Article:
Yiasemidou, M, Glassman, D, Tomlinson, J et al. (2 more authors) (2017) Perceptions About the Present and Future of Surgical Simulation: A National Study of Mixed Qualitative and Quantitative Methodology. Journal of Surgical Education, 74 (1). pp. 108-116. ISSN 1931-7204

https://doi.org/10.1016/j.jsurg.2016.07.011

Perceptions About the Present and Future of Surgical Simulation: A National Study of Mixed Qualitative and Quantitative Methodology ☆

Marina Yiasemidou, MBBS, MSc, MRCS (Eng), PGCer,[*]
Daniel Glassman, MBBS, BSc(Hon), MSc, MRCS (Eng),[†]
James Tomlinson, MA, MB, BChir, FRCS (T&O),[‡] David Song, BSc,[§] and
Michael J. Gough, MB ChB, ChM, FRCS[¶]

[*]School of Surgery, Health Education Yorkshire and Humber, Leeds Institute of Biomedical and Clinical Sciences, Leeds, West Yorkshire, United Kingdom; [†]Leeds Teaching Hospitals, Leeds, West Yorkshire, United Kingdom; [‡]School of Surgery, Health Education Yorkshire and the Humber, Leeds Teaching Hospitals, Leeds, West Yorkshire, United Kingdom; [§]Medical School, University of Leeds, Leeds, West Yorkshire, United Kingdom; and [¶]School of Surgery, Health Education Yorkshire and the Humber, Leeds, West Yorkshire, United Kingdom

OBJECTIVES: Assess expert opinion on the current and future role of simulation in surgical education.

DESIGN: Expert opinion was sought through an externally validated questionnaire that was disseminated electronically.

PARTICIPANTS: Heads of Schools of Surgery (HoS) (and deputies) and Training Program Directors (TPD) (and deputies).

RESULTS: Simulation was considered a good training tool (HoS: 15/15, TPD: 21/21). The concept that simulation is useful mostly to novices and for basic skills acquisition was rejected (HoS: 15/15, TPDs: 21/21; HoS: 13/15, TPDs: 18/21). Further, simulation is considered suitable for teaching nontechnical skills (HoS: 13/15, TPDs: 20/21) and re-enacting stressful situations (HoS: 14/15, TPDs: 15/21). Most respondents also felt that education centers should be formally accredited (HoS: 12/15, TPDs: 16/21) and that consultant mentors should be appointed by every trust (HoS: 12/15, TPDs: 19/21). In contrast, there were mixed views on its use for trainee assessment (HoS: 6/15, TPDs: 14/21) and whether it should be compulsory (HoS: 8/15, TPDs: 11/21).

CONCLUSION: The use of simulation for the acquirement of both technical and nontechnical skills is strongly supported while views on other applications (e.g., assessment) are conflicting. Further, the need for center accreditation and supervised, consultant-led teaching is highlighted. (J Surg Ed 74:108-116. © 2016 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: simulation, accreditation, surgical education, technical skills, nontechnical skills

COMPETENCIES: Practice-Based Learning and Improvement, Professionalism, Interpersonal and Communication Skills, Systems-Based Practice, Medical Knowledge

INTRODUCTION

Within the past decade, surgical training has progressed from the Halstedian paradigm "see one, do one, teach one"[1,2] to the "no learning curve on patient" era.[3] Undoubtedly technological advancements and increasing trainers' expertise led to both enhancement of surgical skills acquirement and augmented patient safety. Despite these achievements, experts would argue that some parts of simulation training are less developed than others.[4]

☆Sources of financial support: Miss Yiasemidou, Mr. Glassman, and Mr. Tomlinson were education fellows of Health Education Yorkshire and the Humber. Miss Yiasemidou was a recipient of the A.G Leventis Scholarship.

Correspondence: Inquiries to Marina Yiasemidou, School of Surgery, Health Education Yorkshire and Humber, Leeds Institute of Biomedical and Clinical Sciences, 14 Adel Green, Leeds, West Yorkshire LS16 8JX, United Kingdom; e-mail: marinayiasemidou@gmail.com

  1931-7204/$30.00 http://dx.doi.org/10.1016/j.jsurg.2016.07.011

A recent white paper issued by the Association of Surgical Education described aspects of simulation implementation as "lagging"[4] while others called it haphazard.[5] Some of the identified areas of inefficiency are inadequate resources, inappropriately trained faculty, lack of evidence on which simulation model is best, shortage of research into the suitability of simulation for applicant selection in training programs, and weaknesses in the quality of relevant research studies.[4]

