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## **Laparoscopic simulation training in gynaecology: current provision and staff attitudes – a cross-sectional survey**

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**Short Running title – Laparoscopic simulation training**

## Summary

The objectives of this study were to explore current provision of laparoscopic simulation training, and to determine attitudes of trainers and trainees to the role of simulators in surgical training across the UK. An anonymised cross-sectional survey with cluster sampling was developed and circulated. All Royal College of Obstetricians and Gynaecologist(RCOG) Training Programme Directors(TPD), College Tutors(RCT), and Trainee representatives(TR) across the UK were invited to participate. One hundred and ninety-six obstetricians and gynaecologists participated. Sixty-three percent of hospitals had at least one box trainer, and 14.6% had least one virtual-reality simulator. Only 9.3% and 3.6% stated that trainees used a structured curriculum on box and virtual-reality simulators respectively. Respondents working in a Large/Teaching hospital( $p=0.008$ ) were more likely to agree that simulators enhance surgical training. Eight-nine percent agreed that simulators improve the quality of training, and should be mandatory or desirable for junior trainees. Consultants( $p=0.003$ ) and respondents over 40 years( $p=0.011$ ) were more likely to hold that a simulation test should be undertaken before live operating. Our data demonstrated, therefore, that availability of laparoscopic simulators is inconsistent, with limited use of mandatory structured curricula. In contrast, both trainers and trainees recognise a need for greater use of laparoscopic simulation for surgical training.

**Word Count – Summary:** 200 **Article:** 2500 (excluding tables and citations)

## Introduction

A recent report on *Improving the safety of Patients* in England called on the NHS to 'Place the quality of patient care, especially patient safety, above all aims (Berwick 2013). Training for open surgery traditionally relied on the operating room to teach surgical skills, but laparoscopic surgery has a shallow learning curve and requires significant time to master. Evidence has shown that trainee involvement in laparoscopic operations slows the procedure down greatly, and results in an increased incidence of complications, creating potential conflicts between training opportunities for future surgeons and patient safety (Monson JR et al 2013). The European Union Working Time Directive(EU WTD), alongside increasing public awareness and demand, has also resulted in increased pressure on surgical training (Temple J 2010, Kern K 1998). Trainees have fewer opportunities to develop and hone such skills through regular clinical practice, so are currently struggling to reach laparoscopic surgical competencies (RCOG 2010).

Laparoscopic simulator training steepens the learning curve, making laparoscopic training more efficient, potentially improving patient safety (Larsen CR et al 2009, Larsen CR et al 2012, Nagendran M et al 2013, Gurusamy KS et al 2014). Two main types of simulators exist to teach laparoscopic technical skills; low-fidelity box trainers(BT) and the more high-fidelity virtual-reality(VR) simulators. The effectiveness of these simulators has been shown in both randomised-controlled trials and systematic reviews (Larsen CR et al 2009, Larsen CR et al 2012, Nagendran M et al 2013, Gurusamy KS et al 2014). Despite well-established advantages of laparoscopic simulators, most surgical departments face significant challenges when implementing simulator training into practice (Burden C et al 2011). This is mainly due to limitations in funding and time, lack of motivation in trainers and trainees, alongside the absence of a structured training program (Burden C et al 2011, Burden C et al 2013, Strandbygaard J et al 2014).

Our study aimed to investigate junior gynaecological trainees' access to laparoscopic simulation training across the UK, to gain insight into experiences of

the use of surgical simulators, and to seek views on how simulators may be used to train and assess gynaecological trainees in the future.

### **Materials and Methods**

An electronic questionnaire survey consisting of 22 parts was developed to assess the availability of laparoscopic simulators for year one and year two UK gynaecology trainees, and to investigate attitudes towards the role of simulators in modern training(Appendix 1).

The questionnaire was created, and data collated using the online survey software SurveyMonkey™. The questionnaire was anonymised and self-administered to protect confidentiality. The questionnaire and explanatory cover letter were sent out to all RCOG college tutors(RCTs), training programme directors(TPDs) and members of the RCOG trainee representative committee(TRs) across the UK. RCTs are based in each hospital so were asked surveyed regarding provision of simulator training in their hospital and Deanery. TPDs are based in each Deanery so were surveyed regarding the provision of simulator training regionally. A reminder email was sent out to all potential participants on two separate occasions and the survey was closed after six weeks. Participation was voluntary; no incentive or compensation was offered. Data were collected in March and April 2013

