstly, it is essential that surgeons are literate in these technologies and understand the basic principles underpinning AI technology, digital medicine and data science. Surgeons should understand their capabilities and limitations and they should possess the skills and attributes to allow them evaluate, implement and use specific technologies as they become available. This includes the ability to interpret AI-generated outputs, critically appraise decision-support tools, and recognise issues such as bias, data limitations, and uncertainty.

In addition, surgeons will require particular training for specific novel devices or clinical platforms. The more the AI mimics the role of the clinician, the more critical our full understanding of AI becomes.

RCSI has a central role in the determination of post-graduate training needs, including those of surgical trainees as well as established surgeons. It should define essential digital literacy and how surgeons can achieve this. It should determine how best this training and education can be delivered on an ongoing basis, taking into consideration the ever-changing landscape in this sphere. AI and digital technologies should be embedded within surgical curricula as core competencies rather than optional or supplementary components.

6.1 Basic AI and Numerical Literacy

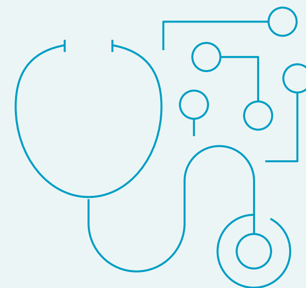
6.1.1 Core Skills in Data Science and AI

Surgeons should have a basic understanding of artificial intelligence as well as numerical and data science concepts. They should have knowledge of different types of AI, how they work and how to evaluate their risks and limitations. They should understand the different types of data, how these are used to train AI models as well as data governance and privacy. Surgeons should also be aware of the ethical and societal implications of AI. This fundamental understanding is essential to allow us properly evaluate and implement specific new AI and data applications in the way that best benefits our patients and society.

This fundamental knowledge of AI and informatics is also essential for discussion and problem solving with technical information technology teams.

The basic core competencies for understanding AI and digital surgery are as follows:

BASIC CORE COMPETENCIES



Understanding Basic Concepts:

Algorithms, datasets, how models are trained, types of learning (e.g. supervised vs unsupervised), bias, overfitting etc.

Different Types of Models and AI Systems

Large Language Models (LLM), Deep Neural Networks, Convolutional Neural Networks (CNN), Agentic AI.

Ethical and Legal Awareness

Regulations surrounding patient data and privacy (e.g. GDPR compliance, de-identification, consent, etc). Ethical implications of AI decision making. Accountability. Safety of systems.

Critical Thinking

Interpretation of outputs from AI models and critical evaluation of results.
Validity and applicability of AI tools in clinical practice, including practical understanding of biases in AI models.

Understanding Interfaces and Workflows

How AI can be implemented into current workflows. How workflows can be adapted to accommodate AI. Human/ machine interface.

Adaptability and Lifelong Learning

Understanding the rapid pace of change in AI and data-science. Continuous education in both surgical advancements and evolving AI technologies. Flexibility and ability to adapt to new tools and methodologies as AI technology evolves.

Communication Skills

Ability to clearly and effectively communicate the role, benefits and risks of AI to patients. Effectively communicate with information technology professionals to improve digital technology performance as well as to troubleshoot problems.

6.1.2 Learning Needs Assessment and Development of Core Curriculum

RCSI has a central leadership role in defining these competencies and ensuring their consistent integration across all stages of surgical training, from core surgical training through to higher specialist training and continuing professional development. The RCSI Expert Group on New Technologies for the Future of Surgery in Ireland highlighted unfamiliar equipment, incomplete evidence, and responsibility as the decision maker as key challenges facing the introduction of new technologies (RCSI, 2024).

These basic core competencies to understand AI and digital medicine are required by surgeons. In this way we can build a surgical workforce which can best assess, implement, utilise and monitor new technologies in their hospitals and practices. These core competencies should be introduced into the surgical curriculum.

6.1.3 Current Digital Skills Assessment

Currently there is a wide range of digital literacy within the health service ranging from leaders in this technology to those with little or no digital literacy. There is also a generational difference in digital knowledge and skills.