As a potential resolution to some of these issues, the authors propose accreditation which in the United States is pioneered by national organizations and societies,[6,7] and it is believed to promote center collaboration for educational and research purposes.[8,9] In the United Kingdom (UK), although guidelines for quality assurance exist,[7] the incentives for formal accreditation are rather insufficient. Lack of accreditation may result in low-quality sessions or even endangerment of the safety of trainees and trainers.[10]

The recent National Health Service (NHS) restructuring has brought significant change to health care education,[11] which some authors consider to have potentially imposed additional challenges to the funding of postgraduate education and surgical training.[12] In addition, the rather poor representation of surgeons in relatively recently formed Local Education and Training Boards (LETBs) and the (thought to be) reduced trainees' input, raises concerns about the future of surgical education.[12] These changes are expected to have direct implications on the implementation of simulation in surgical training.

In the UK, currently, surgical training is administered and regulated by a variety of organizations. National authorities such as Health Education England[13] or NHS Education for Scotland[14] have the overall responsibility for surgical training. The application of surgical training is delegated to regional institutions like LETBs and Deaneries.[13] Each regional authority includes a School of Surgery run by the Head and Deputy Head of School. Training Program Directors (TPD) and their deputies are in charge of the application of surgical training in smaller geographical locations and are answerable to the School of Surgery.[15] Surgical tutors, appointed by the Royal Colleges of Surgery, also assist in the implementation of surgical training.[16] In addition, the Royal Colleges,[17] University medical education departments,[18] and NHS institutions[19] run several surgical training courses independently or in collaboration with each other.

Difficulties in the application of simulation in surgery have not stopped educationalists from using this learning tool for other purposes beyond surgical skills acquisition.

Several reports have shown that adverse events in medicine are associated with nontechnical aspects of performance rather than lack of technical ability.[20-22] Taking a leaf from the book of other specialties (e.g., anesthesiologists),[20] and professions such as civil aviation[23] and oil exploration,[24] surgery too embraced nontechnical skills training.[25,26] As simulation provides a "safe" environment within which a skill or behavioral practice can be taught and learned,[27] it was not long before it was incorporated into human factors learning.[26,28-30]

Besides the didactic applications, simulation-based tests are now used for assessment[31-33] and recruitment purposes[34] in some specialties. One of the most luring features of simulation is the provision of immediate objective feedback.[35] However, as concerns about the use of outdated validation criteria to certify the didactic effect of simulation and lack of evidence about which training models are best for each level of training have been raised,[4,33] some authors think that further investigation is needed to decide whether simulation is suitable for assessing trainees' performance.[33]

The combination of challenges and new applications creates significant alterations to the role of simulation in surgery. It is for that reason we feel it is imperative to explore the perceptions of those responsible for delivering surgical training nationally and about the current and future role of simulation in surgery. We aim to do so with an externally validated questionnaire, which was disseminated nationally, to the Heads of Schools of Surgery (HoS) and their deputies and regionally to the surgical TPD and their deputies.

METHODS

This is a mixed qualitative, quantitative cross-sectional study. The methodology consists of 4 stages: (1) development of questionnaire, (2) external validation of questionnaire, (3) regional dissemination, and (4) national dissemination.

Questionnaire development

The steering group for this study, consisting of surgical education fellows and the Head of School of Surgery (Health Education Yorkshire and the Humber), after conducting a literature review and establishing the grounded theory, developed a draft questionnaire.

Validation

For purposes of external validation, we undertook a series of semi-structured interviews and consequently applied thematic analysis on the transcripts. Agreement $\geq 80\%$ between the emerging themes and questions on the draft questionnaire was considered to demonstrate validity.

Five surgeons with a national educational role and who were speakers/discussants at the Association of Surgeons of Great Britain and Ireland conference in 2014 were interviewed. They were presented with 5 "open" questions (e.g., what are your views on simulation in surgery?). The interviewer was then allowed to ask clarifying questions according to the replies they received, but these were not predetermined or leading.

Interview transcripts data

The transcripts of interviews were analyzed by 2 independent assessors. Data extraction and categorization were conducted for the purposes of thematic analysis. This was aimed at establishing validity of the selected questions. Transcript data were summarized to the degree possible.

Dissemination

The questionnaire was disseminated both regionally (to TPDs and their deputies) and nationally (to HoS and their deputies) through electronic mail. Overall, the questionnaire was disseminated regionally (Yorkshire and the Humber) to 27 TPDs and deputies and Nationally to HoS or their deputies in 14 LETBs or Deaneries. Yorkshire and the Humber LETB were excluded, as the HoS is the senior author of the current study.

