



■ TRAUMA

Current provision of simulation in the UK and Republic of Ireland trauma and orthopaedic specialist training: a national survey

**H. K. James,
R. J. H. Gregory,
D. Tennent,
G. T. R. Pattison,
J. D. Fisher,
D. R. Griffin**

*Warwick Clinical Trials
Unit, Coventry, UK*

Aims

The primary aim of the survey was to map the current provision of simulation training within UK and Republic of Ireland (RoI) trauma and orthopaedic (T&O) specialist training programmes to inform future design of a simulation based-curriculum. The secondary aims were to characterize; the types of simulation offered to trainees by stage of training, the sources of funding for simulation, the barriers to providing simulation in training, and to measure current research activity assessing the educational impact of simulation.

Methods

The development of the survey was a collaborative effort between the authors and the British Orthopaedic Association Simulation Group. The survey items were embedded in the Performance and Opportunity Dashboard, which annually audits quality in training across several domains on behalf of the Speciality Advisory Committee (SAC). The survey was sent via email to the 30 training programme directors in March 2019. Data were retrieved and analyzed at the Warwick Clinical Trials Unit, UK.

Results

Overall, 28 of 30 programme directors completed the survey (93%). 82% of programmes had access to high-fidelity simulation facilities such as cadaveric laboratories. More than half (54%) had access to a non-technical skills simulation training. Less than half (43%) received centralized funding for simulation, a third relied on local funding such as the departmental budget, and there was a heavy reliance on industry sponsorship to partly or wholly fund simulation training (64%). Provision was higher in the mid-stages (ST3-5) compared to late-stages (ST6-8) of training, and was formally timetabled in 68% of programmes. There was no assessment of the impact of simulation training using objective behavioural measures or real-world clinical outcomes.

Conclusion

There is currently widespread, but variable, provision of simulation in T&O training in the UK and RoI, which is likely to expand further with the new curriculum. It is important that research activity into the impact of simulation training continues, to develop an evidence base to support investment in facilities and provision.

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Introduction

Simulation has an increasingly important role in orthopaedic surgical training in a climate of reduced working hours,^{1,2} financial constraints^{3,4} and emphasis on patient safety.⁵ There is a move towards improving training efficiency and quality through

curriculum reform to a competency-based model⁶ and the improved surgical training initiative,⁷ both of which prominently feature simulation.

The main appeal of simulation as a surgical training adjunct is that it moves the early part of the surgical learning curve

Correspondence should be sent to Hannah K James; email: h.smith.1@warwick.ac.uk

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away from patients⁸ into a controlled environment where competency can be measured and assured.⁹ It offers the potential for rapid ‘upskilling’, the expeditious attainment of surgical skill¹⁰ in a manner that is no longer achievable using the traditional master-apprentice model of ‘on-the-job’ training.

There are a wide variety of simulation training options available in orthopaedics, ranging from low fidelity bench-top box trainers^{11,12} and plastic bones^{13,14} for teaching basic orthopaedic skills, up to ultra-high fidelity simulation using human cadavers where an entire operation can be performed in a simulated operating theatre using real implants and instruments.^{15,16}

The potential benefits of simulation also include the acquisition of non-technical skills, which forms a significant part of the skill set of a competent surgeon, the importance of which is only recently gaining recognition.¹⁷ There is an emerging body of evidence that both technical and non-technical skills learnt in the simulated environment can be transferred to the operating theatre,^{18,19} with potential benefit to patients.

Accordingly, there is a move to increase simulation provision within trauma and orthopaedics (T&O) training. It is therefore timely and necessary to provide a comprehensive overview of current simulation provision in T&O training programmes.

Methods

Survey development. The primary aim of the survey was to map the current provision of simulation training within UK and the Republic of Ireland (RoI) T&O specialist training programmes to inform future design of a simulation based-curriculum. The survey questions were developed to describe, by programme and region; the resources available for simulation, sources of funding, timetabling of provision within training, the type of simulation offered at each stage of training, and research activity measuring the educational impact of simulation training.

Participants and survey administration. The survey questions were embedded in the 2019 performance and opportunity dashboard data collection cycle, which annually audits quality of training in T&O across several domains on behalf of the speciality advisory committee (SAC). The questions were flagged as being for research with a brief outline of the study aims, and completion of this section was not mandatory for successful submission to the dashboard. The survey, hosted by a commercial web platform (Survey Monkey, San Mateo, California, USA), was sent by email to the 30 training programme directors (TPDs) in the UK and RoI in March 2019. Three email reminders were sent to non-responders and the survey was closed in July 2019.

Data Analysis. Data were retrieved by the SAC quality assurance lead (RJHG) and sent to the Warwick Clinical Trial Unit for analysis (HKJ). A descriptive analysis was

undertaken, with all responses presented as counts and percentages. The results are presented visually as geo-thermal heat maps to show regional trends in provision ((Figs 1–6), respectively).

Results

Demographics. Overall, 28 out of 30 eligible TPDs completed the survey (93%). The geographical distribution of the 30 UK and ROI T&O training programmes are shown in Fig. 7. It should be noted that the geographical size of the programmes is independent of the number of trainees. The programme boundaries were determined by plotting the hospitals within a given rotation on Google maps (Google, Alphabet Inc, Mountain View, California, USA) and drawing boundaries around them. There are seven programmes in London, and considerable overlap between rotations among the London hospitals. A pragmatic, best-fit approach was therefore taken in determining the programme boundaries in London which allowed for a clear visual representation of the data.

