Royal College of Surgeons of England
ADVANCING SURGICAL CARE

Robotic-assisted surgery

A pathway to the future

December 2025

Contents

1. The current state of robotic-assisted surgery

Robotic-assisted surgery (RAS) was first introduced in the UK in the late 1990s with robotic systems such as AESOP and ZEUS, followed by the da Vinci system in 2000. Since then, nearly 17 million operations have been performed worldwide as of the end of 2024, with more than 2.68 million in 2024 alone, and several newer robotic platforms have emerged in recent years. In 2018, a Royal College of Surgeons of England (RCS England)-led commission on the future of surgery predicted the rapid expansion of RAS across the UK and internationally because of its proposed advantages in ergonomics and operative precision, as well as its potential for improving training and service practices.

The first robotic-assisted cases were in cardiac surgery. Urology subsequently drove adoption of RAS in conditions such as prostatectomy, and it has become the dominant approach for this operation. There is sufficient evidence to support this wide adoption, because RAS has been able to demonstrate a reduction in intraoperative blood loss, length of hospital admission and risk of positive cancer resection margins. For some surgical specialties, adoption of RAS is still in its early stages, but overall RAS has seen an increase in uptake over the past ten years, and is currently available in more than 150 hospitals in the UK. In addition to urology, RAS has become increasingly prevalent in general surgery.

The adoption of RAS has expanded significantly across many different types of procedure, on many parts of the body. These can be broadly categorised into RAS for soft-tissue procedures and RAS for orthopaedic procedures. In the former case, robotic technologies help surgeons carry out procedures in the soft tissues of the body, including refined dissection of blood vessels and internal organs. These technologies typically aim to increase control and precision in cutting, sealing and connecting soft tissues, as well as the visualisation of key structures. The application of RAS has enabled surgeons to safely perform radical surgery for cancer for instance, with the application of minimally invasive surgery. In the case of orthopaedics, robotic technologies help surgeons carry out procedures in the musculoskeletal system, and typically aim to increase precision in cutting bones and implanting medical materials.

Nevertheless, wide recognition of the potential and adoption of robotics has not moved as quickly as other surgical innovations, with the level of robotic adoption varying significantly across different surgical specialties. This is due in part to limited access to RAS platforms, compared with the introduction of laparoscopic surgery. The cause of such limited access is partly the acquisition and running costs of the technology, and partly the difficulty of obtaining multifaceted clinical outcomes and health economics evidence to understand the full impact of RAS implementation in the healthcare system. The challenge is to capture the benefits of RAS at both an individual specialty level and a systemic level, including clear evidence that confirms equivalence of outcomes to open and laparoscopic surgery to justify its cost effectiveness. Despite centralised approaches in Wales and Scotland, the lack of a national strategy in England and Northern Ireland has meant that the use of robotics is often based on the local availability of systems or local policies around the access of specialties to RAS systems, resources and expertise rather than a focus on patient suitability and overall care. This is gradually changing, with the help of guidance from surgical colleges and specialty associations (e.g. Royal College of Surgeons of England, 2023, 2025; British Orthopaedic Association, 2024) and the newly published guidance produced by National Institute for Health and Care Excellence (NICE, 2025) and NHS England (2025). In addition, RCS England has collaborated with a number of experts to set standards for surgeons, teams or services wishing to transition from open or conventional minimally invasive surgery to independent RAS practice. However, many challenges remain, including access to the required training, assessment, feedback and the support necessary to perform robotic surgical procedures competently and safely. There is a lack of clear and comprehensive descriptions of roles and responsibilities for the hospital, trust/health board, surgeon (as a learner and as a trainer), robotic company, proctor or regulators.

1.1 Aims of this document

This document complements the recently published Getting It Right First Time guidance "Implementation of robotic-assisted surgery (RAS) in England" (NHS England, 2025), and NICE Early Value Assessment guidance on robot-assisted surgery for soft-tissue (NICE, 2025) and orthopaedic procedures (NICE, 2025). The RCS England good practice guide makes additional recommendations for sound governance practices that can lead to the safe adoption and expansion of RAS in UK hospitals. The document also proposes a structured pathway for safe transition to RAS among established surgeons. In addition, it expands on the relevant roles and responsibilities of key stakeholders for ensuring safe and sustainable independent practice in RAS and aims to engage in a nuanced conversation around the challenges and possibilities of robotic surgery, to support local and national decision making.

NB: It should be noted that this document makes specific recommendations on metrics for demonstrating competence, including minimum numbers of cases, complexity of procedures, simulator exercises and completion scores. These numbers have been carefully considered by the College's Robotic And Digital Assisted Surgery (RADAR) group and additional consultations with selected experts and industry partners based on the expertise of practising surgeons and wider evidence trends. Clear and long-term evidence, however, is still sparse so the recommended metrics should be treated as indicative. This is an area of surgical practice that is developing at fast pace, so the College will continue to track evidence as this becomes more consistent and reliable and we will be updating the document accordingly, as new data emerge.

2. The promise and challenge of robotic-assisted surgery

The implementation of RAS has been considered disruptive, in the sense that its innovation has the potential to bring about radical change in the field. On the one hand, it can be seen as another tool for improving the technical aspects of surgery, with many operations being similar to their laparoscopic counterpart, requiring similar decision making and operative techniques. On the other hand, it has the potential to introduce a complete transformation of surgical provision: widespread implementation of RAS requires new areas of knowledge and full service realignment, workforce training, new clinical pathways and potentially a different configuration of the surgical team. In some cases, reconfiguration of space for larger equipment is also required, such as theatre floor reinforcement or the installation of multiple independent electrical circuits, although this is not the case for all robotic systems. As such, multiple stakeholders need to be considered: not only patients and surgeons, but also commissioners, regulators, policymakers, industry and others. The emergence of new companies providing robotic equipment adds to the complexity with differing platforms, consoles and delivery systems.