RESULTS

Content validity

Thematic analysis of the semi-structured interviews' transcripts revealed the following themes:

(1) Advantages and shortcomings of simulation in surgery (e.g., does not fully re-enact the stressful environment of an operating theater, or it is a good training tool).
(2) Concerns about delivery of simulation (e.g., quality assurance of sessions and accreditation of centers).
(3) Uses of simulation beyond technical skills acquisition (e.g., assessment of surgical skills and non-technical skills acquisition).
(4) To whom simulation should apply to and which simulation model is optimal (e.g., level of training, basic/procedural tasks, or complete operation).

There was an 82.4% agreement between the thematic analysis of the data extracted for the interview transcripts and the questionnaire.

Survey results

The regional response rate was 78% (21 questionnaires received/27 questionnaires sent) with replies from 9/11 specialties (cardiothoracic surgery, general surgery, maxillofacial surgery, neurosurgery, trauma and orthopedics, Ear, Nose, Throat surgery, pediatric surgery, urology, and

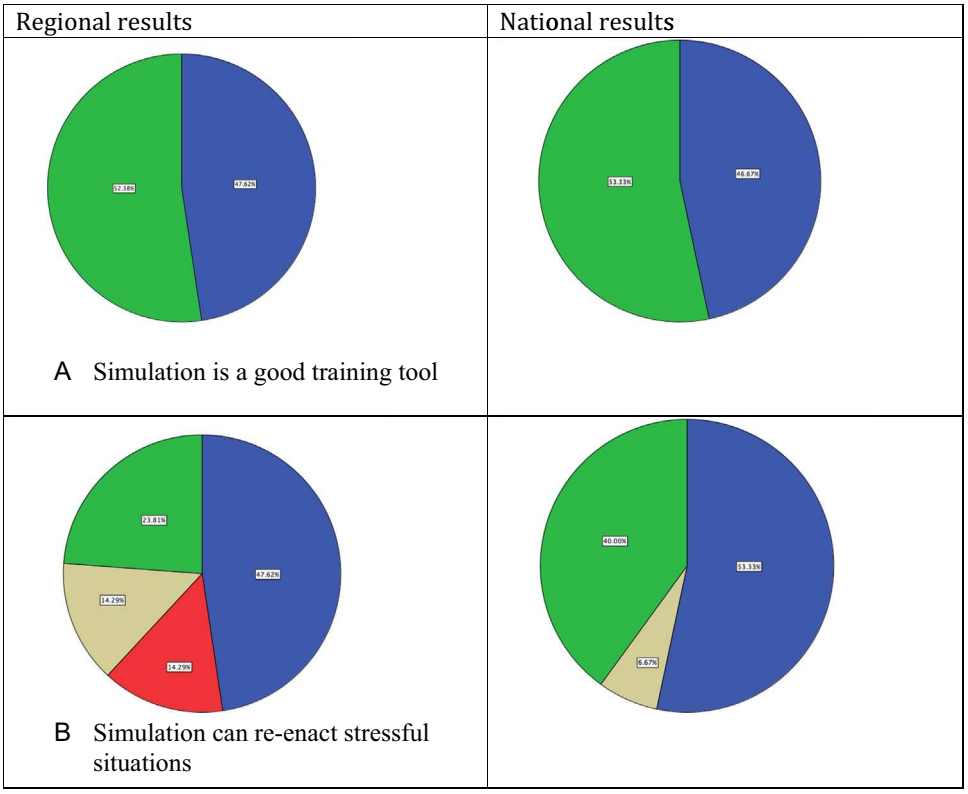

FIGURE 1. (A) Simulation is a good training tool. (B) Simulation can re-enact stressful situations. Green: strongly agree/very important, blue: agree/important, beige: indifferent, red: disagree/not important, and black: strongly disagree/not important at all.