Resources for simulation delivery. Over 96% of programmes had facilities for simulated clinical case management, such as clinical skills teaching rooms within hospitals. Just over half of programmes (54%) had access to non-technical skills simulation, delivering modules related to situational awareness, decision making, communication and teamwork. In terms of technical surgical skills teaching, 82% had access to cadaver-based surgical procedure simulation and 64% of programmes had access to arthroscopy simulation. Less than one-third (29%) of programmes had access to a simulated operating theatre environment. It is probable that the fifteen programmes offering cadaveric simulation without access to a simulated operating theatre are delivering this training within dissection laboratories affiliated with medical schools, rather than dedicated surgical training centres.

Four programmes (14%, three within London) offer access to simulation facilities to trainees out-of-hours on an ‘as required’ basis.

Simulation resources by programme were classified as very low, low, moderate, high and very high according to the facilities available, and are shown in Fig. 1 with descriptors. There was no clear geographical pattern to provision of facilities for simulation, and there was considerable variation regionally. Training (on-line, on-paper, or face-to-face) was available for the simulation trainers in five regions (shown in Fig. 1 by the dotted shading), and this provision bore no relation to the overall quality of simulation facilities within the training programme. The opportunity to be involved in simulation training was made available to all trainers in just under half (46%) of programmes.

Sources of funding. Less than half (43%) of training programmes received centralised funding for simulation provision from Health Education England and/or the

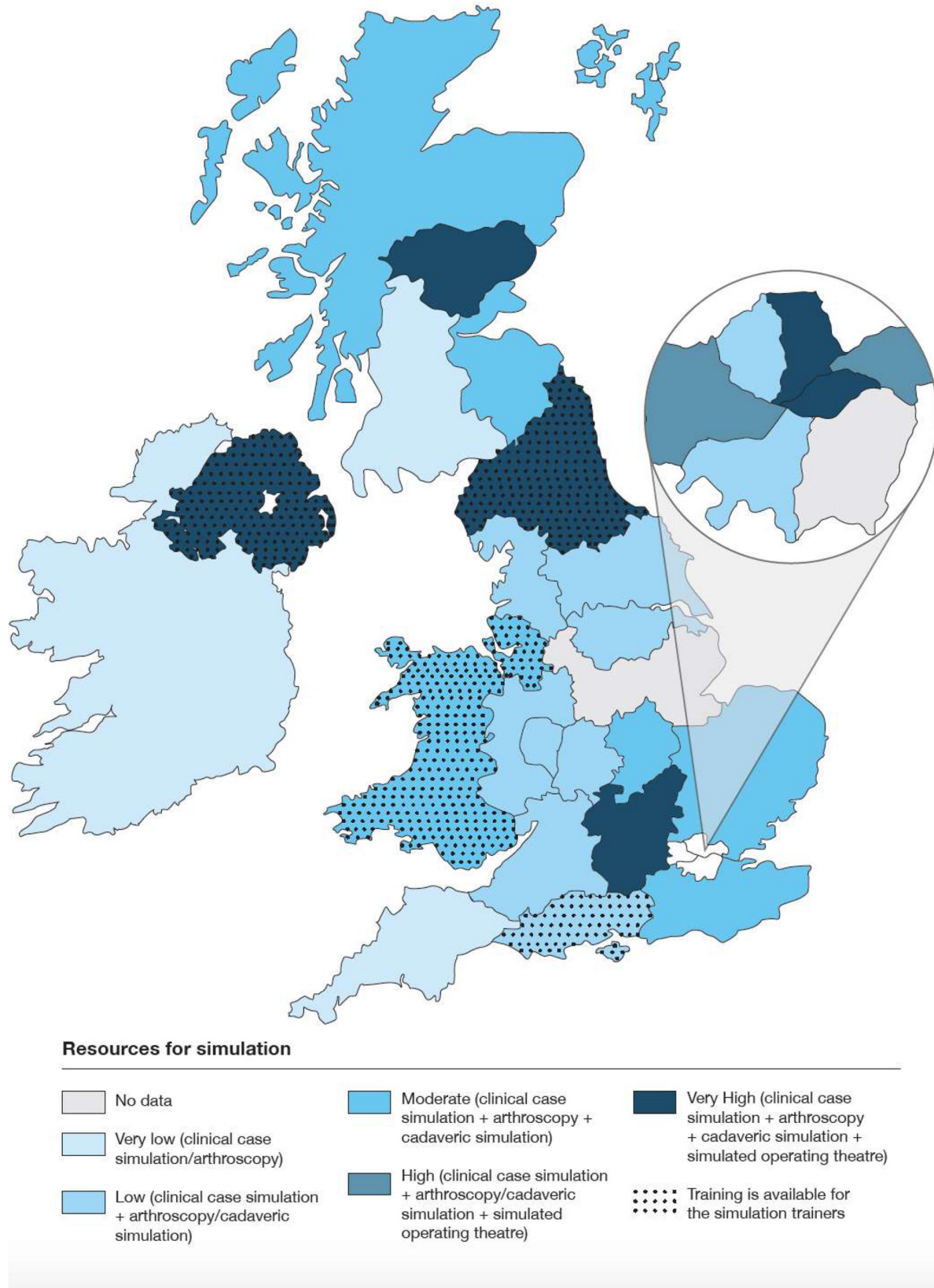


Fig. 1

Resources for simulation training by programme.