The questions were structured as either single answer, multiple choice, or Likert Scale type(Appendix 1). The survey did not ask about specific brand names and models of laparoscopic simulators; thus the results reflect the inclusion of all laparoscopic simulator resources. The questionnaires were beta-tested and validated on a small group of separate general obstetrician/gynaecologists and trainees(n=8). Face and content validity was assessed from the pilot. The test-retest reliability of the questionnaire was confirmed in the pilot study in which the questionnaire was completed on two separate occasions one week apart by the same pilot respondents. The intra-class correlation coefficient(ICC) was between 0.83 -1.00 for all the pilot questions

Descriptive statistics were calculated for dichotomous, ordinal and continuous variables with the number of responses as the denominator. The Binomial test was used to assess differences in respondents' preferences. A two-sided Fisher's exact

test was used to detect differences in responses among groups with the use of Stata statistical software (version 11.1; StataCorp, College Station, TX). For statistical analysis of the opinion responses, the terms *strongly agree* and *agree* were combined into a percentage of agreement, and *disagree* and *strongly disagree* into a percentage of disagreement to each statement. A one-way ANOVA was used to assess the ICC. A probability of  $p \leq 0.05$  was taken to indicate statistical significance throughout.

## Results

One hundred & ninety-six of the 274 contacted (RCT - 114, TPD - 19, TR - 63) responded to the survey (71.5% response rate overall). Of the 176 RCTs, 114 responded (65%). Respondent demographics are listed in Table I. Half of the respondents specialised in obstetrics alone whereas the remaining respondents specialised in gynaecology alone (30.1%), generalist obstetrician and gynaecologists (15.6%), or had not yet made a choice of specialism. **Of the 15.6% who were generalist obstetricians and gynaecologist, 86% had a special interest in gynaecology (12.8% overall).** The majority of the respondents were RCTs (57.9%). Most respondents worked in either a large general (44.1%) or teaching hospital (46.7%). Respondents were fairly well distributed by geographical location, but with a slightly higher proportion of returns from London and East Scotland. Geographical location of the respondents is summarised in Figure 1.

**Laparoscopic simulator access and usage** – Overall, 79 of 114 (69%) hospitals had some form of simulator; 63% of RCTs stated that they had a BT simulator available for use in their hospital for their junior trainees, whereas only 14.6% stated that they had a VR simulator on site. Overall, analysis across the regions from both TPDs and RCTs showed that 11/18 (61%) of NHS Deaneries in the UK had at least one VR trainer available (Figure 1). Eighty-one percent of VR trainers were in either large general or teaching hospitals. Only 9.3% and 3.6% stated that their trainees used a structured curriculum on box and virtual-reality simulators respectively (Table II).

**Knowledge of the effectiveness of laparoscopic simulation** - One hundred and fifty-four respondents (89.0%) stated that they believed that simulator training

improves the quality of surgical training for junior trainees. A large proportion(48.6%) of respondents were not aware of any data on the effectiveness of laparoscopic simulation training(Table III). Respondents' knowledge on the effect of laparoscopic simulation training on patient safety was limited(Table III). A slightly larger proportion of respondents stated that they personally preferred laparoscopic VR simulators over BT simulators(VR 32.3% vs BT 23.6%;  $p= 0.155$ ), 28.2% were unsure, and 16.1% thought they were of a similar value. In terms of scientific efficacy, VR simulators were perceived as more effective than BT simulators(VR 29.4% vs BT13.2%;  $p=0.015$ ), however the largest percentage stated they were unsure(42.3%) and a small percentage(14.9%) believed they were of the same value. **When separately analysed according to specialism (obstetrics or gynaecology) the respondents' knowledge of effectiveness and safety of laparoscopic simulation training did not significantly differ between the two groups.**

**Demographic variables and attitudes** - respondents' opinions are stratified by age, subspecialist interest, role, and type of hospital in Table IV. Respondents who worked in a Large or Teaching hospital(Large/Teaching hospital - 91.7% vs small/general hospital 64.3%  $p=0.008$ ) were more likely to be in agreement that laparoscopic simulator training improves surgical training. Furthermore, consultants(consultants 66.1% vs trainees 40.8%;  $p=0.003$ ) and respondents who were over 40 years in age  $>40$ yrs 66.4% vs,  $\leq 40$ yrs 44.4%;  $p= 0.011$ ) were more likely to believe that a laparoscopic simulation test should be undertaken prior to live operating.

**Mandatory training** – Overall 89% of respondents felt laparoscopic simulator training should be mandatory or desirable. Forty-one percent felt it should be mandatory for junior trainees, 48% said desirable and 11% were unsure. Fifty percent of respondents felt trainees should pass a competency on simulation before being allowed to undertake live laparoscopic operating; 41% felt that an assessment was desirable, 9% were unsure, however no respondents believed an operation before live operating was unhelpful.

