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Value of robotic surgery simulation for training surgical residents and attendings: a systematic review protocol

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ABSTRACT

Introduction Robotic surgery is a method of minimally invasive surgery performed through small incisions using a remote robotic console. Surgical residents and attendings participate in simulation training to be able to effectively perform robotic surgery using wet labs, dry labs and virtual reality platforms. Our objective is to identify the effectiveness of robotic simulation on novice robotic surgeons. This review will answer our review question: To what extent are robotic simulations for training novice robotic general surgery residents and attendings associated with improved outcomes in comparison with no simulation training?

Methods and analysis A comprehensive search of PubMed, Embase, the Cochrane Library and Web of Science was performed. The studies were then determined to meet initial screening criteria by one individual for abstract and title with full text screening performed by two authors independently and in duplicate. Narrative themes will be collected, analysed and summarised where possible.

Ethics and dissemination There is no Institutional Review Board approval required given that the work is carried out on previously published papers. The final manuscript and results will be presented and published at an academic conference and peer -reviewed journal.

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STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This systematic review organises abstracts and full-text papers using an evidence-based evaluation framework—return on investment methodology.
⇒ This review is limited to novice general surgery residents, fellows and attendings.
⇒ This review uses Covidence software to facilitate cooperation between reviewers.
⇒ This review includes database searches as well as hand searches by a qualified librarian so that all possible publications are included.

INTRODUCTION

Robotic surgery is a method of minimally invasive surgery that uses small incisions to perform a variety of surgical procedures. Since 2000, more than 5 million robotic procedures have been performed with more than 22 000 publications.[1] While the basic principles are similar to laparoscopic surgery in that it results in smaller incisions with less pain, the robot allows for stabilisation of instruments in the surgical field and ergonomic comfort for the surgeon.[2] The robot additionally allows for three-dimensional (3D) visualisation of structures and simultaneous near infrared spectroscopy technology to determine anatomy and blood flow resulting in safer and more effective surgery for the patient.[2] These features of robotic surgery enhance surgeon's skills to care for the patient.

General surgery residents and attendings undergo simulation training in order to gain skills in robotic surgery prior to performing robotic surgery on patients. This allows for safe procedural practice using virtual reality (VR), dry labs using models or wet labs using cadavers or live anaesthetised animals. In 2006, SAGES-MIRA (Society of Gastrointestinal and Endoscopic Surgeons and Minimally Invasive Robotic Association) met to establish a consensus document on robotic surgery to look at training and credentialing, clinical applications of robots in surgery, risks of surgery and cost–benefit analysis and research. They broke down training into two separate aspects looking at technical training/capability and the training needed for specific operations.[2] At the time of these guidelines, no specific robotic surgical trainer was available but they outlined specific components that they felt were necessary to provide a comprehensive course. They stated that 'the course should be taught by instructors with appropriate clinical experience, and should have a curriculum that includes didactic instruction as well as hands-on experience using inanimate and/or animate models. The course director and/or instructor should provide a written assessment of the participant's mastery of course objectives. Documentation for certain courses comprising only didactic instruction may consist of verification of attendance.'[2] They additionally state that a course alone is not sufficient to be able to perform a procedure independently and encourage proctoring with observation of live cases being mandatory.

While SAGES recommended a combination of didactic courses, hands-on training and guided operating room components, not all training systems combine these for training and each hospital is allowed to determine their own credentialing and privileges. Due to no standardised training, a variety of different systems have been developed to fill the void, using a combination of didactic only courses, combination courses involving hands on dry or wet labs and/or VR systems. Fundamentals of Robotic-Assisted Surgery (FRS) and DaVinci technology training pathway are didactic only courses designed to set a foundational education system for surgical simulation.[3] Training programmes may use these independently or in conjunction with a VR system. There are three main programmes that are more comprehensive in their scope with both didactic sessions in addition to in person classes with robotic simulation and cadaver courses. These courses are the SAGES robotics masters series, Robotics Training Network and the Fundamental Skills of Robotic-Assisted Surgery. Trainees may go to these programmes exclusively or additionally combine them with other aspects of training. The VR systems work in as an exclusive simulation programme with no associated didactic programmes but can be combined with didactic sessions.[3]

Our aim is to perform a systematic review of the current literature on robotic skill acquisition of general surgery residents and attendings through simulation and the impact of their learning on the learner, faculty and patients/hospital. This review will help determine what current literature is available in the field of robotic simulation and guide future research to elucidate the benefit of robotic surgical simulation. The synthesis of information will additionally help programmes develop training interventions to teach robotic surgical skills for novice robotic surgeons.