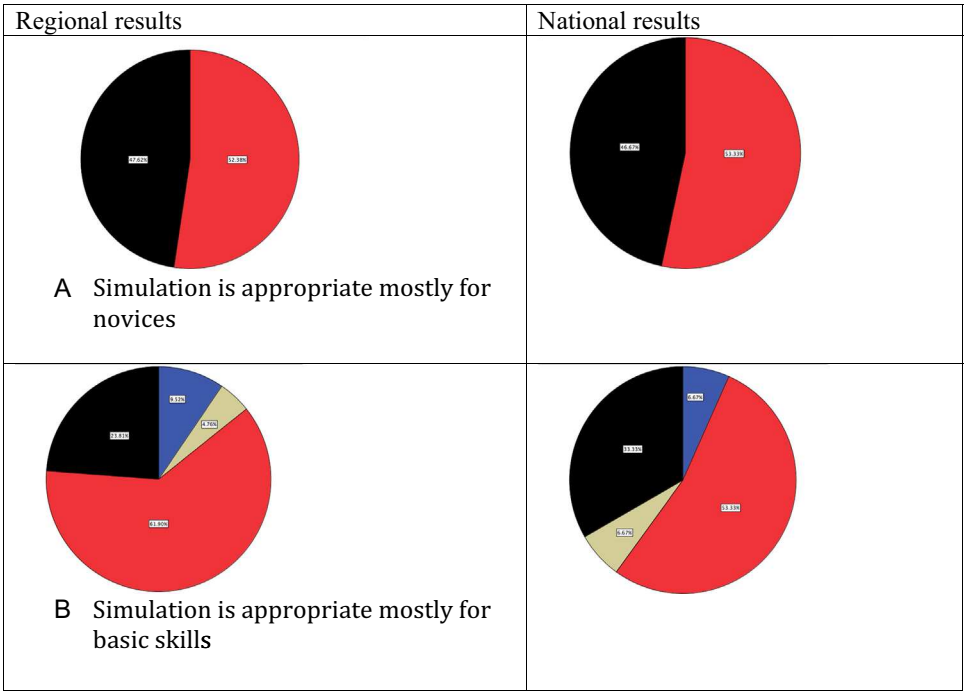

FIGURE 2. (A) Simulation is appropriate mostly for novices. (B) Is simulation appropriate mostly for basic skills? Green: strongly agree/very important, blue: agree/important, beige: indifferent, red: disagree/not important, and black: strongly disagree/not important at all.

vascular surgery). After national dissemination, we received responses from 11/14 LETBs/Deaneries (79%). A total of 28 questionnaires were sent to HoS and deputy HoS (2 for each LETB/Deanery) and 15 were received. However, the response rate nationally was calculated according to the region of response, as the approach to surgical simulation is considered to be identical within a region.

All TPDs and HoS agreed that simulation is a good training tool (Fig. 1). They reject the notion that simulation can be used mostly for acquiring basic surgical skills (TPDs: 18/21, HoS: 13/15) and is useful mostly to novices (TPDs: 21/21, HoS: 15/15) (Fig. 2). Regarding its face validity, 15/21 TPDs and 14/15 HoS felt that it can adequately re-enact stressful situations (Fig. 1).

There is strong support for simulation to be used for acquiring nontechnical skills (20/21 TPDs and 13/15 HoS) (Fig. 3), for supervised (15/21 TPDs, 11/15 HoS) consultant-led training (19/21 TPDs, 12/15 HoS) and for accreditation of clinical skills centers (16/21 TPDs, 12/15 HoS thought accreditation to be important) (Fig. 4).

Fewer believed that simulation should be used for assessment of an individual's surgical skills (TPDs: 14/21, HoS: 6/15) (Fig. 3), and only 8 HoS and 8 TPDs would make a decision on recruitment based on performance at a simulation session.

Opinions were conflicting about simulation becoming compulsory before performing a procedure for the first time (11/21 TPDs and 8/15 HoS agree) (Fig. 3) and whether "hands-on" stand-alone sessions/courses (and not as part of a long-term curriculum) can be of educational value or not (12/21 TPDs and 8/15 HoS thought that stand-alone sessions are of benefit).

Finally, regarding more practical issues, 14 TPDs and 12 HoS replied that simulators should be located in both clinical skills centers and in operating theaters while cadavers are considered the optimum simulation "model" (Table).

DISCUSSION

Here, we present the findings of an externally validated national survey about the present and future of simulation in surgery completed by leading surgical educators. This study provides an insight to the perceptions of experts on simulation in surgery as a whole, as well as areas which may still be considered controversial or are not fully supported (e.g., compulsory simulation). It also offers indications about how experts think simulation should be delivered (e.g., supervised and consultant led), which may be an impetus for change.

Overall, there is substantial agreement nationally and regionally with some exceptions. These may be attributed to local practices. For instance, simulation is used successfully for evaluation purposes during surgical course within the Yorkshire and Humber region, which may have led to increasing confidence in its use for that purpose.