## Discussion

We surveyed the availability, usage and knowledge of the effectiveness of surgical simulation amongst trainers and junior trainees. We found that just over 63% of respondents stated their junior trainees had local access to a laparoscopic box trainer, and only 14.6 % to a laparoscopic VR simulator. The use of a structured programme for simulation training was very limited. In contrast, 89% of trainees and trainers believed that laparoscopic simulation training improves surgical training, and 41% stated that it should be mandatory.

Our study benefitted from a high response rate, increasing the precision of our findings, reducing selection bias, and improving the internal validity. Our respondents were of diverse ages, and they included both obstetricians and gynaecologists, who came from a varied geographical background, with at least one from each NHS Deanery in the UK. One limitation is that the senior respondents we chose might be more likely to be champions of simulation training given their role in education. We also had a low response rate from smaller district general hospitals, where the respondents may not have access to simulators, so were less likely to participate. However, these hospitals are also less likely to have junior trainees. Moreover, our study included a greater number and diversity of respondents than similar published surveys (Forster JA et al 2012, Le CQ et al 2007).

Laparoscopic simulation training in gynaecology has been shown to improve surgical skills, decrease operating time, and, therefore, potentially minimising the chances of complications for patients (Larsen CR et al 2009, Larsen CR et al 2012, Nagendran M et al 2013, Gurusamy KS et al 2014). Furthermore, the Chief Medical Officer for the UK has endorsed simulation training in all its forms as part of building a safer healthcare system in the future (Donaldson et al 2008). Currently, few countries have mandated simulation training integrated into laparoscopic training programmes, however, creating a potential for underutilisation of simulation in surgical education. The understanding of the effectiveness of laparoscopic simulation training in our survey was relatively poor overall, **and this was not affected by the speciality of the respondent, i.e either obstetricians or**

**gynaecologists.** This deficit in knowledge might be playing a part in the lack of use of resources in a significant majority of units.

The most common impediments to setting up a surgical skills lab and educational programme are a lack of consensus on which laparoscopic simulation equipment should be used, appropriate exercises, and the content and structure of the training programme (Burden C et al 2011). Even though the majority of trainees and trainers believed laparoscopic simulation can improve training, lack of access to simulators, alongside the absence of a structured curriculum, is a significant challenge for implementation. The availability and access to laparoscopic simulators, for trainees, probably varies greatly in individual hospitals worldwide. A study assessing the access of laparoscopic simulators for urology trainees in the UK in 2012 showed that all TPDs believed laparoscopic simulators improve the quality of laparoscopic training (Forster JA et al 2012). They demonstrated that just over 50% of the TPDs declared that their hospital owned a laparoscopic simulator(BT or VR) (Forster JA et al 2012). In contrast, a study in the USA in 2007 assessing the provision of simulation training for Urology trainees stated that over 76% had access to a laparoscopic simulator (Le CQ et al 2007).

The majority of respondents stated that they were unaware of scientific data showing that VR simulators are more effective than BT simulators for training. Low-fidelity BT simulators are cheaper to buy, and they have the in-built benefit of haptic feedback. However, they require an expert present for assessment, and are capable of simulating only individual manoeuvres such as lifting an object, rather than imitating surgery as such. VR simulators can allow a trainee to practice surgical procedures, in part of entire, and it can provide immediate structured feedback, crucial for educational effectiveness and assessment. They also allow for gradation of difficulty within a practice session, including correction of surgical errors. Moreover, laparoscopic procedures are performed via a video monitor rather than with the naked eye, lending itself to computer-based simulation. A Cochrane systematic review in 2013 comparing the two modalities has suggested that VR simulation training is more effective in terms of improving operating time and laparoscopic operative performance than the standard BT simulator (Nagendran M et al 2013). The lack of detailed knowledge about simulation training amongst local

developers of gynaecological training might be an impediment to its implementation and revealed a need for them to be better informed.

