

A realist process evaluation of robot-assisted surgery: integration into routine practice and impacts on communication, collaboration and decision-making

Rebecca Randell,^{1*} Stephanie Honey,¹
Jon Hindmarsh,² Natasha Alvarado,³
Joanne Greenhalgh,⁴ Alan Pearman,⁵ Andrew Long,¹
Alexandra Cope,⁶ Arron Gill,⁷ Peter Gardner,⁸
Alwyn Kotze,⁷ David Wilkinson,⁹ David Jayne,¹⁰
Julie Croft¹¹ and Dawn Dowding¹²

¹School of Healthcare, Faculty of Medicine and Health, University of Leeds, Leeds, UK

²School of Management & Business, Faculty of Social Science & Public Policy, King's College London, London, UK

³Institute of Health and Society, Newcastle University, Newcastle upon Tyne, UK

⁴School of Sociology and Social Policy, Faculty of Education, Social Sciences and Law, University of Leeds, Leeds, UK

⁵Centre for Decision Research, University of Leeds, Leeds, UK

⁶Leeds Institute of Medical Education, University of Leeds, Leeds, UK

⁷Leeds Teaching Hospitals NHS Trust, Leeds, UK

⁸School of Psychology, Faculty of Medicine and Health, University of Leeds, Leeds, UK

⁹Lay representative

¹⁰Leeds Institute of Biomedical & Clinical Sciences, Faculty of Medicine and Health, University of Leeds, Leeds, UK

¹¹Leeds Institute of Clinical Trials Research, Faculty of Medicine and Health, University of Leeds, Leeds, UK

¹²School of Nursing, Columbia University Medical Center, Columbia University, New York, NY, USA

*Corresponding author r.randell@leeds.ac.uk

Declared competing interests of authors: David Jayne is a member of the Efficacy and Mechanism Evaluation Strategy Group. There are no competing interests to declare in relation to Intuitive Surgical.

Disclaimer: This report contains transcripts of interviews conducted in the course of the research and contains language that may offend some readers.

Published June 2017

DOI: 10.3310/hsdr05200

Scientific summary

Implementation of robot-assisted surgery and its impact on teamwork

Health Services and Delivery Research 2017; Vol. 5: No. 20

DOI: 10.3310/hsdr05200

NIHR Journals Library www.journalslibrary.nihr.ac.uk

Scientific summary

Background

Robot-assisted surgery (RAS) offers many potential benefits for patients. Although an increasing number of NHS trusts are purchasing da Vinci® robots (Intuitive Surgical, Sunnyvale, CA, USA), there are reports that the technology is failing to be introduced into routine practice. In RAS, the surgeon is physically separated from the patient and the theatre team. The importance of effective communication and teamwork for patient safety in the operating theatre (OT) is well recognised, but the impact of this change in spatial configuration on communication and teamwork has not been explored in previous evaluations of RAS, which typically have focused on the role of the surgeon. The spatial configuration of the theatre team and technology in the OT influences the gathering of information that is used to inform decision-making, but this is another area in which the impact of RAS remains unexplored. Therefore, to ascertain how and under what circumstances RAS is effectively introduced into routine practice, and how and under what circumstances RAS impacts communication, teamwork and decision-making, we undertook a process evaluation alongside ROLARR (RObotic versus LAParoscopic Resection for Rectal cancer), a randomised controlled trial comparing RAS and laparoscopic surgery for the curative treatment of rectal cancer.

Objectives

The study had the following research objectives:

1. To contribute to the interpretation and reporting of the results of ROLARR by investigating how variations in the implementation of RAS, and the context in which it is implemented, impact on outcomes such as operation duration, conversion to open surgery and complications.
2. To produce actionable guidance for health-care organisations on factors likely to facilitate the successful implementation and integration of RAS.
3. To produce actionable guidance for theatre teams on how to ensure effective communication and teamwork when undertaking RAS.
4. To provide data to inform the development of tools and technologies for RAS to better support teamwork and decision-making.