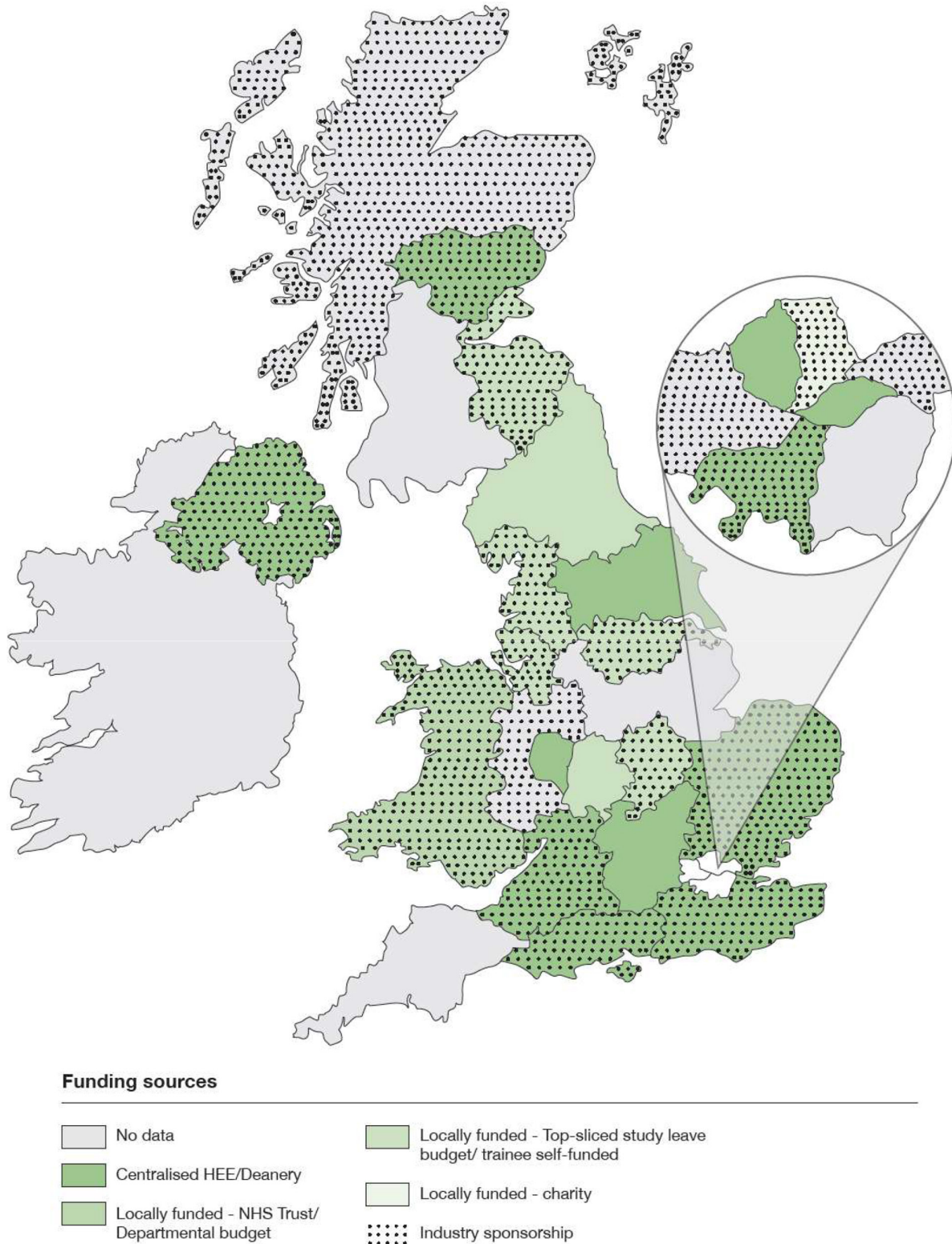


Fig. 2

Sources of funding for simulation training.