The NHS has developed a self-administered digital skills assessment tool for healthcare workers. (NHS, 2025) which can highlight deficiencies and direct staff towards useful learning resources. RCSI should consider offering digital assessment tools to surgical staff.

6.1.4 Implementation of Skills into Training and CME

Structured training is required to bridge the gap between current skills and knowledge of the workforce and that which is required to allow surgeons play a central role in the introduction of AI into clinical practice.

This could include:

- **High Quality Learner-Orientated Courses**
  Short courses and workshops to upskill the workforce in development and application of AI/Digital Medicine techniques, ethical aspects and pitfalls.
- **Sessions at National Meetings**
  e.g. Charter Week, Millin, Freyer, Sylvester O'Halloran, Waterford Surgical etc.
- **Incorporation into Regular Trainee Days in RCSI**
- **Online Platforms**
  Regular updates on developments in AI in the Alumni Magazine, blogs or on other online platforms.
  RCSI's current free-to access online course on Artificial Intelligence in Healthcare.
- **Development of Online Training Tools**

In addition to the online course on Artificial Intelligence in Healthcare, RCSI already provides CPD courses such as Digital Health Technologies, Foundations of Digital Health, Personalised Healthcare and many others. The Professional Development and Practice Committee should continue to introduce these training methodologies into Continuing Medical Education (CME).

6.2 Training of Surgeons in the New Devices

Along with the availability of technology infrastructure, the most important prerequisite is the training and expertise of staff to deploy and utilise it properly. This will require proper governance, resources, time for staff training, etc.

Before the introduction of new technology, surgeons must be familiar with the specific device or technology and understand its indications and role in clinical practice. They must have hands on surgeon-

led training on simulators or on animate, inanimate or cadaveric models. Depending on the device, they may need initial proctoring.

6.2.1 Who Provides the Training?

Ideally, training in novel technologies should be provided by the RCSI and/or specialty societies. In order to scale up training programmes quickly, technical and/or financial support of industry and the HSE may be required.

In the past, for some devices such as the surgical robot, initial training has been provided almost exclusively by industry. However, we believe that the RCSI in conjunction with the specialty societies must play a more central role in the provision, evolution and assessment of this training.

In the case of established devices where there is significant local expertise, initial training may be provided by the RCSI and/or specialty societies in conjunction with local trainers in the individual institutions.

6.2.2 Regulation of Industry-led Training of Surgeons in New Devices

While RCSI welcomes the partnership of industry in the training of surgeons and surgical trainees in new technology, standards should be set and maintained under the auspices of the formal Continuing Professional Development (CPD) structure maintained by RCSI. It is the responsibility of the individual surgeon to ensure that he or she is fully competent before using any new device.

6.2.3 What is the Role of the HSE/Hospital?

The HSE has a critical role in planning the health services including consideration of longer-term population initiatives. Proper planning and integration of future technology is imperative. Through the surgical programmes, RCSI is committed to working with the HSE to integrate these new technologies into practice for the benefit of the patient and for the health service as a whole.

6.3 Ongoing CME

Given how these technologies are likely to influence our practice as well as the rapid rate of innovation, it is important that practicing surgeons keep abreast of these developments in this area. This should be implemented into ongoing Continuing Medical Education (CME) programmes.

Regulators will want to ensure that new technologies and AI are used by trained and competent surgeons. The pace of change will be ever evolving, so RCSI will support Fellows and Members through up-to-date CPD courses and skills masterclasses on the changes to practice. Documentation and confirmation of the acquisition of skills in using the new technologies will be important to reassure patients and regulators.

6.4 Establishment of Leadership Programmes

While it is expected that all surgeons using these digital technologies will be competent in their use, it is also necessary that a cohort of surgeons are trained to provide leadership in this area. Leadership qualifications from RCSI including the Professional Diploma in Leading Digital Health Transformation could equip surgical leaders to work with healthcare managers and other clinicians to lead implementation of these systems, integration with current workflows and develop robust governance programmes. These leaders may also help change healthcare culture which may be required to operate these systems optimally.

RCSI should also work with HSE initiatives such as the Spark Innovation Programme and with the Irish Surgical Training Group.