More respondents in our study opted for VR training over box trainers, and there was no difference in the preference of trainees or consultants, or any other demographic variables. Trainees' preference is inconsistent in the literature, (Hagen SS et al 2010, Madan AK et al 2005, Palter VN et al 2010, Kanumuri P et al 2008, Hamilton EC et al 2002, Burden C et al 2014), and it probably depends on the simulators the trainees are familiar with, the laparoscopic task required, and their training level. Palter et al demonstrated that as a group, senior general surgical residents prefer live animal or BT simulators compared to VR simulators, when learning advanced laparoscopic manoeuvres such as suturing (Palter VN et al 2010). However, an alternative study, which looked at basic laparoscopic simulation tasks for junior trainees, found that VR was favoured (Burden C et al 2014). Haptic feedback in a laparoscopic simulator is a tactile feedback technology. Though the current evidence for the extra benefit from haptic feedback in VR is lacking, it is likely to form an integral part of VR simulators in the future, which might increase user satisfaction for the minority who are against its use currently.

Overall, only a small number of respondents appeared not to favour the incorporation of laparoscopic simulation training. Previous studies have shown concerns regarding laparoscopic simulation training include; lack of realism, lack of resources, and lack of usefulness for nontechnical skills improvement (Burden C et al 2011). Interestingly, however, a recent RCT has shown participation in a structured laparoscopic simulation curriculum (cognitive and skills based), not only improved technical skills, but also enhanced non-technical skills (Palter et al 2013). Perhaps, therefore, attaining a competency in a laparoscopic skills curriculum allows surgeons to function at a more automated level, allowing them to focus on other vital theatre management skills, including team-working, troubleshooting and communication.

The recommendation for a mandatory curriculum that includes simulation training together with an assessment prior to operating on live patients is controversial, and only half of our respondents endorsed this approach. Research on trainees'

perceptions of simulation training has also highlighted trainees' reticence to incorporate a mandatory simulation component in their curriculum (Hagen SS et al 2010, Madan AK et al 2005, Burden C et al 2014). Accepting that potential complications that can occur with procedures performed by junior surgeons, and the current deficiencies in surgical training, it is, however, increasingly vital for patient safety (Iannuzzi JC et al 2013, Davis SS Jr et al 2013, Kiran RP et al 2012) that skills are assessed before clinical exposure. In Denmark, the national postgraduate curriculum requires all residents to undergo laparoscopic VR training to become a specialist in gynaecology (Strandbygaard J et al 2014). Furthermore, a recent qualitative study by our research group has shown that patients themselves endorse a mandatory simulation test prior to live laparoscopic operating. There are, however, many issues with defining the level of competence required in simulation, and of how to manage trainees who have difficulty reaching this standard. And there must be caution in falsely certifying competence for independent live laparoscopic operating after passing a simulation test. Simulation-based laparoscopic training should certainly not be viewed as a replacement for traditional training, but rather a preparation before embarking on clinical practice.

In general, trainers and trainees supported the incorporation of laparoscopic simulation training into the curriculum but it was evident that access to laparoscopic simulators across the UK is inconsistent, and that there is limited use of a mandatory structured curriculum. These data has provided crucial information that will contribute in the planning and design of a national laparoscopic simulation curriculum. There is clearly a need to create a national (and international) strategy and standards for the development of simulation in gynaecology training. Recommendations are required on the type of laparoscopic simulation equipment to be purchased and the structure of simulation curricula. Future research should focus on studies that inform these recommendations. We advocate access to a laparoscopic simulator for all trainees, and a formal competency-based simulation-training programme incorporated into the gynaecology-training curriculum. Consideration should be given to trainees having to reach a minimum standard of proficiency on a simulator before undertaking surgical procedures on patients.

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## **Financial disclosure/Conflicts of interest**

All authors declare that there are no conflicts of interest. None of the authors have been sponsored by any equipment company, and none hold stocks in any simulation company.

## **Contribution to authorship**

All the authors participated in meetings to develop the study methods and protocols. Everyone listed met the ICMJE criteria for authorship. More specifically:

C Burden (CB): Chief investigator, prepared protocol, planned and undertook study, contributed to analysis, wrote and edited manuscript

R Fox (RF): Conceived idea, designed study, analysed data, wrote and edited manuscript

K Hinshaw (KH): Designed study, edited manuscript

T Draycott (TD): Conceived idea, designed study, edited manuscript

M James (MJ): Conceived idea, designed study, wrote and edited manuscript

## **Details of ethics approval**

Advice was sought from the NRES and an ethical review by an NHS Research Ethics Committee was not required. This study was conducted in accordance with the Research Governance Framework for Health and Social Care and Good Clinical Practice. Data storage and protection was in accordance with the research governance framework and the Data Protection Act.