The multidirectional implications of robotic technology make assessment of its benefits and downsides very complex. There has yet to be a clear consensus on how these should be measured, and which outcomes or benchmarks should be used to determine its clinical and economic value. As such, several stakeholders remain uncertain, seeing it as slower and more costly than laparoscopic surgery, certainly during the learning phase. Yet there is general drive towards RAS as recent reports suggest that nine out of ten keyhole procedures will be performed robotically in ten years' time (NHS England news, 11 June 2025).

Nevertheless, studies across a variety of surgical procedures demonstrate significant advantages of RAS, particularly when performed by experienced robotic surgeons, on appropriately selected patients and in advanced programmes, with the correct infrastructure. These advantages include increased patient satisfaction, reduced overall complications, reduced conversions to open surgery, reduced postoperative pain, more efficient use of anaesthetics, reduced perioperative blood loss, fewer blood transfusions, improved bed utilisation, shorter hospital stays, faster return to work and family, and lower rates of return to theatre. To benefit from the potential advantages of RAS, however, any investment in purchasing robots needs to be accompanied by proper planning for its introduction into the service. This includes the potentially long learning curve for surgeons and theatre teams before these efficiencies can be observed at a large scale.

In the area of patient safety, the suggested benefits are significant. For example, most platforms provide a magnified, three-dimensional image of the surgical site, tremor elimination, motion scaling and instruments that increase freedom of movement, while newer platforms include even more enhanced technologies such as eye tracking and haptic feedback – all these in combination can be argued to increase precision and reduce the likelihood of surgical error. At a time when there is less exposure of resident surgeons to in-depth procedural training, RAS could allow for increased safety across the spectrum of case complexity, and expand both the capacity of the surgical workforce more broadly. Training the future generation of surgeons while current consultants are being trained is another area of focus.

Despite this evolution of robotic technology over the past 30 years, there is still considerable work to be carried out by all relevant stakeholders to overcome the challenges it poses. The elevated cost of commercially available robotic equipment is often cited as one of the reasons for the slower adoption of robotic technology. It is difficult to quantify precisely the cost effectiveness of robotic adoption; a number of studies suggest that RAS will always be more costly to the NHS because of the cost of acquisition, training and maintenance of the robotic system, including the cost of disposables and energy use. It is likely that such costs can eventually be reduced by application to a larger volume of patients and by taking account of efficiencies, such as possibly reduced operating time and reduction in length of hospital stay, both of which can be improved when the surgical team is experienced and well-trained in RAS. It is possible that the costs of purchasing and maintaining the robotic system may also reduce through commercial negotiation, particularly as more companies bring systems to market. The iceberg model of costs and hidden costs can showcase the benefits and how those could offset overall costs by way of reduction.

One of the main challenges of RAS is the lack of consistent and sufficiently comprehensive data to adequately evaluate robotic technological advancements, such as collaborative multicentre cohort studies, registries and large data sets that can reveal patterns, trends and associations across the spectrum of relevant surgical procedures (including in relation to human behaviours and team interactions). This means that there needs to be more research of all types, from randomised trials to cohort studies and large data sets, and a meticulous investigation across all specialties that utilise RAS to demonstrate improved instrumentation accuracy, operative efficiency and patient safety. RAS will also come with its own set of complications, which may be different from other methods of operating, and have to be identified and fully understood.

In addition, there is currently no national, multistakeholder strategy to support the adoption and growth of RAS, and no robust regulatory framework to delineate the responsibilities between the technology and the surgeon, and to determine the roles and relationships of the various stakeholders. This inevitably results in variations in governance processes and in the availability of robotic technology, and has an adverse impact on quality control and equity of access for patients.

It is essential that national training standards are developed to enhance the readiness of the workforce to meet this rapidly expanding robotic technology. National guidelines are needed to standardise several aspects of RAS practice, such as the metrics needed to quantify quality, skills and expertise and to determine competence. This includes the nature of tasks that should be evaluated, minimum volumes of procedures and relevant clinical outcomes. Standardisation can also include a provisional selection of procedures that are suitable for RAS, although it is important not to be too prescriptive on this because the field is still evolving.

The following sections aim to put forward a series of principles and recommendations for establishing a robust training programme on RAS and for introducing RAS into service.

3. Establishing a training pathway for robotic-assisted surgery

There are no national/NHS protocols or minimum requirements for robotic training of either established surgeons or surgical residents/surgeons in training, although a number of organisations have developed curricula to support surgeons' exposure to basic robotic technology. These curricula do not match the Intercollegiate Surgical Curriculum Programme (ISCP) and adoption is entirely dependent on access to the platforms. Such training may vary based on the specialty, procedure and the various tasks involved, but they should entail both robotics-related technical and non-technical skills, including decision making, troubleshooting and effective communication. Training in robotic surgery can generally be divided into four sequential stages: e-learning, device training, simulation and hands-on procedure-based training.

3.1 Minimum requirements of robotic-skills training for established consultants

We recommend that a minimum training in robotic skills should include the following elements:

- **Online training**. This should include foundational learning on general robotic principles and general, platform-agnostic skills to ensure early-career surgeons are safe to enter a robotic theatre. In addition, basic training in specific systems, normally specified by the respective robotic system provider, can introduce learners to the various components of specific robotic platforms, common applications and troubleshooting tips, and include an assessed component that leads to a Certificate of Completion. This area can also include review of videos and other online learning material.