AI-generated

7. Governance of AI and Digital Surgery

Surgical governance is an essential framework for modern healthcare delivery. It supports clinicians in the delivery of high-quality safe patient care while maintaining best practice, optimal outcomes and minimising adverse events. It provides for robust risk management and accountability and helps us meet our legal and regulatory requirements. It facilitates the continuous improvement required in any ever-changing system. The principles of Surgical Governance are outlined in a recent RCSI publication *"A Framework for Surgical Clinical Governance"* (RCSI, 2026). These principles also align with recent framework documents on Digital Medicine and AI published by the Irish Government and the HSE (Rialtas na hÉireann 2024, Health Services Executive 2026).

Innovation has always played a central role in the development of surgery. With the advent of new digital technologies and artificial intelligence, this process has accelerated with the potential for extensive opportunities but also widespread disruption to the delivery of surgical care. These technologies are evolving very quickly and may not always behave as expected in the real world setting (Bean et al., 2026). The interface between humans and AI may determine outcomes in unexpected ways. We need to set clear goals and determine if they are being met. We must ensure that the patient remains central to the process.

Robust governance and leadership are essential and surgeons have a central role in governance both at national and local level. Proper engagement of surgeons with healthcare providers, regulators and patient advocates will ensure that the new technologies are introduced, utilised and continuously improved safely and responsibly with optimal benefit to patients and the healthcare system.

There are a number of distinct roles for the surgeon in the governance of the lifecycle of AI and digital medicine technologies including the identification of clinical need, their implementation in clinical practice, the ongoing monitoring and risk management and the continuous improvement of the use of the technologies after implementation. This will ensure that the technologies operate safely, effectively and as envisaged.

7.1 Implementation of New AI or Digital Technologies

The main roles of the clinician in the development and implementation of AI are in determining need, clearly setting goals, overseeing datasets, testing and validation, cost effectiveness and ensuring implementation in a safe and predictable way.

7.1.1 Identifying the Need for AI and Digital Medicine Technologies

Surgeons should identify the need for new AI and digital technologies within their clinical practices. These should have clear clinical benefit to patients and be cost-effective. The goals and outcomes of the technology should be clearly defined.

The need for these technologies should also have the support of specialty groups or the Clinical Programmes in RCSI. Important factors include: clinical evidence, clinical need, ethical issues including impact on patients, cost effectiveness, etc.

7.1.2 Development and Approval of Proposals

Proposals for the implementation of AI and digital technology in an individual hospital, Regional Health Area (RHA) or nationally may be developed by individual surgeons or groups of surgeons in association with hospital, RHA or national governance structures. Proposals should include clinical evidence for benefit, safety, risks, regulatory and ethical issues, training requirements as well as a business case.

These proposals should be approved by the healthcare provider prior to implementation.

It is advised that these technologies are implemented through the healthcare providers and not by individual surgeons.

7.1.3 Training and Competency Assurance

Before using new technologies, surgeons must be familiar with the techniques and demonstrate training and competency prior to introduction (This is covered in section 6).

Surgeons and institutions must ensure that they are equipped to deal adequately with possible complications.

7.1.4 Implementation

Surgeons should play a central role in the implementation of these AI and digital technologies to ensure that the goals are clearly defined, that the user interface is appropriate and that the ethical and governance oversight is in place. Surgeons have a critical role in the design and implementation of the interface between the technology, the healthcare worker and the patients.

Implementation should also include robust data governance structures and compliance with GDPR. It is essential that data architecture is designed correctly, with a clear understanding of the data to be shared and clear standards for the processing and sharing of health data to ensure reliability, security and privacy both for the patient and for healthcare professionals involved in the patient's care.

7.1.5 Integration of Systems

Digital systems in Ireland have developed in a piecemeal way and it is essential that systems of the future are properly integrated and connected. Data should be stored in a way that facilitates its sharing by different components of the system as appropriate.

7.1.6 Patient Consent

Patients should be informed when AI plays a material role in their diagnosis, assessment of risk or delivery of clinical care. Reliable processes for providing patient information, resolving patient queries and obtaining patient consent should be established. This should be clearly documented in the patient record.