Methods

Realist evaluation, which involves eliciting, testing and refining stakeholders' theories of how an intervention works, provided an overall framework for the study. The study was organised into three phases.

In phase 1, a review of the literature was undertaken to identify stakeholders' theories concerning how RAS becomes embedded into surgical practice, and its impacts on communication, teamwork and decision-making in the OT. These theories were refined and added to through interviews conducted across nine NHS trusts that were using RAS for rectal cancer resection. A total of 44 interviews were conducted; participants included surgeons, anaesthetists, theatre nurses, operating department practitioners and surgical trainees. The interviews were undertaken using the teacher–learner cycle, whereby the interviewees were invited to reflect on the theories from the review, based on their experience of RAS, and to describe how and in what ways those theories fitted with or differed from their experience. The interviews were audio recorded and transcribed verbatim. An iterative approach was taken to data collection and analysis so that emerging theories could be explored in subsequent interviews. Framework analysis was used to analyse the interview data, with codes focusing on capturing and tracking how the theories were expanded, supported and refined.

At the beginning of phase 2, the tentative theories emerging from phase 1 were prioritised with input from clinical stakeholders to select four theories to take forward for testing. These theories were tested in a multisite case study conducted across four NHS trusts. Data were collected using multiple methods: the structured observation tool OTAS (Observational Teamwork Assessment for Surgery), video recordings of operations, ethnographic observation, interviews and the Surgery Task Load Index (SURG-TLX) questionnaire, which measures the subjective workload associated with an operation. A total of 22 rectal cancer resections were observed, 16 robot-assisted and six laparoscopic, representing 202 hours of data collection. Video data were collected across three case sites, for eight robot-assisted operations and one laparoscopic operation, providing 52 hours of recordings. Thirty brief postoperation interviews were undertaken with surgeons and members of the theatre team, along with four longer interviews with surgeons once the observations had been completed. Fifty-five questionnaires were completed. An iterative approach to data collection and analysis was taken, to enable ongoing testing and refinement of the theories and the gathering of further data in the light of such revisions. As a first step in analysing the data, a series of matrix displays was produced, one for each theory. This provided a summary of the data for each operation that were relevant to the theory, drawing together data from the field notes, the postoperation interviews, OTAS and the SURG-TLX questionnaire. This led to further analysis, including the indexing of the field notes and interview transcripts, a qualitative and quantitative analysis of the video data and a statistical analysis of the OTAS and SURG-TLX data, in order to answer specific questions related to the theories.

In phase 3, interviews were conducted at the case sites with staff representing other surgical specialties, to assess the extent to which the results of phase 2 were generalisable and to refine the resulting theories to reflect the experience of a broader range of surgical specialties. A total of 13 participants were interviewed, with experience in urology, gynaecology and upper gastrointestinal surgery. Participants were surgeons, theatre nurses, operating department practitioners and surgical trainees. The interviews were audio recorded and transcribed verbatim. An iterative approach was taken to data collection and analysis, with framework analysis being used as the method of analysis.

Findings

In phase 1, the literature review identified 228 relevant papers, consisting of 22 systematic reviews of colorectal RAS, 94 other systematic reviews of robot-assisted surgery, 37 individual studies of colorectal robot-assisted surgery, and 75 editorials or commentaries, along with 34 websites. There was considerable repetition of the theories across sources. The majority of the papers were authored by surgeons with a clinical interest in RAS. The review revealed the series of decisions that are made in the process of introducing RAS and the challenges that need to be overcome if RAS is to be successfully integrated into routine practice. A number of theories emerged from the review regarding how and in what contexts RAS becomes integrated into routine practice, including how and in what contexts the strategies of having a dedicated team and a dedicated OT help to overcome the challenge associated with RAS of increased operation duration. The review identified less literature concerned with the impact of RAS on communication and teamwork in the OT. However, the findings of the review suggested that RAS can hinder communication, owing to the physical separation of the surgeon from the theatre team, which makes it harder for the team to hear the surgeon's requests. The review suggested that RAS can both support and impede decision-making by changing the team's situational awareness, reducing the tactile information available to the surgeon, increasing the surgeon's sense of immersion when at the console and reducing surgeons' stress through the ergonomic benefits of the robotic console.