- **Virtual reality training, competency-based and using a console-based skills simulator and/or wet lab training (a minimum indicative number of 30 hours and dexterity/accuracy scores above 90% for all parameters)**. Learners here obtain hands-on experience with the functionality of the robotic platform. Simulation allows for progress through the learning curve and can be transferable to the clinical setting. Most simulators have a variety of exercises dedicated to technical training for camera clutching, instrument manipulation and switching, use of surgical energy and other skills. Learners can progress from virtual reality training to dry and wet lab training. The latter enables the learner to take particular steps of the procedure using low- and high-fidelity models (hydrogel models, animal models or in a cadaveric training centre and/or in simulated models).
  A dedicated RAS training curriculum should include didactic instructions for:
  - technology introduction on the specific robotic system;
  - basic console orientation;
  - cognitive skills training;
  - psychomotor skills training;
  - team training/communication skills;
  - basic and intermediate surgical skills;
  - procedure-based, speciality specific skills.

- **Observership**. There are currently two ways through which peri-CCT or established surgeons are introduced to robotics: a fellowship or as a consultant already in post. The requirements of observership and the interaction with the trainer will be slightly different in each case.
  - *Observership for a robotics fellow*. This includes observing and assisting in robotic surgery performed by an existing robotics-trained surgeon, usually within the learner's own hospital or as part of a formal RCS England approved fellowship. Under supervision, learners should be familiar with all aspects involved with proper and optimal set-up to provide safe and efficient care, while maximising the utility of robotic technology. This includes instruction on:

- operating theatre set-up and patient position;
- choice of port placement based on the case;
- effective communication with operative staff when docking the robot;
- patient positioning and port placement (NB: some systems use a mechanical connection to the port for establishing the pivot point through which the instrument moves, whereas others employ a virtual pivot point which is supported by a software algorithm);
- principles of instrument exchange/camera manipulation;
- assistant port side selection and utilisation;
- emergency undocking;
- serving as first assistant to the robotics-trained surgeon and understanding the principles of being by the bed-side of a docked robot. A minimum number of bedside assists has been suggested as 10–15 cases.

» *Observership for an established consultant surgeon*. This includes observing and/or assisting in robotic surgery performed by a proctor, within the surgeon's own trust or by visiting the proctor's hospital. Some platforms offer remote observation options that can enhance the flexibility and scalability of proctoring, which is important in settings with limited local expertise. Some platforms also offer dual-console experience which may enhance the observership. Digital technology can also be utilised to achieve the same.

Under supervision, learners should be familiar with all aspects involved with proper and optimal set-up to provide safe and efficient care, while maximising the utility of robotic technology. This includes instruction on:

- operating theatre set-up and patient position;
- choice of port placement based on the case;
- effective communication with operative staff when docking the robot;
- patient positioning and port placement;
- principles of instrument exchange/camera manipulation;
- assistant port side selection and utilisation as well as the bedside assistant role;
- emergency undocking;
- observing the proctor for a minimum of two cases. We recommend that the surgical team (including scrub team, ODP, surgical assistant and anaesthetist) should visit the proctor's hospital for at least one of their operating lists. The nuances of the proctor's surgical technique can then be gleaned from more detailed study of the proctor's own operative videos.

- **Operating at the console for a minimum number of procedures under the guidance of a proctor**. In the early learning curve, it is essential that the proctor can take control at any point, with an approach of graduated autonomy (see Section 5.4 for more detail on the proctor role and responsibilities). For robotic systems with periscope-style consoles, a second console will be recommended to facilitate this process, whereas for systems with open consoles, the proctor can take over the procedure in the same way that an experienced surgeon would in an open or standard manual laparoscopic surgery.

  » New consultants are recommended to have ten proctored cases and those post-fellowship should have five proctored cases. The cases can be a mixture of low- and high-complexity cases which reflect the surgeon's usual practice. Should a surgeon wish to develop a new procedure, they should undergo training for undertaking such procedures which lie outside their usual practice, before on embarking on performing these using RAS.
  » The early learning curve is suggested at a minimum of 20 cases on a dual console (or equivalent, depending on the platform), or such a number specified by the proctor.
  » The proctor can give suggestions of what is required before the surgeons are considered for independent practice.

- **Sign off for platform proficiency and consideration for independent robotic practice to an oversight committee (see also Section 3.3)**. Currently, there is no validated accreditation system for RAS and this requires further research. In the meantime, and where more informal systems of accreditation are in place, we recommend that upon completion of the above stages of training, the learner graduates with a certificate that enables them to apply for a form of accreditation to practise independently. We also recommend that the surgeon is enabled to practise independently in a graduated way and in specific procedures to be agreed with the proctor. Surgeons need mentorship and support during their learning curve, by the wider departments and team.

3.2 Training the future generation of surgeons

Although the training recommendations in this document mostly refer to established consultant surgeons and those in a fellowship programme, RCS England is committed to supporting training of the future generation of surgeons in robotic surgery, which may include some of the above requirements (see also Section 5.6).

Given the increasing adoption of RAS and the likely future need for more proficient robotic surgeons, we recommend the introduction of a structured and validated curriculum of core, pre-procedural skills in robotic surgery across all stages of surgical training, ensuring trainees/residents are not left behind. This will support the general competence and early development of relevant knowledge and skills and will allow resident doctors to be prepared for procedure-based training in robotic surgery when the opportunity arises.