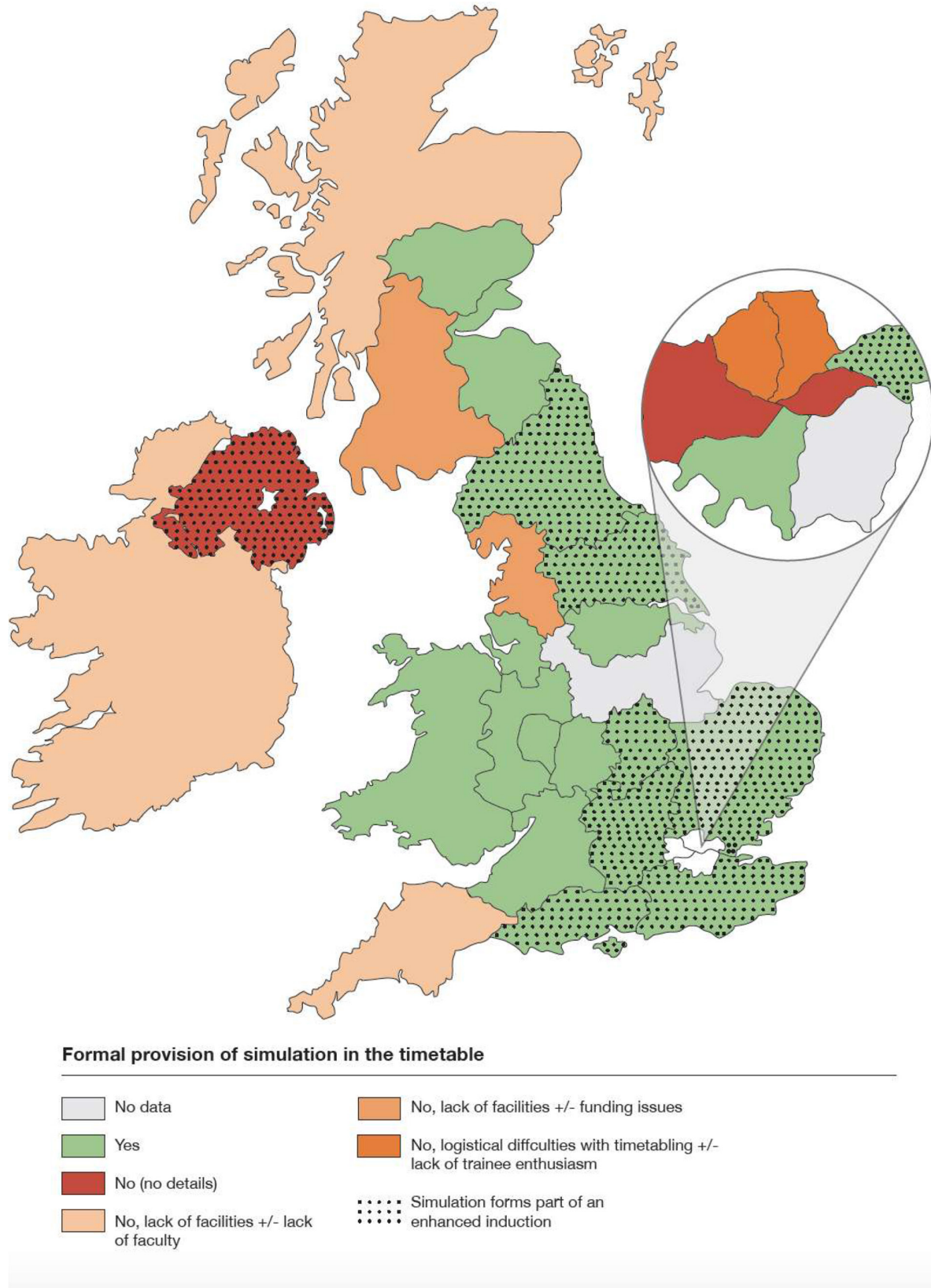


Fig. 3
Provision within training timetable and barriers to delivery.

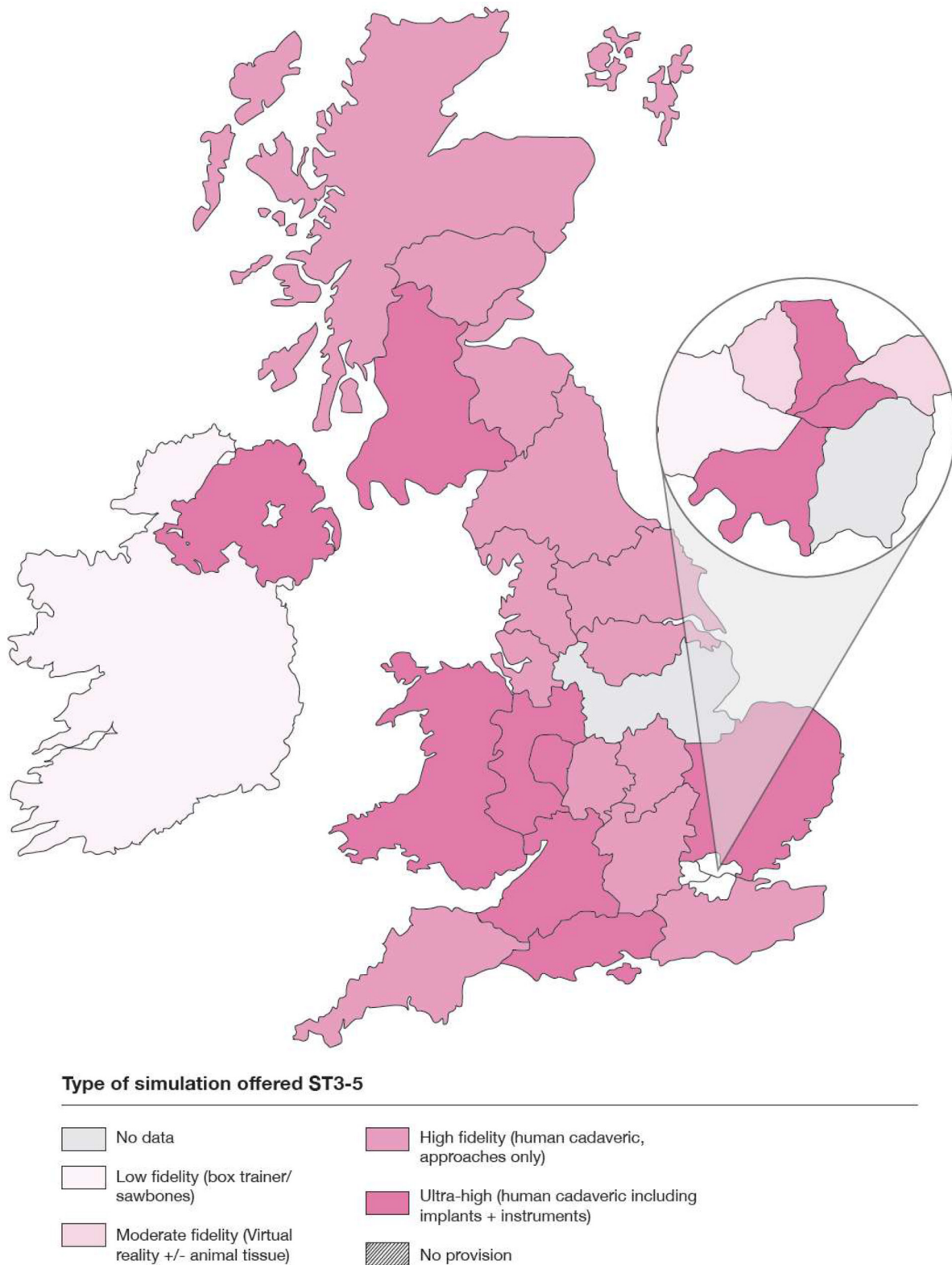


Fig. 4

Provision by programme at the mid-stage of training (ST3-5).