The phase 1 interviews explored the introduction of RAS into the NHS. The findings suggested that this was a surgeon-led process, but one that was dependent on support at different levels of the organisation. There was also significant variation across sites in terms of the training provided to members of the theatre team. The interviews led to a refinement of the literature-based theories and the generation of additional theories, reflecting the experience of a broader range of OT personnel. In relation to the implementation of RAS, the interviews suggested that whole-team training, handpicked teams and manufacturer support were

all contextual factors that influenced the integration of RAS into routine practice. Greater understanding of the impact of RAS on communication and teamwork was obtained, and theories emerged regarding how and in what contexts particular strategies used by theatre teams – such as explicit communication, providing a commentary and working with an experienced first assistant – work to overcome the challenges of communication and teamwork introduced by RAS. Further insight was provided into the contexts in which the different resources provided and taken away by RAS impact decision-making in the OT.

In phase 2, an analysis of the empirical data led to the refinement of the four theories that had been selected for testing. We found that working with an experienced first assistant supported teamwork in RAS but that experience of the procedure was not sufficient for competence in RAS. Scrub practitioners played an important role in supporting first assistants who lacked experience in RAS. RAS required more explicit communication than open and laparoscopic surgery, with surgeons undertaking additional work to secure the attention of the first assistant and scrub practitioner prior to issuing a request. Theatre team members also needed to provide oral responses to the surgeon's requests to confirm that work would be done and to make apparent any challenges in completing the request. RAS can result in reduced distraction and increased concentration for the surgeon, compared with open and laparoscopic surgery, but only when supported by an experienced first assistant or an experienced scrub practitioner. There was limited impact on the surgeon's situational awareness of the wider OT owing to their position in the console, but they did experience challenges in maintaining awareness of the position of robotic instruments within the surgical site.

The phase 3 interviews revealed the theories resulting from the multisite case study to be generally applicable to other surgical specialties that undertake RAS. However, the interviews also identified other contextual factors to be incorporated into the theories. For the experienced first assistant, their ability to provide support without prompting will be affected by the extent to which the steps of the operation are routinised, the extent to which patient factors affect the level of support required and the frequency with which they participate in robot-assisted operations. Maintaining awareness of the position of robotic instruments within the surgical site is less of a concern in those surgical specialties such as urology, where they are working in a more confined space.

Conclusion

Implications for practice

Our research suggests that, to support the integration of RAS into routine practice, health-care organisations may find it useful to:

- Engage staff at different levels of the organisation. Although board-level support is likely to be essential for the introduction of RAS, it is also important to engage team leaders, as they can assist in creating conditions that accommodate the introduction of RAS, such as organising training and ensuring that the right skill mix is available. The engagement of those surgeons who will not be using the robot is also important; if surgeons perceive that the introduction of RAS is supported by their colleagues, they are likely to be more willing to undertake an operation with robot assistance, despite the initial longer operation duration.
- Handpick a dedicated robotic team. Although unlikely to be feasible as a long-term strategy, a handpicked dedicated team can increase the speed with which experience is built up, increasing confidence and efficiency. However, care should be taken not to alienate those who are not part of that initial team.
- Ensure that the team undertake training together. This is beneficial in terms of understanding the impact of robot-assisted surgery on each other's roles, supporting teamwork. It can work to increase trust in each other's knowledge so that the surgeon feels more confident in the team's ability to support him or her.
- Establish a suitably sized dedicated theatre. By having a suitably sized OT, operation duration is reduced, as staff are able to move quickly, and the risk of decontamination is reduced. A dedicated OT reduces the time required to set up the robot and also speeds up turnover to the next case.

A strategy is also needed for the training of the theatre team beyond the initial team, and, when planning rotas, it is necessary to consider the skill mix of the team.