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**Figure 1 – Geographical location of respondents and VR laparoscopic simulators by NHS Deaneries**

\* RR – response rate in Deanery

\*\* VRS – availability of at least one laparoscopic VR simulator in Deanery

**Appendix 1**

1. What is your current educational role? \*

TPD  
CT  
Both

2. In which Deanery are you based?  
3. Which best describes your place of work?

Teaching Hospital  
Large General Hospital(6 or more wte Consultants)  
Small General Hospital(5 or less wte Consultants)  
Other

4. What is your area of special interest?  
5. Which category below includes your age?

30-39  
40-49  
50-59  
60+

6. How many years have you been a consultant? \*

0-5  
5-10  
10-15  
15-20  
20+

Or for TRs

What year of training are you in?

ST1-3  
ST4-5  
ST6-7  
Other

7. How many junior (ST1/2) obstetric and gynaecology trainees do you have in your hospital at present?

0  
1-5  
5-10  
10 +

8. This question relates to the availability and accessibility of laparoscopic simulators? Do your junior (ST1/2) obstetric and gynaecology trainees have access to a STANDARD LAPAROSCOPIC BOX TRAINER in your hospital?

Yes  
No  
No but one is available for use at another hospital in the Deanery\*\*

Have heard of laparoscopic box trainers but do not know if available.  
Never heard of laparoscopic box trainers

9. This question relates to the availability and accessibility of laparoscopic simulators? Do your junior (ST1/2) obstetric and gynaecology trainees have access to a LAPAROSCOPIC VIRTUAL REALITY SIMULATOR in your hospital?

Yes

No

No but one is available for use at another hospital in the Deanery\*\*

Have heard of laparoscopic virtual-reality simulators but do not know if available.

Never heard of laparoscopic virtual-reality simulators

10. If available, do your junior (ST1/2) obstetric and gynaecology trainees use the STANDARD LAPAROSCOPIC BOX TRAINER in your hospital and/or Deanery?

Yes with a compulsory structured curriculum

Yes as and when they feel like it

No

Not sure

No access to laparoscopic box trainer

11. If available, do your junior (ST1/2) obstetric and gynaecology trainees use the LAPAROSCOPIC VIRTUAL-REALTY SIMULATOR in your hospital and/or Deanery?

Yes with a compulsory structured curriculum

Yes as and when they feel like it

No

Not sure

No access to laparoscopic virtual-reality simulators

12. If your junior (ST1/2) obstetric and gynaecology trainees have access to a virtual-reality laparoscopic simulator, how many simulators are there in your HOSPITAL?

13. If your junior (ST1/2) obstetric and gynaecology trainees have access to a virtual-reality laparoscopic simulator, how many simulators are there in your DEANERY? \*\*

14. Have you ever used a STANDARD LAPAROSCOPIC BOX TRAINER personally for training or maintaining skills?

Yes

No

15. Have you ever used a LAPAROSCOPIC VIRTUAL-REALITY SIMULATOR personally for training or maintaining skills?

Yes

No

16. In your personal opinion, do you feel laparoscopic simulators improve the quality of laparoscopic training for junior (ST1/2) trainees?

Strongly Agree

Agree

Disagree

Unsure

17. Which type of simulator do you think has been shown scientifically to be more effective for training junior (ST1/2) trainees?

Box trainer is better

Virtual-reality is better

Similar effectiveness

Unsure

18. What do you think is the effect of laparoscopic virtual-reality simulation training on basic skills for junior (ST1/2) obstetric and gynaecology trainees?

- Conclusively shown to significantly reduce time to competency
- No conclusive evidence on competency available
- Conclusively shown to significantly increase time to competency
- I am not aware of any data on effectiveness of training

19. What do you think is the effect of training with virtual-reality simulators on patient safety when used by junior (ST1/2) trainees?

- Shown to significantly improve safety
- No conclusive evidence on safety
- Shown to significantly reduce patient safety
- I am not aware of any data on safety

20. Which in your personal opinion do you think is better for laparoscopic training for junior (ST1/2) trainees?

- Virtual-reality simulator
- Box trainer
- They are of the same value
- Not sure

21. What is your view on the availability of simulator equipment (standard box or virtual-reality) for laparoscopic training for junior (ST1/2) obstetric and gynaecology trainees? It should be...

- Mandatory
- Desirable
- Undesirable
- Unsure

22. If laparoscopic simulation were readily available to all junior (ST1/2) obstetric and gynaecology trainees, what is your view about achieving a level of competency in basic laparoscopic skills using simulation before operating on live patients?

- Trainees should pass an assessment on a laparoscopic simulator first
- Assessment desirable but not required before live operating
- Assessment before live operating unhelpful
- Unsure

\* Only for RCTS and TPDS

\*\* Only for TPDS