All appropriate stakeholders including heads of schools, training programme directors, deaneries, in consultation with royal colleges, should take the lead in making the necessary changes in training curricula and work cohesively to support the implementation of robotic training within their programmes.

Consultants who have gained sufficient experience in the use of a robot can support trainee surgeons by implementing modular training for parts of an operation for trainees who have completed their simulation training.

It is important that trainees continue to gain experience in more traditional surgical techniques and to ensure they are able to perform the procedure regardless of the tool, in addition to the added knowledge of decision making, including whether RAS is the most appropriate approach for the benefit of their patient.

3.3 Determining safety, competency and proficiency

In the interest of patient safety, it is important that the necessary standards and governance measures around training, practice and assessment of competence set locally and proposed in this document are properly followed and robustly maintained, particularly as more surgeons start to engage in RAS.

Until recently, competence was based on case observations by proctors. Proctors are appointed by the hospital, which can choose to use a proctor selected by the robotic company or an internal proctor who is experienced in robotic surgery and is part of an established robotics programme. Sufficient case volumes are key to ensuring good clinical outcomes, cost effectiveness and operative efficiency, whereby a surgeon can become quicker than conventional methods, which is important in the current climate of increased waiting lists and financial constraints. However, case volumes alone cannot determine competence. Ideally, there would be evidence of competence based on agreed metrics and clinical outcomes, which are collected, recorded and monitored through a local oversight committee in charge of maintaining quality. Video-recording of cases can provide a good educational opportunity for the operating surgeon to review their own performance and to support structured feedback to learners. Hence, we recommend that, where possible, surgeons provide evidence of video-recording of cases for review when assessing initial competence for independent practice. Continuous professional development can be aided both by logbooks or by video-based assessments.

It is important to note also that competence and proficiency may be device- or platform-specific, and further training with additional robotic cases would be required for a different platform to focus on the nuances related to the different platform.

An example of metrics to demonstrate competence can be the following:

- Ten core simulator skill exercises with a passing score of 90% should be completed every two years.
- Case logs from two recent years must include at least 20 high-complexity procedures per year, and a mixture of a higher number of low- and high-complexity procedures per year across these two years, the number and type of which to be agreed with the proctor.
- Failure in the above will result in the next two cases being overseen by a proctor.
- Surgeons who are inactive for more than 60 days must complete core simulator exercises with a passing score above 90%, or be observed during a case as part of their return to work process. Mentorship is required as part of the usual return to work processes.
- Surgeons performing more than 50 cases per year will be exempt from the above.

It is important to note that some robotic platforms provide metrics-based simulators with validated assessment criteria. These can objectively track skill development and help guide progression through training.

The criteria for qualifying as a proctor need to be based on a multidimensional assessment that considers volumes of procedures, but also goes beyond mere volumes to include clinical benchmarks and the demonstrable ability to train and educate others (see Section 5.4).

When it comes to simulator performance, the collection of anonymised performance data from simulators or intraoperative recordings can support institutional benchmarking and national quality assurance efforts.

4. Developing the robotic surgical team

Safe and successful surgery always depends on effective teamwork, with every member of the surgical team contributing and playing a part in a complex division of labour. When it comes to robotic surgery in particular, several studies demonstrate that building effective robotic teams is integral to successful robotic programmes.

When planning for the introduction of RAS, it is important that each hospital has a surgical workforce strategy in place that focuses on capacity-building and appropriate training for surgical care practitioners, surgical assistants and nurses, so that they are able to effectively support robotic surgeons. The surgical royal colleges have published a curriculum framework for surgical care practitioners which should be reflected in local workforce planning for robotic programmes. It is important to note that the involvement of the wider surgical team is to facilitate the productivity and efficiency of the programme as well as support training of consultants and residents who are performing the surgery.

When developing surgical robotics teams, it is particularly important to take account of how the introduction of RAS alters the nature of the surgical work, including the absence of tactile feedback for the operating surgeon, who may not be scrubbed and be remote from the sterile area, resulting in verbal and non-verbal communication barriers for the surgeon and the team. Relying on visual cues and effective communications skills with the whole team becomes enormously important to focus on.

Therefore, non-technical skills such as effective communication and teamworking are crucial in RAS, particularly when there are complications or incidents. Connection with the team during this critical time is very valuable for patient safety and some teams adopt an allocation of roles for emergency undocking as part of their team briefing.

Using robots has a significant impact on the division of labour in the team: as the robotic equipment enables the surgeon to do more, the role of assisting the operating surgeon changes and there is a different distribution of tasks among team members, different professional jurisdictions and a different way of coordinating the surgical workflow, including the need to communicate information to the operating surgeon who may not have visual contact with the patient. This includes reverse communication of the assisting practitioner repeating instructions back to the operating surgeon to avoid any errors of communication related to instrument exchange or removal. It is imperative that there is a clear understanding of each member’s respective role and responsibilities, and a defined framework for verbal and non-verbal communication between members of the surgical team who may not be close to each other.

Hospitals should therefore focus on more than just training surgeons or individual members of the surgical team in isolation, but make plans for the training of whole teams, including team evaluation processes and assessment benchmarks.

5. Introducing robotic-assisted surgery into surgical services

There are currently no national standards for introducing and maintaining a successful programme of RAS in hospitals, including procurement, adequate further training, accreditation of skills and ongoing quality improvement. This section outlines individual roles and responsibilities for all key stakeholders involved in the successful introduction and governance of the programme, alongside basic principles for building and maintaining competence and quality.