Our research suggests, to ensure effective communication and teamwork when undertaking RAS, it is beneficial for surgeons to:

- Encourage the theatre team to communicate both actions and concerns. This helps theatre team members feel comfortable to speak up, leading to improved co-ordination and increased situational awareness for the surgeon. This strategy is more likely to be effective when there is a positive relationship between the theatre team and the surgeon.
- Secure the attention of the first assistant before issuing a request, particularly after a period without communication. This supports the first assistant to hear the message, leading to improved co-ordination. This strategy is more likely to be effective if the first assistant is already engaged in the operation.
- Acknowledge the role of the scrub practitioner in supporting an inexperienced first assistant, so as to increase the first assistant's willingness to accept that support. When the scrub practitioner is experienced, this increases the likelihood that actions will be performed correctly.

Our research suggests that it is beneficial for the theatre team to:

- Provide an oral response to the surgeon's requests. This reassures the surgeon that the request will be completed and makes him or her aware of any challenges in doing this. This strategy requires that team members communicate loudly and clearly.
- Monitor both the screen and the movement of the robotic arms. This enables the team to notice when the robotic arms are clashing and to alert the surgeon, increasing the surgeon's situational awareness. More experienced team members will be aware of the need to move their attention between the screen and the robotic arms.

Implications for research

Future research should include:

1. Exploration of other areas of surgery in which technology leads to the separation of the surgeon from the rest of the team, either physically or perceptually, and the transferability of guidance for effective communication and teamwork to those settings. Possible areas are the use of microscopes in plastic and reconstructive surgery, ophthalmic surgery and neurosurgery.
2. Investigation of the potential for realist evaluation to contribute to the design of randomised controlled trials and associated process evaluations through the inclusion of realist methods in feasibility and pilot studies.
3. Assessment of the feasibility of using routinely collected data, such as those contained within the NHS National Reporting and Learning System and national registries, to understand the impact of RAS on rare end points associated with patient safety.
4. Development and evaluation of methods for whole-team training.
5. Experimental evaluation, in situ, of the impact of different physical configurations of the robotic console and team members on communication and teamwork in the OT, with quantitative and qualitative data collection and analysis.

Funding

Funding for this study was provided by the Health Services and Delivery Research programme of the National Institute for Health Research.

Health Services and Delivery Research

ISSN 2050-4349 (Print)

ISSN 2050-4357 (Online)

This journal is a member of and subscribes to the principles of the Committee on Publication Ethics (COPE) (www.publicationethics.org/).

Editorial contact: journals.library@nihr.ac.uk

The full HS&DR archive is freely available to view online at www.journalslibrary.nihr.ac.uk/hsdr. Print-on-demand copies can be purchased from the report pages of the NIHR Journals Library website: www.journalslibrary.nihr.ac.uk

Criteria for inclusion in the *Health Services and Delivery Research* journal

Reports are published in *Health Services and Delivery Research* (HS&DR) if (1) they have resulted from work for the HS&DR programme or programmes which preceded the HS&DR programme, and (2) they are of a sufficiently high scientific quality as assessed by the reviewers and editors.

HS&DR programme

The Health Services and Delivery Research (HS&DR) programme, part of the National Institute for Health Research (NIHR), was established to fund a broad range of research. It combines the strengths and contributions of two previous NIHR research programmes: the Health Services Research (HSR) programme and the Service Delivery and Organisation (SDO) programme, which were merged in January 2012.

The HS&DR programme aims to produce rigorous and relevant evidence on the quality, access and organisation of health services including costs and outcomes, as well as research on implementation. The programme will enhance the strategic focus on research that matters to the NHS and is keen to support ambitious evaluative research to improve health services.

For more information about the HS&DR programme please visit the website: <http://www.nets.nihr.ac.uk/programmes/hsdr>

This report

The research reported in this issue of the journal was funded by the HS&DR programme or one of its preceding programmes as project number 12/5005/04. The contractual start date was in September 2013. The final report began editorial review in September 2016 and was accepted for publication in February 2017. The authors have been wholly responsible for all data collection, analysis and interpretation, and for writing up their work. The HS&DR editors and production house have tried to ensure the accuracy of the authors' report and would like to thank the reviewers for their constructive comments on the final report document. However, they do not accept liability for damages or losses arising from material published in this report.