Research question and objectives

Question: To what extent are robotic simulations for training novice robotic general surgery residents and attendings associated with improved outcomes in comparison with no simulation training?

The objective is to identify the effectiveness of robotic simulation on novice robotic surgeons.

More specifically, the objectives are to identify:

The effectiveness of robotic simulation on how it benefits the learner, attendings, patients and hospital system using an evidence-based evaluation approach called the return on investment (ROI) methodology.[4] The ROI Methodology is considered one of the most credible and widely used approaches for demonstrating the impact training. It categorises the benefits of training into five levels consisting of: Reaction, Learning, Application and Implementation, Impact, and ROI. Specifically in our review we are looking at levels 3, 4 and 5 as it relates to the value of robotic surgery simulation listed below in table 1.[4]

METHODS

Inclusion and exclusion criteria

Types of participants

The quantitative and qualitative components of this review will include novice robotic general surgery residents and attendings who participate in simulation-based robotic surgery training. These will be people learning robotics for the first time but may have had training in other methods of surgery including open and laparoscopic cases.

Types of intervention(s)/phenomena of interest

The quantitative and qualitative components of the review will consider studies that investigate how novice surgery residents and attendings with no robotic skills acquire their skills through simulation and the value of that simulation using the ROI methodology.

Table 1 Levels of evaluation[4]

Level		Measurement focus
0	Input	Measures input into the programme including the no of participants, costs and time involvement
1	Reaction, satisfaction and planned action	Measures participant's reaction to and satisfaction with a training programme and participant's plans for action
2	Learning	Measures increase in knowledge and/or skills, and changes in attitudes
3	Application and implementation	Measures transfer of knowledge, skills and/or attitudes from classroom to the job (change in job behaviour due to a training programme)
4	Impact	Measures business and/or healthcare (eg, patient safety, quality of patient care) impact
5	Return on investment (ROI)	Compares the monetary value of the business and/or healthcare outcomes with the cost of the training programme

ROI methodology levels of evaluation.

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Types of outcomes

Studies will be collected to evaluate five-level outcomes from the use of robotic surgical simulation with the ROI Methodology. Specifically, we are looking at application and implementation, impact and ROI.[4]

We define Application and Implementation Studies as those that evaluate how the development of robotic skills transfer to the operating room.

We define Impact Studies as those that evaluate how simulation benefits the patient.

We define Return of Investment Studies as those that evaluate the monetary benefits of simulation-based training relative to the cost of training.

Types of studies

Inclusion criteria

The quantitative component of the review will consider both experimental and epidemiological study designs including randomised controlled trials, non-randomised controlled trials, quasi-experimental studies, prospective and retrospective cohort studies, case–control studies and analytical and descriptive cross-sectional studies for inclusion.

Exclusion criteria

Studies were excluded if they did not have quantitative or qualitative data nor focused on robotic simulation in non-general surgeons. Studies in languages other than English, without translation available as this is the only language all our reviewers share in common and no translation services were available, and those without full content (ie, abstracts only), comments, editorials and letters to the editor without qualitative or quantitative data will be excluded. Studies exclusively looking at level 1 and level 2 outcome data will be excluded.

Patient and public involvement

There was no patient or public involvement in the development of the protocol.

Sources of data

PubMed via the National Library of Medicine, Embase via Elsevier at embase.com, the Cochrane Library via Wiley, Web of Science via Clarivate (including Web of Science Core Collection, SciELO Citation Index (2002–present)) were used for comprehensive literature searches.

Search strategy

The search strategy aimed to find both published and unpublished studies. A three-step search strategy was used in this review. A preliminary search of PubMed undertaken followed by analysis of the text words contained in the title and abstract, and of the index terms used to describe studies. A comprehensive literature search using all identified keywords and index terms (unique to each database) was then undertaken across all included databases.