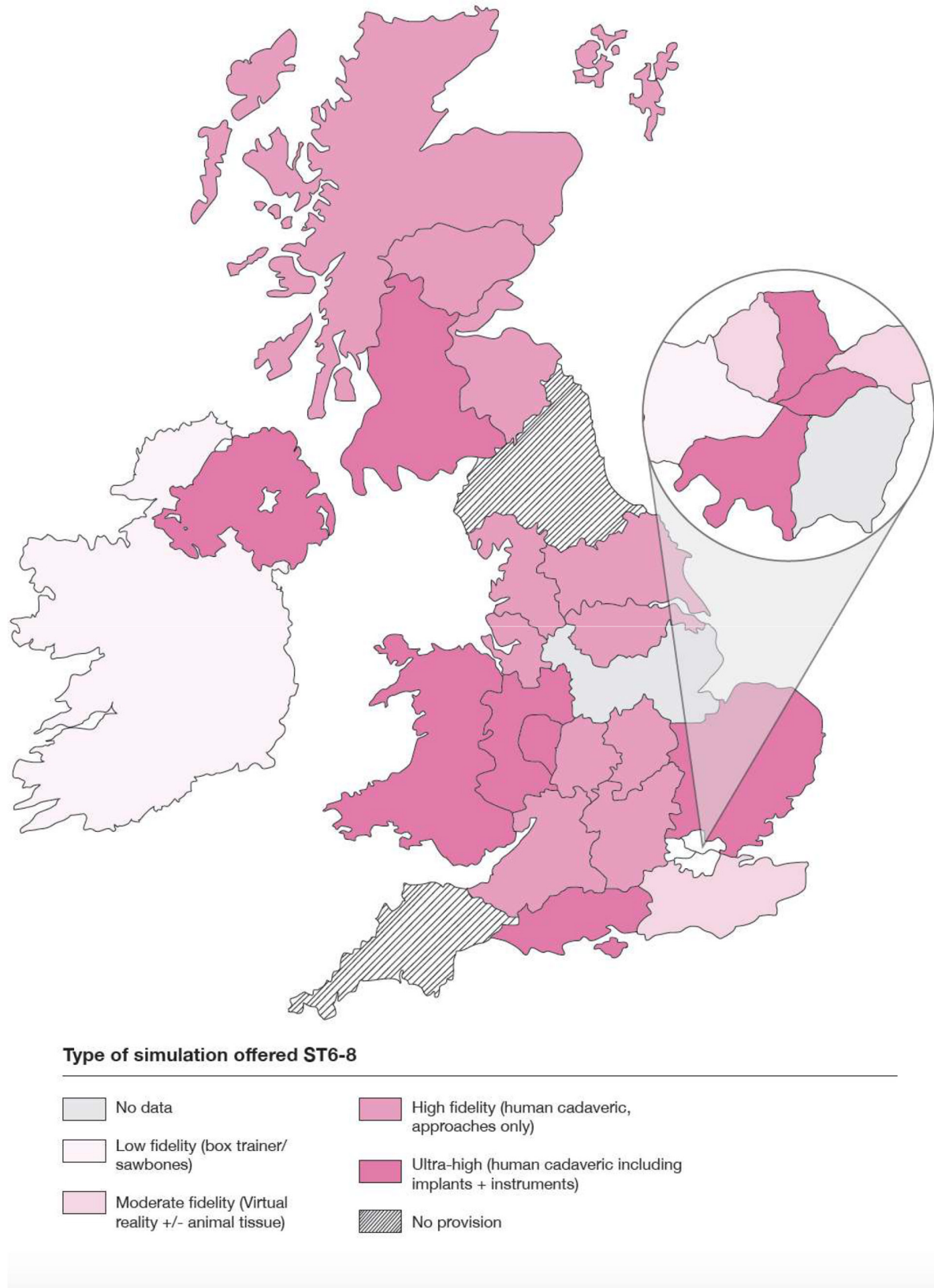


Fig. 5

Provision by programme at the late stage of training (ST6-8).