7.1.7 Human in the Loop

It is important that the surgeon remains central to the delivery of clinical care, that there is always clinical oversight and that the final decision is made by the clinician. This is known as "human in the loop". This is to ensure safety and accuracy and to ensure an ethical and human-centred approach to surgical care.

7.1.8 Early Phase Audit and Monitoring

In the case of novel technologies, introduction should be carefully controlled with monitoring of key indicators through multi-disciplinary team meeting (MDT) and morbidity and mortality meeting (M&M) processes. Depending on the outcome of this review, technologies may be retained or rolled out elsewhere.

7.1.9 Legal and Ethical Responsibility of Technology Company/Developer

Most medical devices incorporating AI (including diagnostic or therapeutic systems) are classified by the AI Act (European Parliament, 2023) as high risk systems as they may negatively affect safety or fundamental rights. These devices require a CE mark through a notified body (e.g. National Standards Authority of Ireland NSAI). This requires a detailed Health Technology Assessment (HTA) including the establishment of technical documentation and clinical evaluation. Currently, HIQA is the relevant body for HTA in Ireland (Health Information and Quality Authority, 2018), but the EU is developing a European-wide framework to avoid duplication and to streamline the process. High risk medical devices must be registered with the Health Products Regulatory Authority (HPRA).

Generative AI such as large language models are not classified as high risk but do have specific requirements such as the disclosure that the content was generated by AI.

7.2 Ongoing Governance of AI and Digital Technologies

7.2.1 Governance in Individual Hospitals

It is essential that the operation of AI and digital technologies is carefully monitored in a reliable open and transparent way on an ongoing basis. Surgeons should monitor the outcomes of new technologies in relation to effectiveness, safety, known or unknown risks and cost.

In individual hospitals, these processes should be incorporated into the existing surgical governance structures including MDTs, M&Ms, Risk Management and Clinical Audit. Consideration should be given to the establishment of a dedicated committee to oversee the implementation of new technologies and associated clinical pathways. There should be close engagement with the Clinical Director and/or Perioperative Clinical Director, Hospital Quality, Safety and Risk as well as the overall hospital management and the overarching Hospital Executive Management Board.

There should be sufficient safeguards for the implementation and use of AI. Quantitative metrics should be used to ensure reliability and reproducibility. Where possible, performance should be benchmarked and compared to Key Performance Indicators (KPIs) when available. Audit loops should be closed. Adverse incidents should be reported as per the HSE Incident Management Framework, effectively communicating findings and insights with colleagues and team members. Feedback of errors or inconsistencies should lead to learning by the system.

7.2.2 Supervision of Autonomous or Semi-Autonomous Systems

Autonomous or semi-autonomous operating systems should be supervised by the responsible surgeon at all times. The abiding principle should be of "human in the loop". AI does not make final clinical decisions, it should be considered as a support tool for the clinician. A human must always be in the loop, the consultant surgeon will always make the final decision and will take responsibility for this.

7.2.3 Documentation

Clinical records should document where AI was used in clinical diagnosis, assessment or treatment and how the decision of the AI classifier was incorporated into the final clinical decision. All planning should be verified by the clinical team, and this should be documented in the patient records. Careful records detailing the use of new technologies should be maintained and these should be subject to audit.

7.2.4 Data Governance, Privacy and Cybersecurity

All data used in decision making should be accurate and verifiable to ensure valid and fair outcomes. In addition, algorithms used to make these decisions must also have been determined to be effective and reliable.

Data governance structures should be established in each hospital, the exact structure to be decided based on local needs. However, membership may include the Chief Information Technology Officer, Information Technology/Cyber Security Lead, Medical Records/EHR Officer, GDPR Officer, Quality and Safety Lead and representatives from Nursing, Paramedical and Medical staff (including Surgery).

Data governance should identify data owners, stewards, access rules and audit trails.

Ideally, all digital technologies should have the ability to interconnect hospitals and should enforce interoperability standards (such as HL7 FHIR, DICOM) as well as role-based access. Consideration should also be given to the cost of ownership of data, particularly as volumes increase.

7.2.5 Governance of Electronic Health Records

Strong governance is required for electronic health records. Essential among this is privacy protection with compliance with GDPR. In addition, there must be strong security including strong access controls, encryption, robust processes to audit the technology and management of data breaches.