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses literature search extension checklist will be used to ensure clarity and reproducibility of the search strategies.[5 6] A combination of index terms and keywords were used. The searches were limited to English language. The search terms used are listed below:

PubMed

(robotic surgical procedures [majr] OR robotics [majr] OR robot*[ti] OR "camera targeting"[ti] OR "PEG transfer"[ti] OR "Da Vinci"[ti] OR "SimSurgery educational platform"[ti] OR "mimic dV-Trainer"[ti] OR "3D systems"[ti]) AND (specialties, surgical/education [mh] OR surgical procedures, operative/education [mh] OR simulation training [mh] OR education [mh] OR education [sh] OR learning [mh] OR clinical competence [mh] OR program evaluation [mh] OR program development[mh] OR train [ti] OR instruct*[ti] OR teach*[ti] OR educat*[ti] OR learn*[ti] OR program*[ti] OR curricul*[ti] OR "clinical skills"[ti] OR "clinical skill"[ti] OR "surgical skills"[ti] OR "surgical skill"[ti] OR "surgical performance"[ti] OR "clinical competency"[ti] OR "clinical competencies"[ti] OR "clinical competence"[ti] OR "program effectiveness"[ti] OR "program evaluation"[ti] OR "program development"[ti] OR "learning outcome" OR "learning outcomes" OR "training outcome" OR "training outcomes") AND (Internship and residency [mh] OR fellowships and scholarships [mh] OR education, medical, graduate [mh] OR surgeons [mh:noexp] OR resident* [ti] OR "house staff" [ti] OR residenc*[ti] OR internship*[ti] OR fellows[ti] OR trainee*[ti] OR postgraduat*[ti] OR post-grad*[ti] OR "post graduate"[ti] OR surgeon*[ti]) OR (robot*[ti] AND (surgical[tiab] OR surger*[tiab] OR surgery[sh]) AND (residents*[ti] OR residenc*[ti] OR internship*[ti] OR fellows[ti] OR trainee*[ti] OR postgraduat*[ti] OR post-grad*[ti] OR "post graduate"[ti])

Embase

(robot* OR 'camera targeting' OR 'PEG transfer' OR 'Da Vinci' OR 'SimSurgery educational platform' OR 'mimic dV-Trainer' OR '3D systems' OR 'RobotiX mentor') AND (surgical OR surgery OR surgeries) AND (train* OR instruct* OR educat* OR learn* OR teach* OR programs OR programme OR curricul* OR 'clinical skills' OR 'clinical skill' OR 'surgical skills' OR 'surgical skill' OR 'surgical performance' OR 'clinical competency' OR 'clinical competencies' OR 'clinical competence' OR 'program effectiveness' OR 'program evaluation' OR 'program development' OR 'learning outcome' OR 'learning outcomes' OR 'training outcome' OR 'training outcomes') AND ('graduate medical education' OR resident* OR residenc* OR 'house staff' OR internship* OR fellows OR trainee* OR postgraduat* OR post-grad* OR 'post graduate' OR (novice next/1 surgeon*)) OR (robot* OR 'camera targeting' OR 'PEG transfer' OR 'Da Vinci' OR 'SimSurgery educational platform' OR 'mimic dV-Trainer' OR '3D systems' OR 'RobotiX mentor') AND (surgical OR surger*) AND ('graduate medical education' OR resident* OR residenc* OR 'house staff' OR internship* OR fellows OR trainee* OR postgraduat* OR post-grad* OR 'post graduate' OR (novice next/1 surgeon*) OR ('robotics'/exp/mj AND 'surgery'/exp AND ('clinical competence'/exp OR 'education'/exp OR simulation training/exp OR 'learning'/exp OR 'training'/exp OR 'program evaluation'/exp OR 'program development'/exp) AND ('residency education'/exp OR resident/exp)