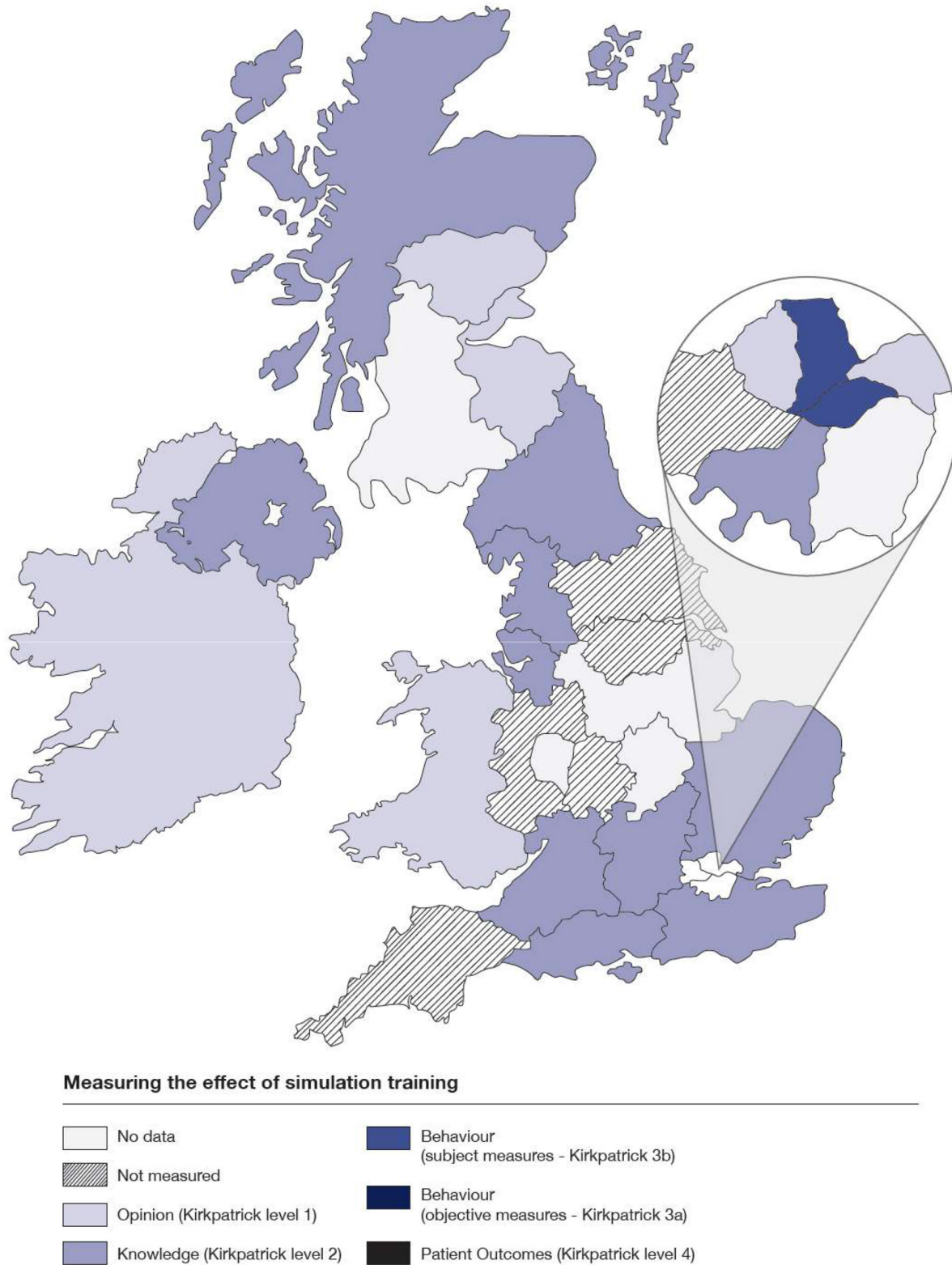


Fig. 6

Research activity to measure the educational impact of simulation provision in training.