EHR must comply with data standards for terminology, interoperability and communication. Surgeons and other clinicians have a major role in advising which data to collect and how it is processed and shared.

Processes to reduce error in recording and using patient data must be in place. This includes mandatory fields, consistency checking and protocols for the prompt entry of data.

Patients will increasingly access their EHR data, so it is important that this is considered in creating content.

7.2.6 Cyber Rescue Plans

Regular assessments of the technology should be undertaken including audits of effectiveness and compliance as well as ongoing assessment of risks associated with the processes. A clear crisis management plan which allows rapid access to patient record in the event of a major cyber incident or other failure of the technology should be in place.

This includes preparation and readiness, identification and assessment of the issue, limiting the impact, removing the threat, restoration of access to essential records immediately with access to all records as soon as possible and finally what lessons can be learned.

7.2.7 Resources

Given the known and unknown risks associated with these new technologies, it is essential that these governance structures are adequately resourced. Healthcare providers such as the HSE should provide administrative support including data managers, appropriate hardware and analytics to facilitate this.

7.3 Liability

Traditionally, the ultimate responsibility for clinical decision making rested with the responsible clinician. However, with the advent of these new technologies it remains to be seen what responsibility rests with the AI developer (in relation to design, training and validation), the healthcare provider (in relation to procurement, implementation and governance) and the regulatory bodies (in relation to establishing safety and efficacy standards).

Legally, this will be have to be tested in the courts, but currently to maintain patient trust, we will require humans in the loop. Material decisions must be made by the responsible clinician either before the decision is actioned or at least while it can still be corrected.

7.4 What is the Responsibility of Individual Surgeons?

- Understand the new technologies including safety and ethical risks and how to evaluate these.
- Advocate for the introduction of new technologies that offer clinical benefit for our patients and that are cost effective.
- Ensure that they have completed appropriate training in the use of a new device or technology before deploying it.
- Work with health authorities and patient groups to ensure that new technologies are optimally integrated into healthcare infrastructure.
- Support proper governance structures within our institutions to ensure that new technologies are monitored in relation to safety, benefit and cost.
- Uphold ethical principles, professional responsibility, accountability and clinical oversight at all times.

7.5 Regulatory and Ethical Control of AI

Artificial intelligence may be seen as a new form of agency which interacts with the world, which learns from the data it receives and which, if used properly and remains under control, may provide solutions to many of our most pressing problems in healthcare. However, there are significant safety concerns related to technology not behaving as planned whether this is because of poorly defined goals, bad actors, prioritisation of technology development over safety or a variety of other reasons. The question of how much autonomy to give to this technology is real, particularly in the era of agentic AI with the real risk of agents operating independently and out of control.

AI must be subject to legal and ethical principles which must prevent harm and injustice but which must not inhibit its potential to do good. Legal regulation, such as the European AI Act 2024 is important to enshrine standards in law. However, law is a set of constraints, is not a guide to behaviour, does not comment on many issues and may sometimes be unethical or unrepresentative of human values. Regulation cannot keep pace with the rapid pace of development in this space and over-regulation will hinder proper development of AI. Regulation must be complemented by ethical principles which are context-driven with minimal rules. AI should adhere to the ethical principles of beneficence, non maleficence, autonomy, justice and explicability and should provide benefits for the autonomy of the individual, what we can do, what individuals and society can achieve and how we can interact with others and with the world (Floridi et al., 2018).

The balance between ethical and legal principles is essential to simultaneously facilitate and control AI and this must be shaped by society. Surgeons and other clinicians have a critical role in working with developers, legislators, regulators, ethicists and the public to ensure that AI and digital medicine are implemented effectively, efficiently, transparently and ethically for the benefit of our patients and for society.

7.6 RCSI's Role in AI and Digital Medicine Policy

As a long-established leader in healthcare delivery, with a wealth of highest level domain expertise, RCSI has a long track record of working with many national and international bodies on policy, regulatory and legislative frameworks to help guide the development of surgery and surgical practice. RCSI has a significant collective role in collaborating with bodies such as the healthcare providers, legislators, regulators, industry and the public to help develop AI and digital medicine policy, regulation and ethical oversight.