Cochrane library

((robot* OR "camera targeting" OR "PEG transfer" OR "Da Vinci" OR "SimSurgery educational platform" OR "mimic dV-Trainer" OR "3D systems") AND (surgical OR surger*) AND (train* OR instruct* OR teach* OR educat* OR learn* OR program* OR curricul* OR "clinical skills" OR "clinical skill" OR "surgical skills" OR "surgical skill" OR "surgical performance" OR "clinical competency" OR "clinical competencies" OR "clinical competence"OR "program effectiveness" OR "program evaluation" OR "program development" OR "learning outcome" OR "learning outcomes" OR "training outcome" OR "training outcomes") AND (resident* OR residencies OR "house staff" OR internship* OR fellows OR trainee* OR postgraduat* OR post-grad* OR "post graduate")) OR (robot* AND (surgical OR surger*) AND (residents OR residenc* OR "house staff" OR internship* OR fellows OR trainee* OR postgraduat* OR post-grad* OR "post graduate" OR surgeon*)

Web of Science

(robot* OR "camera targeting" OR "PEG transfer" OR "Da Vinci" OR "SimSurgery educational platform" OR "mimic dV-Trainer" OR "3D systems") AND (surgical OR surger*) AND (train* OR instruct* OR teach* OR educat* OR learn* OR program* OR curricul* OR "clinical skills" OR "clinical skill" OR "surgical skills" OR "surgical skill" OR "surgical performance" OR "clinical competency" OR "clinical competencies" OR "clinical competence"OR "program effectiveness" OR "program evaluation" OR "program development" OR "learning outcome" OR "learning outcomes" OR "training outcome" OR "training outcomes") AND (resident* OR residencies OR "house staff" OR internship* OR fellows OR trainee* OR postgraduat* OR post-grad* OR "post graduate") OR (robot* AND (surgical OR surger*) AND (residents OR residenc* OR "house staff" OR internship* OR fellows OR trainee* OR postgraduat* OR post-grad* OR "post graduate" OR surgeon*)

Assessment of methodological quality

To help prevent duplication the systematic review was registered with PROSPERO which is an international database of prospective systematic reviews.

Studies will be evaluated for quality using the Joanna Briggs Institute (JBI)critical appraisal tools found at jbi.global/critical-appraisal-tools, matching each tool used with its appropriate study type independently and in duplicate.[7]

Article screening

All search results were imported into Covidence (a web-based software program). Title and abstract screening followed by full-text articles screening will be conducted in Covidence. Title and abstract screening was performed by one individual. Prior to abstract screening by one individual, the first 20 abstracts were analysed in a meeting with all the reviewers to make sure consensus was achieved on each abstract. Only one author was chosen to review the initial abstracts as the second full-text reviewer was not as well versed in surgical robotic curriculum at the time of abstract review. Two authors/researchers will conduct full-text screening in duplicates and independently.

Data collection

Quantitative data will be extracted using an institution created extraction template based on the JBI-MAStARI using the covidence software. The data extracted will include specific details about the interventions, populations, study designs and outcomes of significance to the review question and specific objectives.

Qualitative data will be extracted from papers included in the review using pooled using an institution created extraction template based on the JBI-QARI using Covidence. The data extracted will include specific details about the interventions, populations, study methods and outcomes of significance to the review question and specific objectives.

Data synthesis

Quantitative papers will, where possible, be pooled in statistical meta-analysis. All results will be subject to double data entry. Effect sizes expressed as OR (for categorical data) and weighted mean differences (for continuous data) and their 95% CIs will be calculated for analysis. Heterogeneity will be assessed statistically using the standard I^2 and also explored using subgroup analyses based on the different quantitative study designs included in this review. Where statistical pooling is not possible the findings will be presented in narrative form including tables and figures to aid in data presentation where appropriate.

Qualitative research findings will, where possible be pooled using an institution created extraction template based on the JBI-QARI using Covidence. This will involve the aggregation or synthesis of findings to generate a set of statements that represent that aggregation, through assembling the findings rated according to their quality, and categorising these findings on the basis of similarity in meaning. These categories are then subjected to a meta-synthesis and analysed for themes in order to produce a single comprehensive set of synthesised findings that can be used as a basis for evidence-based practice. Where textual pooling is not possible the findings will be presented in narrative form.

Deviations

Deviations to the protocol we be published as amendments to the original protocol document.

Ethics and dissemination

No ethical approval from the Institutional Review Board (IRB) is required given no direct patient involvement.

Once analysis is completed the results and manuscript will be presented and submitted for publication.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

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