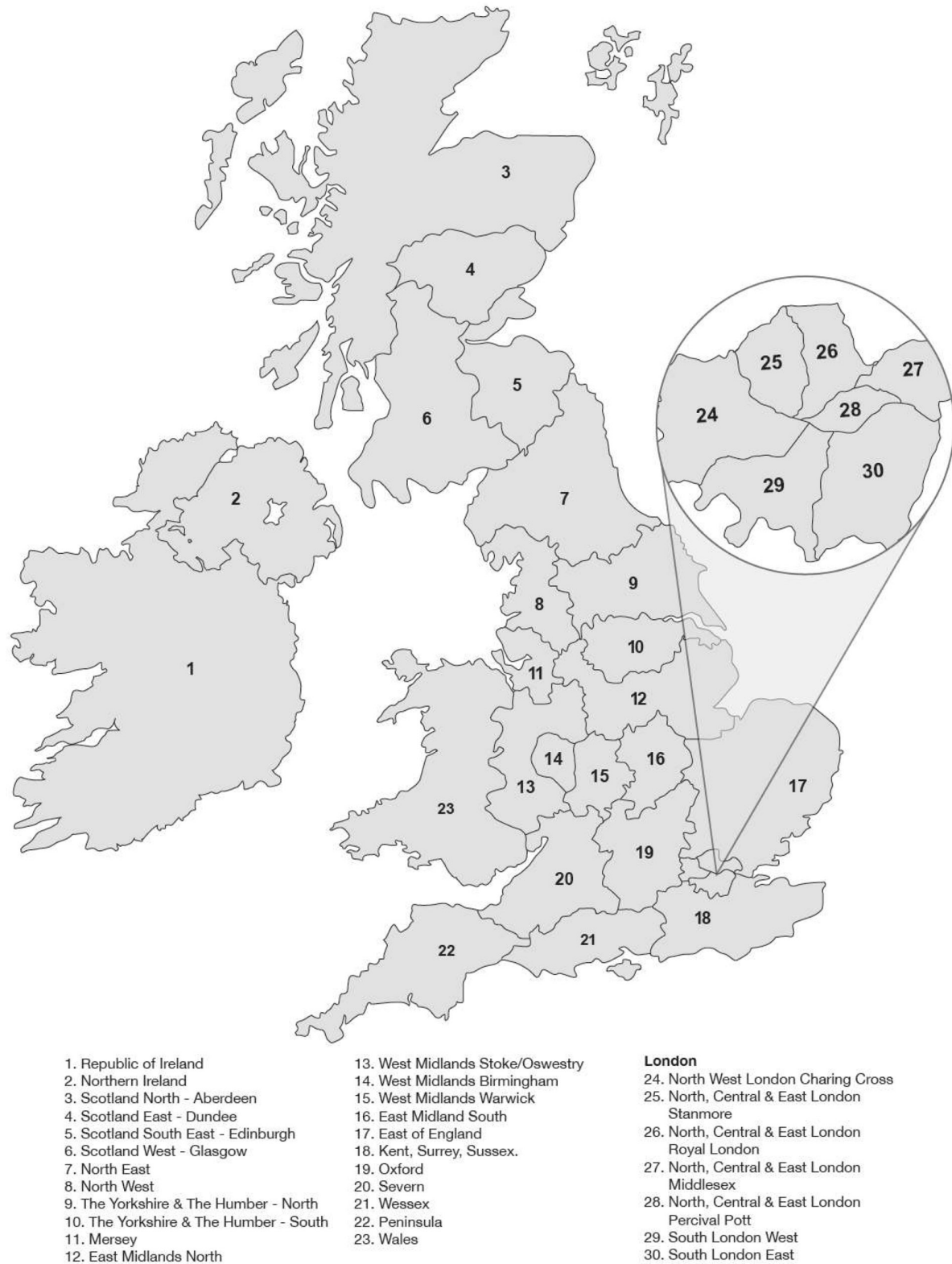


Fig. 7

Geographical distribution of training programmes in the UK and RoI.

postgraduate deanery (Fig. 2). One-third (32%) of programmes funded simulation provision locally, using either NHS trust/departmental budget (two programmes), top-slicing trainee study budgets or trainee self-funding (six programmes) or via a charitable foundation (one programme). Of note, two-thirds (64%) of programmes received industry or other commercial sponsorship for the provision of simulation. There was no relationship between lack of centralized funding and reliance on industry sponsorship, and quantitative estimates of funding were not sought in the survey. The programmes with centralized funding support for simulation were mainly clustered in the south of England (Fig. 2). No funding information was given for six programmes.

Barriers to provision. The TPDs were asked about obstacles to provision of simulation within their respective programmes (Fig. 3). Overall, 40% of TPDs reported barriers to delivery of simulation; six programmes reported lack of facilities, two had funding issues, two reported logistical difficulties related to timetabling, one reported lack of available faculty, and one reported lack of trainee enthusiasm.

Formal provision of simulation within the timetable. Simulation was formally timetabled in 19 (68%) of training programmes, and was used as part of an enhanced induction programme in nine (32%). There was a clear relationship between the provision of a simulation enhanced induction programme and formal timetabling of simulation, with only one programme offering the former without the latter. Simulation was more likely to be formally provided in the timetable in England and Wales than in Scotland and Ireland/Northern Ireland (Fig. 3).

Type of simulation offered by stage of training. Provision of simulation by type and stage was measured, with mid (ST3-5) and late (ST6-8) specialist training considered separately. Low fidelity simulation was defined as box trainer or Sawbones (Sawbones Europe, Malmö, Sweden) or equivalent. Moderate fidelity was defined as virtual reality (VR) or animal tissue. High fidelity was defined as human cadaveric simulation, involving surgical approaches only, and ultra-high fidelity was the addition of implants, instruments and the ability to perform the entire procedure on the cadaver. Type of simulation offered by stage of training by programme is shown in Figs 4 and 5. As would be expected, the degree of fidelity offered within programmes broadly correlates with the facilities available for simulation (Fig. 1.) There is a trend towards less provision at the later stages of training, with two programmes offering no simulation provision at ST6-8, and three programmes offering high and ultra-high fidelity simulation to ST3-5 only.

Measuring the impact of simulation. Research activity measuring the educational impact of simulation provision was stratified according to Kirkpatrick's hierarchy,²⁰ which is a widely accepted framework for classifying

the educational outcomes of a training intervention. Six programmes (21%) did not measure the impact of their simulation training. Six programmes (21%) measured the effect of simulation training on trainee opinion (Kirkpatrick level 1), which typically involves using pre- and post-training questionnaires to assess change in subjective metrics such as confidence. In all, 11 programmes (40%) assessed simulation provision using changes in trainee knowledge (Kirkpatrick level 2), through either bespoke post-training knowledge testing or the annual UKITE exercise. Neither of these methods assess technical or clinical skill improvement from simulation or transfer to the workplace. Two programmes in London (Fig. 6) report measuring the impact of simulation training using subjective behavioural measures (Kirkpatrick 3b). It is striking that there is no assessment of the impact of simulation within training programmes using the highest level of educational impact metrics - objective behavioural measures (Kirkpatrick level 3a) or patient outcomes (Kirkpatrick level 4).

Discussion

Orthopaedic educators face the considerable challenge of continuing to train high-quality surgeons amid increasing clinical, financial, regulatory and time pressures on training.²¹ The traditional master-apprentice model of surgical training, with its reliance on the two central tenets of high volume of case exposure and a sustained mentor-mentee relationship,²² has been rendered obsolete in the modern surgical healthcare environment.⁸ This is due largely to increased service demands at the expense of training,²³ shift based working patterns, and short training rotations.