The results of the current study show that surgical educators believe simulation to be a good training tool, the use of which should not be restricted to teaching basic

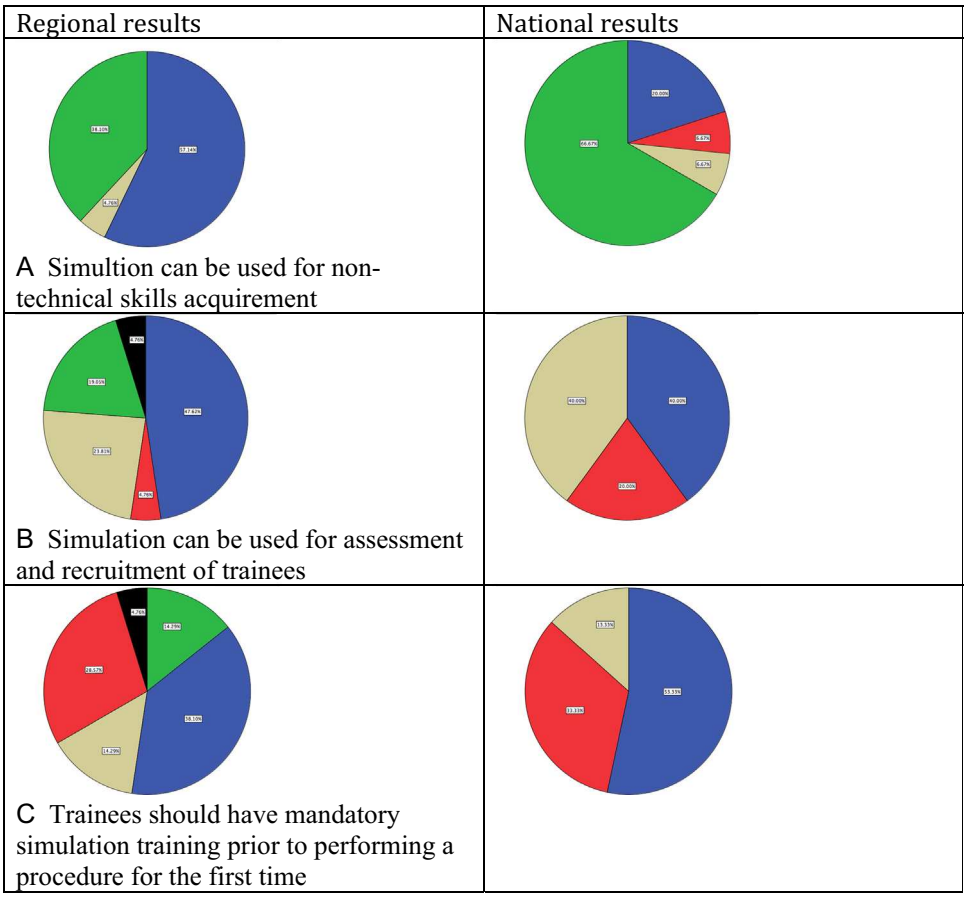

FIGURE 3. (A) Simulation can be used for nontechnical skills acquirement. (B) Simulation can be used for assessment and recruitment of trainees. (C) Trainees should have mandatory simulation training before performing a procedure for the first time. Green: strongly agree/very important, blue: agree/important, beige: indifferent, red: disagree/not important, and black: strongly disagree/not important at all.

surgical skills to novices. They strongly support the use of simulation for nontechnical skills acquisition and consider accreditation of simulation skills centers and consultant-led teaching important.

Compulsory training on simulators before performing a procedure for the first time and use of simulation for assessing trainees' technical skills or for recruitment did not yield homogenous support. It should be noted, however, that regarding the assessment question, there is a discrepancy in the results from the regional and national respondents; the majority from Yorkshire and the Humber (Y&H) believed that simulation (14/21) can be used for assessment compared with only 40% of national respondents.

Regarding the location of the simulators, it was widely believed (regionally and nationally) that simulators should be found both in the operating theaters and in clinical skills centers to maximize the opportunity for both taught and self-directed training. However, there is general reluctance by Trusts to locate high-fidelity simulators in surgical theaters as use by trainees who have not undergone appropriate induction on the simulator is considered more likely to increase the risk of damage to the equipment. Equally, there is likely to be a lack of technical staff in theater who can take "ownership" of the simulator.

Although the difficulties surrounding the deployment of high-fidelity simulators could probably be overcome, there is mounting evidence to suggest that low-cost/low-fidelity simulators produce the same or better pedagogic result as high-fidelity trainers.[36-38] Such equipment can be easily transferred to theaters, their use is self-explanatory dismissing the need for an initial induction, and there are no significant maintenance costs.

