

THE FUTURE

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Minimal access surgery has changed surgical practice; however, it has not changed the nature of disease. The basic principles of good surgery still apply, including appropriate case selection, excellent exposure, adequate retraction and a high level of technical expertise. Endoscopic and robotic surgery training is key to allow the specialty to progress. The pioneers of yesterday have to teach the surgeons of tomorrow not only the technical and dexterous skills required but also the decision-making and innovative skills necessary for the field to continue to evolve. Training is often perceived as difficult, as trainers have less control over the trainees at the time of surgery and caseloads may be smaller, especially in centres where laparoscopic and robotic procedures are not common. However, trainees now rightly expect exposure to these procedures, and training systems should be adaptable for international exposure so that these techniques can be disseminated worldwide. The predominant video and digital component of these new techniques opens the door for simulation approaches for training in these modalities, which have demonstrated benefits in reducing learning curves and in turn are aimed at improving patient outcomes. The ultimate goal for this educational approach is to develop expert surgeons through the 'totally safe' and 'risk-free' environment of simulation before they

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actually have to operate on patients. Indeed, both videoscopic and robotic platforms now have established simulation programs that are a prerequisite for surgical trainees. Modern robotic simulation modules are able to create an environment that mirrors console use (face validity) and subsequently vide hierarchical training compatible with the user's expertise. The combination of simulation with proficiency-based 'mastery' training may be the key to optimising the impact that simulation may have on the surgical learning curve and remains the subject of research in a range of surgical specialties. With widespread uptake of minimal access surgery, trainees are now facing a new problem owing to lack of experience in open surgery. Surgeons must have sufficient open surgical experience to feel comfortable converting cases in the event of difficulty or emergency. A minimal access approach to a particular procedure may differ significantly in the

order of operative steps and dissection technique. It is therefore vital that the new generation of surgeons continues to receive training in open surgery so that they can apply either technique as appropriate. Advances in robotic surgery lend themselves to further AI integration, with potential advantages such as providing enhanced clinical decision support, warning of deviation from optimal workflow or detecting and overlaying potentially at-risk structures. In this way, artificially intelligent systems may streamline procedural technique, reduce error and improve patient outcomes. Intelligent operating theatres may provide automated optimisation of a wide range of ergonomic features such as table positioning, lighting and temperature, further facilitating procedural efficiency and effectiveness. In turn, more advanced artificial systems may also develop a degree of supervised autonomy whereby basic surgical procedures can be independently performed by the robotic system. Indeed, Berkeley George Andrew Moynihan (Lord Moynihan), 1865–1936, Professor of Clinical Surgery, Leeds, UK. Moynihan felt that English surgeons knew little about the work of their colleagues both at home and abroad. Therefore, in 1909, he established a small travelling club which in 1929 became the Moynihan Chirurgical Club. It still exists today. He took a leading part in founding the until his death. Robot) robotic system has demonstrated superiority over human surgeons in porcine bowel anastomosis. Translation of such laboratory-based experiments to real-world surgery is not simple. Application requires detailed understanding of surgical workflow and integration of complex data. To provide a fully comprehensive, annotated training data set on which deep learning may be established, all devices and systems in the dynamic operating environment must be integrated, including operating room set-up, tool and camera usage and the variable patient and procedural factors. In addition there are complex questions in terms of data protection and confidentiality, not to mention the ethical considerations and accountability of autonomous or semi-autonomous robotic surgeons. The most promising elements of AI integration into minimal access surgery remain enhanced object detection, speech recognition, video characterisation and integration with next-generation technologies. Real-time metabolic profiling and tissue-level diagnosis may differentiate between cancerous and non-cancerous tissues on the basis of their metabolic signature. An example is the iKnife, which uses a rapid evaporative ionisation mass spectrometric (REIMS) technique to report tissue histology in real time by analysing aerosolised tissue during electrosurgical dissection. Artificially intelligent systems also hold potential to dramatically improve the fidelity of simulation training in minimal access surgery, through the creation of a 'real-world' training environment based on the vast data accrued in their development. Such data may be used to create a dynamic simulation environment for any procedure, much more akin to that of 'real-life' surgery. This holds potential for a stepwise tutorial system similar to that of bedside teaching, with objective feedback provided against standardised proficiency benchmarks that can be easily integrated into national training programmes. One major obstacle for minimally invasive technology remains the cost efficiency and device financing in an increasingly rationed global healthcare environment; this is an issue that will require surgical liaison with hospital management and national policy providers. Surgeons need to continue to have a dialogue, discussing their experiences and ideas in order to effectively progress minimal access surgery and continue to adopt novel technology. As technological advancements are adopted, carefully designed outcomes research is required to provide a clear evidence base to support changes to clinical practice. In this way the comparative effectiveness of novel minimal access technologies will be better understood in terms of both clinical outcomes and cost-effectiveness, allowing selection of those with the greatest potential to provide lasting

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