5.1 The hospital trust/health board

While developing a robotic surgery programme, a hospital trust or a health board should ensure that it has developed processes and procedures for safe and continued training of its workforce (surgeons and theatre staff), infrastructure (sterilisation, theatres) and service agreements with the provider robotic company for 24/7 technical support.

The robotics programme in each individual hospital trust/health board should be overseen by an oversight committee; e.g., a 'robotics surgery governance group' (RSGG) with responsibility for ensuring the safe delivery of RAS for patients. Once established, this RSGG would meet on a regular basis and comprise representatives from the surgical directorates undertaking RAS, theatres, audit and governance lead.

We recommend collaborative data-sharing with platform providers, to support outcome tracking, quality improvement and audit processes.

Its terms of reference will be defined by each individual hospital trust/health board and will include:

- ensuring RAS is conducted in a safe manner by appropriately trained surgeons;
- approving new programmes/departments intending to develop RAS;
- approving proposals for new procedures to be performed with RAS before their submission to the New Interventions and Procedures Committee (NIPC);
- facilitating low complexity cases to be carried out robotically if deemed beneficial for the patients or for training;
- approving surgeons for platform competence/proficiency and independent robotic practice;
- developing a surgical workforce strategy that builds capacity and ensures appropriate training for the wider surgical team, including SCPs, robotic assistants and nurses (see Section 4);
- overseeing audit and outcome data of established and new RAS procedures, including the regular submission of data to the quality and safety governance group of the trust and to the NIPC as required;
- providing recording equipment/facilities for all robotic operations for the purposes of audit and/or assessment;
- encouraging innovation and research in the field of RAS in a secure governance framework;
- devising an efficient process of temporary contracts for UK and Recognised International Proctors that streamlines human resources checks.

Independent practice (approval and full accreditation)

- Surgeons could be granted permission to practise RAS after completing the minimum required number of proctored cases as outlined above; and after submitting completed proctoring forms and a letter of platform competence from their surgical proctor, as supported by the platform provider's team, to the RSGG.
- Approval of independent practice can be obtained from multiple sources including proctor letter and/or clinical supervisor, with continuous technical support by the platform providers.
- Such permission for independent practice should consider the differences in robotic platforms and, where appropriate, it should be device- or platform-specific.
- Data collection and audit of clinical outcomes should be submitted regularly to and reviewed at the RSGG. Advancement beyond the early learning curve of 20 cases should be supported by the department and ratified by the RSGG. Where the necessary expertise was not available locally, audited outcomes must be submitted to a national or international expert for review, as required.
- Where possible, we strongly recommend that surgeons start a robotic surgery practice in collaboration with at least one other surgeon – this can provide valuable peer support and safeguard against isolation.

5.2 The surgeon

Surgeons wishing to incorporate RAS into their scope of practice would first have to demonstrate completion of the following requirements:

- evidence of an approved, fully costed business case for a specific procedure(s), signed off by the clinical lead/director; this does not apply to every surgeon if an approved business case is already in place;
- approval by the NIPC (or a similar body with the same function) if new procedures are planned outside the initial approved business case;
- a letter of support from the applying surgeon's clinical lead/director which details of scope of practice and expected number of procedures per year as well as a dedicated plan to support with suitable cases during the learning curve and beyond.

Once all the above requirements have been met, surgeons would submit the documentary evidence to the RSGG to apply for structured training on the robotics surgical system (or another robotics system, as applicable). This would be primarily to ensure that training and resources were coordinated and utilised as efficiently as possible. Structured training would comprise the mandatory elements mentioned in the previous section.

Costs of initial training should be supported by the platform providers. It would be the responsibility of the hospital trust/health board to fund and support any further training as required. All surgeons would be required to provide documentary evidence of completion of all elements of the training.

Surgeons with prior full robotic training such as robotic fellowships and or prior robotic training as part of their residency programme with the appropriate evidence to support their robotic training may be exempt from the full rigorous process whilst supported with mentorship and the metrics stated above. The hospital trust/health board may, however, request that the surgeon's first few robotic cases should be proctored by a recognised proctor as they would be working in a new environment and with a new surgical team.

To be considered a fellowship-trained robotics surgeon, an applicant would need to demonstrate that they had successfully completed no less than 6–12 months' training at a nationally and/or internationally recognised high-volume centre for robotic surgery and training. Required documentation could include:

- details of the specific robotics training fellowship undertaken, including information regarding the amount of time spent on the following elements: theoretical training, the number of simulator sessions, dry-lab training and operations performed as a bedside assistant and console time undertaken;
- a completed robotics training logbook and completing a satisfactory number of performed cases in line with the fellowship targets;
- a Certificate of Completion of robotics training, or alternatively, a letter of support from a robotics training supervisor confirming satisfactory completion of specific robotics training.

Established robotics surgeons, newly appointed to a respective hospital trust and intending to continue offering robotics surgery, would need to submit:

- a letter of support from the lead clinician at their previous employing trust, confirming their competence to perform RAS, or a letter from the platform provider confirming the number of procedures undertaken, and a copy of their most recent appraisal;
- a completed surgical logbook demonstrating surgical outcomes from the last 12 months of robotic-assisted surgical procedures;
- data from the robotic company on the numbers and types of procedures (that confirm the surgeon's scope of practice);
- confirmation of accreditation requirements for robotic-assisted surgical practice as outlined above.

An established robotics surgeon who wishes to utilise the robot for surgical indications not previously offered in their scope of practice would have to go through the appropriate training and governance processes for introducing a new technique as this is outlined in the College's guidance on Surgical Innovation, New Techniques and Procedures (Royal College of Surgeons of England, 2019).