The outcomes of this study are consistent with the ones of similarly themed surveys. Aydin et al.[39] surveyed both specialists and trainees and reported that both groups recommend simulation as a method of overcoming the reduced training opportunities in the operating theater and believe it to be suitable for technical and nontechnical skills learning. Forster et al.[40] assessed the opinion of TPDs, who expressed enthusiasm for surgical simulation. The respondents considered that laparoscopic simulators improved training and that simulation for trainees was desirable. Similar to the opinion of HoS in our study, the TPDs did not feel that simulation should be used for assessment at that time of the survey (2011) but considered it a possibility

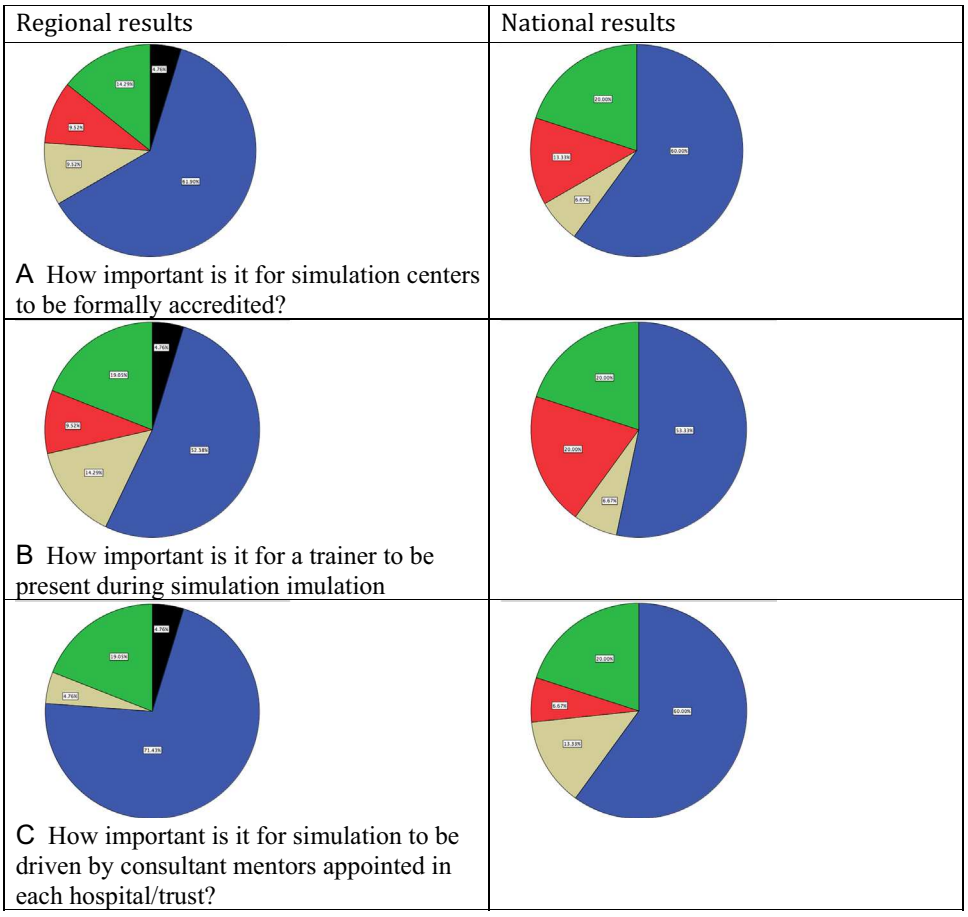

FIGURE 4. (A) How important is it for simulation centers to be formally accredited? (B) How important is it for a trainer to be present during simulation sessions? (C) How important is it for simulation to be driven by consultant mentors appointed in each hospital/trust? Green: strongly agree/very important, blue: agree/important, beige: indifferent, red: disagree/not important, and black: strongly disagree/not important at all.

in the future. These findings both in the Forster et al. and the current study may reflect the paucity of high-quality evidence regarding the use of simulation for assessing surgical skills.[33]

De Win et al. sought the opinion of Belgian gynecology, urology, and general surgery trainees about their training. Almost all responders found clinical skills training to be helpful and important for their future career. Most trainees in this survey attended extracurricular courses or freestyle stand-alone training, which they found to be of didactic value.[41] This is consistent with our finding that simulation outside of a long-term curriculum is also considered educational.

Further, De Win et al.[41] reported poor access to skills centers, owing to either inconvenient hours or location. The current study indirectly assessed this issue by asking the respondents whether they thought that simulators should be located in the operating theaters (ensuring 24-hour access) or in clinical skills centers. The majority suggested that simulators should be placed in both clinical skills centers and operating theaters. Further data from Y&H suggest that usage in centers that are only accessible to trainees between 0900 and 1700 is limited.[42] It is clear that simulators should be accessible for free-training 24/7; however, it should be noted that the presence of a trainer

TABLE. Optimal Simulation Model. MOST Popular First- and Second Choice are Italicized

	First Option (%)		Second Option (%)		Third Option (%)		Fourth Option (%)	
Models	**HoS**	**TPDs**	**HoS**	**TPDs**	**HoS**	**TPDs**	**Hos**	**TPDs**
Animal models	2 (13.3)	2 (9.5)	*7 (46.7)*	9 (42.9)	2 (13.3)	5 (23.8)	4 (26.7)	5 (23.8)
Synthetic models	0	1 (4.8)	4 (26.7)	4 (19)	6 (40)	6 (28.6)	5 (33.3)	10 (47.6)
Cadavers	12 (80)	13 (61.9)	2 (13.3)	5 (23.8)	1 (6.7)	1 (4.8)	0	2 (9.5)
Virtual reality simulators	1 (6.7)	5 (23.8)	2 (13.3)	3 (14.3)	6 (40)	9 (42.9)	6 (40)	4 (19)

is of vital importance at least for the initial training sessions.