There is a growing evidence base supporting the use of simulation as an adjunct to training, showing that the learning curve can be advanced away from patients,¹⁰ with inherent safety advantages,²⁴ and that skills learnt in the simulated environment can transfer to the operating theatre.¹⁹ There have been many studies demonstrating the face²⁵ and construct^{26,27} validity, feasibility²⁸ and educational impact^{29,30} of various orthopaedic simulators for both open and arthroscopic surgery, ranging from low-fidelity, low-cost box-trainer type models through to ultra-high-fidelity cadaveric simulation.

This study is the first to map simulation in T&O training, and describe its current provision status on a national scale. The results of the study show that overall, simulation provision is highly variable across the 30 T&O training programmes of the UK and RoI. The availability of resources varies widely (Fig. 1), and is likely to be at least partly influenced by the geographical and financial relationship of training programmes with University medical schools, where cadaveric wet-laboratory facilities are generally situated.

The funding landscape for simulation provision is complex and not explored in detail in this study. There was a tendency for simulation provision in the southern half of England to be described as centrally funded, the reason for which is unclear, and a widespread reliance on industry sponsorship (64%) was seen, seemingly independent of centralized funding status. Of note, four programmes reported that trainees were required to self-fund simulation training. This raises obvious ethical concerns around equity of access to training opportunity, as some trainees may be disadvantaged through being unable to pay to access simulation training. Six studies reported funding simulation training by top-slicing trainees' study budget, which although fairer than asking trainees to self-fund, erodes their already limited study budget and may jeopardise access to other valuable training opportunities such as attendance at courses and conferences.

Barriers to formally integrating simulation in the timetable were explored. Barriers cited included; lack of facilities (n = 6), lack of faculty (n = 1), funding issues (n = 2), logistical issues with timetabling (n = 2) and, surprisingly, lack of trainee enthusiasm (n = 1). The majority of programmes (68%) have formally timetabled simulation provision, which is important for logistical considerations when planning training, and also assures the trainees of protected 'bleep-free' teaching time. Formal timetabling also removes the need for a separate study leave application process or annual leave usage to attend simulation training, and attendance rates can be monitored.

Type of simulation offered by stage of training and region is shown in Figs 4 and 5. A disparity is seen between available facilities and reported provision in Glasgow, where ultra-high fidelity training is provided at both the mid- and late-stages of training but the resources for simulation is given as very low with no cadaveric facilities. One explanation is that cadaveric training is outsourced to another region, which we did not address in the survey. Less simulation provision was generally available during late stage training (ST6-8). This may be explained by the potentially greatest gains being obtained from simulation at an earlier stage of training, where the learning curve is steeper.

A limitation of this study is that we have focussed on establishing facts about provision at the expense of a more nuanced understanding of TPD opinion on the role of simulation in their training programmes. We have also not included trainees in this study, who as the direct beneficiaries of simulation training, should be central to discussions around provision. We obtained a very high response rate of 93% but the survey cannot claim to be comprehensive as there are two training programmes for which we have no data. Provision of simulation is only one of several quality indicators relevant to assessing a training programme, and we make no inferences as to

the quality of individual training programmes based on these results.

Despite the obvious appeal of simulation as a partial solution to the challenges of the modern surgical training environment, there is no evidence to date that simulation training in orthopaedics benefits patients (Kirkpatrick level 4 evidence). Orthopaedics lags behind general surgery in its efforts to measure the educational impact of simulation training, in a systematic review¹⁸ of skill transfer to the operating theatre after simulation training only one³¹ of 34 studies was from orthopaedics. Research efforts to measure so called 'transfer validity' have been complicated by a lack of appropriately validated objective outcome measures,³² and are largely restricted to the research setting. Only two studies^{31,33} have shown evidence of transfer validity following simulation training in orthopaedics, both of these involve diagnostic knee arthroscopy. Arthroscopic procedures lend themselves more easily to objective measurement of skill transfer, as motion analysis can be used to objectively measure performance in the simulated environment, and subsequently the operating theatre. The measurement of transfer validity of open procedures is considerably harder.³²

Simulation delivery can be costly, cadaveric training especially so.³⁴ Until such a time that there is a high-quality evidence base showing that simulation training in T&O improves technical and non-technical skills that translate into the workplace for the benefit of patients, it is unlikely that simulation is going to be mandated for training or comprehensively funded by HEE.

The survey results show that despite some challenges there is currently widespread simulation provision in training, much of it using sophisticated techniques such as cadaveric simulation (Figs 4 and 5). The use of innovative funding streams, and widespread efforts, albeit imperfect, to measure the educational benefit of simulation suggests a high level of enthusiasm for the delivery of simulation in T&O. These results reveal a promising foundation for the future of simulation delivery in T&O training, which we anticipate will continue to grow further with the implementation of the new curriculum next year. It is important that research activity continues keeps pace with the anticipated expansion of simulation provision, and can inform future developments in an evidence based manner.

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Author information:

- H. K. James
- D. R. Griffin
Clinical Trials Unit, Warwick Medical School, Coventry, UK; Department of Trauma & Orthopaedic Surgery, University Hospitals Coventry & Warwickshire, Coventry, UK.
- R. J. H. Gregory, Department of Trauma & Orthopaedic Surgery, University Hospital of North Durham, Durham, UK.
- D. Tennent, Department of Orthopaedics, St. George's NHS Trust, London, UK.
- G. T. R. Pattison, Department of Trauma & Orthopaedic Surgery, University Hospitals Coventry & Warwickshire, Coventry, UK.
- J. D. Fisher, Clinical Trials Unit, Warwick Medical School, Coventry, UK.

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