A dynamic, collaborative approach is required to anticipate opportunities and challenges in this rapidly changing ecosystem. This collaboration should be underpinned by a commitment to improve efficiency, quality and safety of healthcare delivery by aligning strategic vision in a patient-centred approach. We must deal with new and unforeseen opportunities and threats. RCSI has the ability to offer agile strategic advice on the types of technology which should be implemented, what clinical benefits could be expected and what cost savings could be achieved.

7.6.1 Establishment of New Expert Committee in AI and Digital Surgery

The field of AI and digital medicine is changing at an unprecedented rate, much faster and in a more unpredictable fashion than anything seen before. We recommend the establishment of a new Expert Committee in AI and Digital Surgery to advise RCSI on these rapid developments and the possible responses of the College. A dedicated forum for deep discussion of developments in AI will allow for faster, more proactive and better informed strategic decision making, as well as mitigation of risk. It will have an important role in shaping and evolving governance of AI in Surgery.

This Committee will report to the Committee for Surgical Affairs. However, it will engage with and provide advance updates to other RCSI committees where significant developments in AI will impact on their roles. It will ensure that the College is well positioned to proactively interact with and advise the appropriate stakeholders (including regulators, legislators, developers, healthcare providers and the public) on the surgical and ethical considerations of AI and Digital Surgery.

7.6.2 Educational Role

We recommend that this is provided by the Professional Development and Practice Committee (PDP) and the Irish Surgical Postgraduate Training Committee (IPSTC). This would include defining skills required, implementation and provision of training, as well as ensuring compliance with regulatory and legislative requirements.

The Chair of the Expert Committee in AI and Digital Surgery would sit on the PDP Committee.

7.6.3 RCSI and Research Collaboration

RCSI is centrally placed to interact with the other Universities nationally and internationally to help develop and validate AI and digital technology in surgical practice, to establish collaborative research initiatives, to share expertise and to obtain research funding.

Ireland hosts the European headquarters of many of the major technology companies and has a very well-educated work force in this area. RCSI will continue to develop its links with these companies to help establish Ireland as a global hub in the development of AI technologies in Surgery.

8. Use of AI and Digital Surgery to Facilitate Training

Artificial intelligence and digital technologies are increasingly employed to help prepare the surgical workforce for clinical practice. These technologies have the potential to transform surgical training from a predominantly time-based model to a competency-driven, data-informed training system, enhancing both the efficiency, consistency, and quality of training.

AI provides an opportunity not only to improve how technical skills are acquired, but also how judgement, decision-making, and system-level understanding are developed and assessed.

8.1 Simulation, Robotics and Digital Training Environments

AI-enabled simulation platforms represent one of the most immediate and impactful applications of AI in surgical training. Technologies such as Virtual Reality (VR) and Augmented Reality (AR) provide highly realistic, reproducible, and scalable training environments. These platforms allow trainees to practice complex procedures in a risk-free setting, gaining experience in both routine and rare clinical scenarios.

AI enhances these environments by enabling adaptive learning. Simulation systems can analyse trainee performance in real time and adjust difficulty levels, introduce complications, or focus on specific skill deficits. AI could also generate complex clinical scenarios to allow trainees develop and hone their problem-solving skills. These technologies could also be used for established surgeons to maintain skills, particularly in techniques not frequently performed.

8.2 Robotic Assisted Surgery

Robotic-assisted surgery is a key domain where AI and surgical training intersect. As robotic platforms become increasingly embedded in surgical practice, structured and standardised training pathways are essential. RCSI's development of curricula for robotic-assisted surgery provides a strong foundation for ensuring competence in this area.

AI-enhanced robotic systems may further support training by providing objective metrics on performance, including instrument handling, motion efficiency, precision, and error rates.

8.3 Digital Twin

The concept of the "digital twin" represents a significant future development, where trainees may rehearse procedures on patient-specific models derived from imaging and clinical data.