Moreover, the respondents to our survey considered that the ideal simulation model was cadavers with the most popular second option being animal models. Blaschko et al.[43] described the importance of human cadavers as an optimal method for minimally invasive surgical skills acquisition. Further, the British Association for Urological Surgeons developed the Human Cadaveric Training program as a multimodular teaching program for trainees.[44] Relatively recent developments can make the use of cadavers for surgical simulation in the UK, even more appealing. Firstly, changes in the in the Human Tissue Act in England, Wales, and Northern Ireland and the Anatomy Act in Scotland[45] permit surgical procedures to be performed on human cadavers. Furthermore, the use of alternative soft-fix embalming techniques, such as the Thiel method[46] by UK institutions,[47] provide all the benefits of simulation training of formalin fixed cadavers (e.g., can be used for a longer period of time compared with fresh frozen), with the addition of significantly more well-preserved tissue texture and color.[46]

It should be noted that specialties of the responders vary significantly adding to the potential generalizability of the findings of this survey. Transferability of surgical skills acquired to the operating room has been demonstrated in various surgical specialties in the past.[48,49]

Although this study has not assessed trainee opinion about simulation, there has been a detailed report published by the Association of Surgeons in Training (ASiT) in which trainees are calling for simulation to be included in the curriculum with appropriate quality assurance of training centers and improved access to the facilities that are available.[50] This is consistent with the strong support for clinical skills center accreditation expressed during our survey.

This study has several limitations. It does not provide high-level evidence, as it is designed to explore expert opinion (i.e., level evidence VII)[51]; however, as TPDs and HoS have a crucial role in shaping the delivery of surgical education, we feel it is important to be aware of their perceptions. Further, as we decided to focus on expert opinion, we did not seek the opinion of trainees; however, we do feel this was done extensively in previous reports.[39,50]

CONCLUSION

In summary, the TPDs and HoS had a positive attitude toward simulation in surgical training and believed it to be a useful tool for acquisition of both technical and nontechnical skills. They were rather more apprehensive about simulation being a compulsory part of surgical training and being used for assessment and recruitment purposes. Finally, center accreditation, dedicated training staff, and the appointment of lead consultants are highly desirable.

REFERENCES

1. Kerr B, O'Leary JP. The training of the surgeon: Dr. Halsted's greatest legacy. *Am Surg*. 1999;65(11): 1101-1102.
2. Tan SY, Uyehara P. William Stewart Halsted (1852-1922): father of American surgery. *Singapore Med J*. 2010;51(7):530-531.
3. McCaskie AW, Kenny DT, Deshmukh S. How can surgical training benefit from theories of skilled motor development, musical skill acquisition and performance psychology? *Med J Aust*. 2011;194(9): 463-465.
4. Stefanidis D, Sevdalis N, Paige J, et al. Simulation in surgery: what's needed next? *Ann Surg*. 2015;261 (5):846-853.
5. Windsor JA. Role of simulation in surgical education and training. *ANZ J Surg*. 2009;79(3):127-132.
6. Sachdeva AK, Pellegrini CA, Johnson KA. Support for simulation-based surgical education through American College of Surgeons—accredited education institutes. *World J Surg*. 2008;32(2):196-207.
7. Society of Simulation in Healthcare Accreditation 2014. Available at: ⟨http://www.ssih.org/Portals/48/Accreditation/14_Informational_Guide.pdf⟩ Cited 28.01.16.
8. Andrew B, Plachta S, Salud L, Pugh CM. Development and evaluation of a decision-based simulation for assessment of team skills. *Surgery*. 2012;152(2): 152-157.
9. Scott DJ, Pugh CM, Ritter EM, Sachdeva AK. New directions in simulation-based surgical education and training: validation and transfer of surgical skills, use of nonsurgeons as faculty, use of simulation to screen and select surgery residents, and long-term follow-up of learners. *Surgery*. 2011;149(6):735-744.
10. Riem N, Boet S, Chandra D. Setting standards for simulation in anesthesia: the role of safety criteria in accreditation standards. *Can J Anaesth*. 2011;58(9): 846-852.
11. *Department of Health*. Liberating the NHS: Developing the Healthcare Workforce—From Design to Delivery. Available at: ⟨http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/216421/dh_132087.pdf⟩ Cited 28.01.16.
12. Wild JR, Fitzgerald JE, Beamish AJ. Health Education England, Local Education and Training Boards (LETBs) and reform of healthcare education: implications for surgical training. *BMC Surg*. 2015;15(1):3.