This report presents independent research funded by the National Institute for Health Research (NIHR). The views and opinions expressed by authors in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, NETSCC, the HS&DR programme or the Department of Health. If there are verbatim quotations included in this publication the views and opinions expressed by the interviewees are those of the interviewees and do not necessarily reflect those of the authors, those of the NHS, the NIHR, NETSCC, the HS&DR programme or the Department of Health.

© Queen's Printer and Controller of HMSO 2017. This work was produced by Randell et al. under the terms of a commissioning contract issued by the Secretary of State for Health. This issue may be freely reproduced for the purposes of private research and study and extracts (or indeed, the full report) may be included in professional journals provided that suitable acknowledgement is made and the reproduction is not associated with any form of advertising. Applications for commercial reproduction should be addressed to: NIHR Journals Library, National Institute for Health Research, Evaluation, Trials and Studies Coordinating Centre, Alpha House, University of Southampton Science Park, Southampton SO16 7NS, UK.

Published by the NIHR Journals Library (www.journalslibrary.nihr.ac.uk), produced by Prepress Projects Ltd, Perth, Scotland (www.prepress-projects.co.uk).

Health Services and Delivery Research Editor-in-Chief

Professor Jo Rycroft-Malone Professor of Health Services and Implementation Research, Bangor University, UK

NIHR Journals Library Editor-in-Chief

Professor Tom Walley Director, NIHR Evaluation, Trials and Studies and Director of the EME Programme, UK

NIHR Journals Library Editors

Professor Ken Stein Chair of HTA Editorial Board and Professor of Public Health, University of Exeter Medical School, UK

Professor Andree Le May Chair of NIHR Journals Library Editorial Group (EME, HS&DR, PGfAR, PHR journals)

Dr Martin Ashton-Key Consultant in Public Health Medicine/Consultant Advisor, NETSCC, UK

Professor Matthias Beck Chair in Public Sector Management and Subject Leader (Management Group), Queen's University Management School, Queen's University Belfast, UK

Dr Tessa Crilly Director, Crystal Blue Consulting Ltd, UK

Dr Eugenia Cronin Senior Scientific Advisor, Wessex Institute, UK

Ms Tara Lamont Scientific Advisor, NETSCC, UK

Dr Catriona McDaid Senior Research Fellow, York Trials Unit, Department of Health Sciences, University of York, UK

Professor William McGuire Professor of Child Health, Hull York Medical School, University of York, UK

Professor Geoffrey Meads Professor of Health Sciences Research, Health and Wellbeing Research Group, University of Winchester, UK

Professor John Norrie Chair in Medical Statistics, University of Edinburgh, UK

Professor John Powell Consultant Clinical Adviser, National Institute for Health and Care Excellence (NICE), UK

Professor James Raftery Professor of Health Technology Assessment, Wessex Institute, Faculty of Medicine, University of Southampton, UK

Dr Rob Riemsma Reviews Manager, Kleijnen Systematic Reviews Ltd, UK

Professor Helen Roberts Professor of Child Health Research, UCL Institute of Child Health, UK

Professor Jonathan Ross Professor of Sexual Health and HIV, University Hospital Birmingham, UK

Professor Helen Snooks Professor of Health Services Research, Institute of Life Science, College of Medicine, Swansea University, UK

Professor Jim Thornton Professor of Obstetrics and Gynaecology, Faculty of Medicine and Health Sciences, University of Nottingham, UK

Professor Martin Underwood Director, Warwick Clinical Trials Unit, Warwick Medical School, University of Warwick, UK

Please visit the website for a list of members of the NIHR Journals Library Board:
www.journalslibrary.nihr.ac.uk/about/editors

Editorial contact: journals.library@nihr.ac.uk