8.4 AI and Assessment of Training

8.4.1 Learning Analytics and Performance Assessment

AI offers significant opportunities to enhance the assessment and monitoring of surgical training through advanced learning analytics. By analysing large volumes of data from logbooks, simulations, video records of operative procedures, and clinical outcomes, AI systems can provide objective, continuous, and granular assessment of trainee progression.

This supports personalised training pathways, early identification of trainees requiring additional support, objective benchmarking, and improved documentation of progression. It is very important that any data analytical or AI structure to evaluate performance is properly validated. The HSE has recently funded the National Learning Analytics Unit (NLAU) to establish proper systems of evaluation and governance around this.

8.4.2 Feedback, Benchmarking and Quality Assurance

AI has the potential to significantly enhance feedback mechanisms within surgical training. Real-time or near-real-time feedback can complement traditional trainer-led feedback, improving its timeliness and objectivity.

At an organisational level, RCSI can leverage AI to support benchmarking and quality assurance across training programmes. Aggregated data may allow comparison of performance across institutions and specialties, identifying variation and informing targeted interventions.

8.4.3 Role of AI in Supporting Trainers and Training Systems

AI tools may assist in curriculum delivery, case selection, and allocation of training opportunities, ensuring appropriate exposure to clinical cases. AI may also support administrative aspects such as documentation and reporting, therefor reducing administrative burden.

At a system level, AI can support workforce planning by analysing training outputs and service demands.

AI will be a critical enabler of modern surgical training, supporting simulation, personalised learning, performance assessment, and quality assurance. RCSI is well positioned to lead in this area by embedding AI within curricula and leveraging data to enhance training outcomes.

8.5 Research into Digital Enhanced Learning

With its extensive experience in delivering and evaluating training, RCSI is uniquely positioned to study the implementation and outcome of digital methods used for teaching and training.

9. Summary of Key Recommendations

9.1 Training and Education of Surgeons in AI / Digital Medicine

- RCSI should define and establish a comprehensive curriculum that includes fundamental concepts of AI, data science, and digital medicine tailored specifically for surgical education. This should encompass core skills, theoretical knowledge and practical competencies.
- Core competencies should be introduced into the surgical curriculum. Continuing Medical Education programmes should be introduced and continuously updated to provide training in AI and digital skills.
- The Professional Development and Practice Committee should work towards setting and maintaining standards in training in new devices.
- RCSI should continue to develop AI, augmented and virtual reality techniques to facilitate training and personalised learning in surgery.
- RCSI should explore the methods of assessing training by means of learning analytics.
- RCSI should focus on programmes to develop leaders within the surgical community who can champion the adoption of AI and digital technologies both in their institutions and at a national level.

9.2 Establishment of Governance Structures within the Health Services

- Healthcare providers in conjunction with surgeons should design governance frameworks that outline responsibilities and processes for the implementation of AI technologies. This should include guidelines for ethical considerations and standards of practice. The Government of Ireland and the HSE have already published detailed framework documents on Digital Health and AI for Health which will form a basis for this (Rialtas na hÉireann 2024, Health Services Executive, 2026).
- Governance structures should be established for ongoing governance of AI and digital surgery. This encompasses assessment of their impact on patient care and safety and should include audit and feedback mechanisms.
- Data governance structures should be established in each hospital. This should cover both AI and electronic health records with an emphasis on data security and privacy as well as cyber rescue plans.

9.3 Role of the Individual Surgeon

- Surgeons should understand new technologies, help implement these when appropriate, undergo relevant training before use and support proper governance structures.
- Surgeons should uphold ethical principles, professional responsibility, accountability and clinical oversight at all times.

9.4 Establishment of Governance Structures within RCSI

- RCSI should establish an Expert Committee in AI and Digital Surgery which would report to the Committee for Surgical Affairs.
- The Chair of the Expert Committee should sit on the Professional Development and Practice Committee to help advise on educational requirements.

9.5 RCSI Liaison with External Bodies

- RCSI should work with health service providers, legislators, regulators, patients and other stakeholders to align standards, develop policy and progress ethical frameworks for the introduction of these technologies into clinical practice.
- RCSI should work with other higher education institutions and industry to explore, develop and evaluate innovative applications of AI and digital surgery in the surgical setting.

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