5.3 The robotic company

It is the responsibility of the company supplying a robotic system to ensure that:

- its system is provided with 24/7 technical support;
- it may support equipment training through developing well-defined technology training pathways for surgeons and theatre staff, which are compliant with good clinical practice and recommended that it is accredited by RCS England. This should include online training modules, simulation and technical training on the robotic system. It is important to note that the robotic company provides device training, whereas procedure training needs to take place at a different stage;
- it may support team training, including anaesthetists, to visit the proctor hospital and/or select units with robotic centres to learn from examples of good practice around efficiency and productivity;
- it may support arranging for the proctor to come over to train the surgeon and the surgical team until the surgeon is able to be considered for independent practice by the RSGG. The focus of the training should be on the safety and proficiency of the device, as well as procedure-based competence;
- it maintains and, where appropriate, makes available to surgeons a register of RAS proctors (UK and European) with a clear delineation of each proctor's device- or platform-specific and clinical areas of expertise;
- it also maintains a register of hand-dominance, to match a left-handed surgeon with a left-handed proctor where this is feasible, and consider the possibility of catering for diverse surgical abilities.

5.4 The proctor

We acknowledge that there is an evolving definition of the term proctor, which is understood differently in different surgical cultures and contexts. In some platform-specific trainings, the term 'proctor' is used for an experienced surgeon who supervises or monitors a skill that another surgeon already possesses, whereas the term 'preceptor' is used for those who supervise the training of a skill not currently acquired – this document uses the term 'proctor' to cover both cases.

In addition, in the UK, the proctor's primary responsibility is to the patient, whereas in other areas, the primary responsibility is to the surgeon.

Every attempt should be made to utilise existing internal proctors or robotic-trained surgeons already employed in a department that the RSGG approves as potential mentors who have fulfilled the above-set criteria (see Section 3). This would not only be the most cost-effective solution for the hospital trust/health board, but would also provide more robust governance measures than external 'drop-in' proctors who would have no specific allegiance.

Where there are no robotically trained surgeons in a specific department or in the UK, mandatory requirements for robotics proctors would be:

- a surgeon already accredited to perform RAS elsewhere, who had performed more than 100 robotic procedures on a specific platform, and is an experienced consultant surgeon with minimum five years in consultant practice;
- a surgeon with their own library of prerecorded operative videos demonstrating the surgical techniques or procedure they plan to teach;
- a surgeon on the respective robotics company's list of approved surgical proctors. Robotic companies should maintain objective and transparent criteria for approving proctors, to ensure consistency and avoid variation;
- once appointed, the same surgeon would attend all proctored cases for the robotics trainee to ensure appropriate safety and progression. For the sake of continuity and consistent oversight, we recommend avoiding the use of more than two proctors other than in exceptional circumstances;
- a proctor would be required to be a surgeon in the same specialty as the training surgeon and be familiar with both the robotics and non-robotics form of the surgery. They should also be an expert on the specific robotic platform;
- ideally, the proctor would be on hand to assist with specific issues pertaining to positioning, system docking and instrumentation and system troubleshooting. It would, however, be expected that from time to time, the proctor might be required to perform components of the surgery; for example, to assist in a difficult dissection and to ensure that the surgery was completed in a timely fashion, but most importantly to maintain patient safety;
- all visiting surgical proctors would require a letter of authority from the human resources department of the receiving hospital, indicating that they were indemnified by the hospital trust/health board to supervise robotics training;
- every effort should be made to avoid the occurrence of adverse events at the hospital trust. As such, all training surgeons would be required to undertake a minimum of ten proctored surgical cases before being considered for independent surgical practice. Exceptions would include fellowship-trained robotics surgeons who would be required to undertake a minimum of five proctored cases;
- established robotics surgeons from outside the hospital but recently employed may still require observation by an internal trust/health board proctor for a minimum of three cases. Each proctored case would be signed off by the surgeon, proctor and scrub nurse or anaesthetist for submission to the RSGG. Exceptions to this would be if the established surgeon has more experience than the local surgeons or is a recognised proctor.
- Mentorship and reverse mentorship may be useful in any of the above scenarios.

5.5 The General Medical Council

The General Medical Council (GMC) needs to define its role and responsibility in developing a safe RAS practice in the UK.

Because the number of surgeons and surgical specialities seeking to develop RAS is expected to increase in the UK, there will invariably be a need to rely on RAS proctors from Europe or the US as there will be very few or no proctors available in certain specialities in the UK.

We would welcome a confirmation from the GMC that they will offer temporary registration to internationally recognised proctors and world-renowned surgeons who may agree to come over to train UK surgeons for a short period (3–6 months).

Under current arrangements a European/US proctor may come over and advise but cannot legally take over part of the robotic procedure in case of a difficulty. This exposes the patient, surgeon and the trust to great jeopardy. This remains one of the major factors for the slow development of RAS in the UK compared with Europe and the US.

A mechanism needs to be developed under which a proctor could be given a temporary registration (3–6 months) by the GMC on the recommendation of the hospital trust's medical director.

There is a need to develop (in concert with the surgical royal colleges and surgical specialty associations) a national register/audit of patients undergoing RAS, or to adapt existing audits to incorporate comprehensive new datasets to capture this information.

Hospital trust/health board

Develop a process and procedures for safe and continued training of its workforce (surgeons and theatre staff), infrastructure (sterilisation, theatres), service agreements with robotic company for 24/7 technical support.

Develop a robotic surgery governance group with clearly defined terms of reference.

Devise a streamlined process of temporary contracts for proctors.

Sign-off process for surgeons and surgical teams and provide the necessary supportive surgical teams and resources to ensure an efficient programme.

Surgeon

Apply for and undertake structured training in RAS.

Online training programme (as specified by respective robotics system provider).

Undertake a specified number of robotic procedures under the guidance of a proctor.

Sign-off from RSGG for autonomous robotic practice.

Participate in continuous audit of robotic surgical outcomes.

Continue to upskill and work collaboratively with the team to improve outcomes.

Proctor

A surgeon who has already performed more than 100 robotics procedures and is registered as a robotics proctor for those procedures.

Attend all surgical cases to ensure appropriate safety and progression.

Assist with all aspects of surgery including trouble-shooting and performing components of the surgery if required for patient safety.

Would advise RSSG on the sign-off of the trainee surgeon.

Robotic company

Its system is provided with 24/7 technical support.

Develop well-defined platform-specific device-training pathways for surgeons and theatre staff in concert with RSGG.

Arrange for the proctor visits to train the surgeon and the surgical team until the surgeon is deemed fit for autonomous practice by the RSGG.

Keep a device-specific register of RAS proctors.

Work with the royal colleges and stakeholders to support training the next generations in a structured and defined pathway.

GMC

Devise a mechanism of temporary registration for a recognised proctor on the advice of the medical director of a hospital trust/health board, including facilitating the employment of visiting proctors from abroad.

Support the introduction of RAS in the surgical curricula towards CCT completion.

Royal College of Surgeons of England

Operate as an advisory body and support the training of established consultants and future surgeons in robotic surgery.

Develop standards of practice and accreditation, as well as senior RAS clinical fellowships. To also update learning packages to include RAS.

Work with surgeons, industry, the GMC, NICE, GIRFT and other stakeholders to support latest research and evidence on the application of robotic assisted surgery.

Work with the GMC, and the surgical specialty associations for the development and maintenance of a national audit and register.

Develop in concert with surgical royal colleges and surgical speciality associations a national register/audit of patients undergoing RAS.

Surgical specialty associations

Develop procedure-specific training pathways in collaboration with RCS England, and work with the College and other stakeholders on the development and maintenance of a national audit and accessible registries.

5.6 Royal College of Surgeons of England and surgical specialty associations

RCS England has worked with a number of experts through its Future of Surgery group, the RADAR programme group and additional consultations from robotic and non-robotic experts to consider the impact of new technologies for patients, surgeons and services. The College's RADAR group in particular, has been established to consider the benefits and issues around the implementation of RAS in the UK including training and research.

We expect that the College should serve as an advisory body to develop standards of practice and accreditation, and support the training of both established consultants and future surgeons in robotic surgery. The College is in the process of revising and updating relevant learning courses and materials to incorporate RAS, including courses such as Basic Surgical Skills and Train the Trainer. It accredits major RAS platform providers as training centres and several robotics courses across the UK. So far, it has also approved and supported numerous senior clinical fellowships including in the area of RAS and works closely with all training and curriculum stakeholders to make the most of emerging opportunities in the field.

The surgical specialty associations should develop procedure-specific training pathways in collaboration with RCS England, and work with the College and other stakeholders on the development and maintenance of a national audit and register.

The College and surgical specialty associations are committed to working with surgeons, industry partners, the GMC and other stakeholders to support and incorporate latest research and evidence on the application of RAS and the training of surgeons.

5.7 Further governance considerations

The College's guidance on Surgical Innovation, New Techniques and Procedures (Royal College of Surgeons of England, 2019), sets out broad governance recommendations around clinical oversight, audit, training and safety to support hospitals with the smooth introduction of any new technique, which complements the advice provided in this document. Additional governance considerations are specific to RAS.

- **Selection of cases**. There must be careful consideration around which cases should be selected for the initial cases of RAS. We recommend learners start with easier cases and non-severely comorbid patients before gradually stepping up to more complex cases. High body mass index (BMI) is one of the main determinants of surgical difficulty in robotic surgery, because intracorporeal fat tends to obscure normal anatomy and compounds the challenge of a lack of tactile feedback. Learners should aim to restrict training cases to those with a BMI below 30. Colleagues and unit support are essential to ensure that learners have sufficient and suitable cases to undergo their robotic training. A mixture of low- and high-complexity cases is advised.

- **Consent**. The College's guide *Consent: Supported Decision-Making* (Royal College of Surgeons of England, 2022) sets out the information that surgeons should provide to patients as part of the consent process. This includes the purpose and expected benefit of the treatment, what it involves, the likelihood of success, the material risks of the procedure and the alternative options. Even if a surgeon cannot offer all alternatives, they should be familiar enough with the relevant literature to refer the patient to the right service/professional. When it comes to new technologies such as RAS, it is essential that the consent discussion also includes information about:

  - the innovative nature of the procedure;
  - the surgeon's learning curve and their specific experience with the technology;
  - the presence or absence of a surgical proctor for the procedure;
  - the risks and benefits of the procedure, including possible unforeseeable or unknown risks or outcomes;
  - alternatives to the innovative procedure.

  The learning curve refers to the increased risks to patients during the time in which a surgeon or surgical team gain competency in a new procedure. It applies where the original innovator is gaining experience in the new technique, but also where the technique is performed in different hospitals by other surgeons (Soomro et al, 2019). Patients and their families must know when they are participating in innovation, so it is essential that surgeons are transparent and particularly tell their patients when they carry out a procedure for the first time. Lack of transparency when it comes to material information and the availability of other options can result in furthering disparities in healthcare literacy, which in turn is correlated with lower socio-economic status.

- **Managing conflicts of interest**. In line with *Good Surgical Practice* (section 4.1 of Royal College of Surgeons of England, 2025), surgeons must be open about any conflict of interest arising for both the surgeon and their organisation. Such conflict can arise from their relationship with the companies that manufacture the innovative technology, particularly where this leads to significant financial or reputational gain. Conflicts may also arise where the patient has been referred to, or has specifically asked to see, a particular surgeon because they are known to undertake an innovative procedure, placing pressure on the surgeon to undertake the procedure even though an alternative might be more suitable for that particular patient. There may be financial incentives for both the surgeon and for healthcare providers to offer an innovative procedure, in terms of the fees paid. In these situations, conflicts can arise for both the surgeon and the organisation.

Surgeons should disclose to their patients all interests and financial benefits relevant to the circumstances of their care, including all relationships with companies that manufacture technology used as part of their operation. Surgeons should have the care and wellbeing of their patient as their primary consideration.

Good surgical practice also requires that any information about surgeons' knowledge, skills and services, including promotional information that is published online, or on social media, is truthful, factually accurate and serves the interests of patients.

Oversight mechanisms for surgical innovation must exclude any temptation to encourage patients to participate in innovation over an established procedure or to overstate its benefits. The natural desire to obtain positive outcomes when implementing new technologies may lead to bias in patient management decisions, as well as in data collection and reporting. At all times, surgeons must preserve the best interests of their patient and uphold ethical standards when making decisions about the application and dissemination of new technologies.

In addition, any novel robotic platform must obtain the required CE mark prior to their use in the UK, to show conformity with European health, safety, and environmental protection standards. Likewise, off licence application of RAS should not be supported.

- **Registers**. For registers to be effective and to adequately support the safe and consistent expansion of RAS, they must be accessible. In this document, we have therefore recommended that each company keeps a public register of RAS proctors with a clear description of their experience and expertise in any given device. In due course, we would like to see a single, international register across all companies.

- **Mentoring**. Other than proctorship, which is an essential part of RAS training, the College (*Good Surgical Practice*, 2025) also recommends that surgeons seek a surgical mentor throughout their career and particularly when taking on a new role and in the early stages of their autonomous RAS practice. Proctorship includes hands-on training, feedback and oversight in the clinical setting, as well as an assessment of the surgeon's skills and competence before practising autonomously. Mentoring, on the other hand, is an informal (albeit structured) supportive relationship with an experienced colleague who can guide and support another surgeon at any stage of their career regarding their personal and professional development. The mentor achieves this by listening and talking to the mentee in confidence. The mentoring relationship can include a re-examination of the surgeon's ideas or career goals, identifying further learning, skills improvement and wider professional development needs, and can provide support in difficult situations.
  In the cases of post-fellowship surgeons who are new to consultant practice, as well as having to use surgical robots as a new tool, mentoring and dual-consultant operating are particularly important to ensure safety and support the surgeon with potential gaps in their surgical experience as a consultant. Such mentoring arrangements for new consultant surgeons should be supported by the employer.

6. A pathway to the future

The 21st century has brought an increasing variety of less invasive ways to treat disease and to carry out surgery. In addition to being a tool in the surgeon's toolkit, robotics and computer-assisted technology, in particular, have the potential to provide a pathway to the future not just by improving the technical or mechanical aspects of surgery, but also by providing enhanced vision around preoperative or intraoperative imaging. Incoming technologies in surgery can support intraoperative decision making through rapid pattern recognition and by converting data to information in a way that can support the operating surgeon's judgement and perception and steer them away from danger or error.

Digital surgery can also enhance training through the integration of digital tools into the surgical curriculum, enabling telementoring and teleproctoring, where appropriate. Such technologies can provide more sophisticated ways of benchmarking training progress and introduce better and more accessible simulation training. They can also drive improvements in patient care by converting large data into valuable information that accurately measures technical performance, identifies poor surgical outcomes and advances equity of access to surgery. They can leverage intraoperative data as captured by digital surgical systems for introspective learning, skill benchmarking and surgical performance improvement. As such, they can offer better value to society at large when it comes to understanding and responding effectively to the population's surgical needs.

It is possible that robotic surgery will eventually reach an era in which a robot could either perform preprogrammed tasks, thereby complementing human performance, or learn from its own experience through a feedback sequence of good and poor outcomes. This is probably a long way in the future and comes with significant additional ethical and systemic considerations. This makes the proper and cautious evaluation and meticulous comparative effectiveness research of RAS even more important. Any future developments need to proceed with transparency and sufficient assurances of patient privacy and confidentiality of data through high-security platforms and appropriate regulation. Decisions need to be based on objective research that considers the full implications of using new technologies, not just at the individual level but also at a systemic and societal level.

It is also important to establish the right relationship with industry, being clear and transparent about what constitutes a conflict of interest and establishing an effective dialogue that will benefit both patients and surgical education.

The College is committed to working with surgeons, patients, industry partners, regulators and commissioners, and to achieve and maintain a high standard of surgical training and practice so as to realise the benefits of RAS for hospitals, surgeons and patients.

As discussed in Section 1.1 of this document, this is a live document and will be updated as more evidence comes to light, particularly in the area of training and competence assessment.

To find out more about the College's work on robotic surgery, please visit our website at www.rcseng.ac.uk.

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Royal College of Surgeons of England
ADVANCING SURGICAL CARE

Produced by the
Royal College of Surgeons of England

Published December 2025