13. *Health Education England*. Local education and training boards. Available at: ⟨http://www.hee.nhs.uk/about-us/our-leaders-structure/local-education-training-boards⟩ Cited 15.06.16.

14. NHS Education for Scotland. Available at: ⟨http://www.nes.scot.nhs.uk⟩ Cited 15.06.16.

15. *Surgery*. Yorkshire and the Humber. Available at: ⟨http://www.yorksandhumberdeanery.nhs.uk/surgery/⟩ Cited 15.06.16.

16. Surgical Tutor role description and framework August 2014. Available at: ⟨http://www.hee.nhs.uk/about-us/our-leaders-structure/local-education-training-boards⟩ Cited 15.06.16.

17. *Royal College of Surgeons of England*. Courses. Available at: ⟨https://www.rcseng.ac.uk/courses⟩ Cited 15.06.16.

18. *Cuschieri Skills Centre*. University of Dundee. Available at: ⟨https://cuschieri.dundee.ac.uk/courses/general-surgery⟩.

19. Medical education Leeds. Available at: ⟨http://www.medicaleducationleeds.com/venue/limit-suite/⟩ Cited 15.06.16.

20. Fletcher GC, McGeorge P, Flin RH, Glavin RJ, Maran NJ. The role of non-technical skills in anaesthesia: a review of current literature. *Br J Anaesth*. 2002;88(3):418-429.

21. Williamson JA, Webb RK, Sellen A, Runciman WB, Van Der Walt JH. The Australian Incident Monitoring Study. Human failure: an analysis of 2000 incident reports. *Anaesth Intens Care*. 1993;21(5):678-683.

22. Cooper JB, Newbower RS, Long CD, McPeek B. Preventable anesthesia mishaps: a study of human factors. 1978. *Qual Saf Health Care*. 2002;11(3):277-282.

23. Flin RM, Martin L, Goeters KM, et al. Development of the NOTECHS (non-technical skills) system for assessing pilots' CRM skills. *Hum Factors Aerospace Safety*. 2003;3(2):95-117.

24. Robb M, Miller G. Human factors engineering in oil and gas—a review of industry guidance. *Work*. 2012;41(suppl 1):S752-S762.

25. Yule S, Flin R, Paterson-Brown S, Maran N. Non-technical skills for surgeons in the operating room: a review of the literature. *Surgery*. 2006;139(2):140-149.

26. Yule S, Parker SH, Wilkinson J, et al. Coaching non-technical skills improves surgical residents' performance in a simulated operating room. *J Surg Educ*. 2015;72(6):1124-1130.

27. Bradley P. The history of simulation in medical education and possible future directions. *Med Educ*. 2006;40(3):254-262.

28. Agha RA, Fowler AJ. The role and validity of surgical simulation. *Int Surg*. 2015;100(2):350-357.

29. Rashid P, Gianduzzo TR. Urology technical and non-technical skills development: the emerging role of simulation. *BJU Int*. 2016;117(Suppl. 4):9-16.

30. Paige JT, Kozmenko V, Yang T, et al. High-fidelity, simulation-based, interdisciplinary operating room team training at the point of care. *Surgery*. 2009;145(2):138-146.

31. Thomsen AS, Kiilgaard JF, Kjaerbo H, la Cour M, Konge L. Simulation-based certification for cataract surgery. *Acta Ophthalmol*. 2015;93(5):416-421.

32. *GP National Recruitment Office*. Simulated Surgery. Available at: ⟨https://gprecruitment.hee.nhs.uk/Induction-Refresher/Simulated-Surgery⟩.

33. Tavakol M, Mohagheghi MA, Dennick R. Assessing the skills of surgical residents using simulation. *J Surg Educ*. 2008;65(2):77-83.

34. McElnay PJ, George J, Lodhia J, et al. How to apply successfully for an ST1 training post in cardiothoracic surgery. *BMJ Careers*. 2014. Available at: http://careers.bmj.com/careers/advice/How_to_apply_successfully_for_an_ST1_training_post_in_cardiothoracic_surgery. Accessed 23.08.16.

35. Andersen D. How can educators use simulation applications to teach and assess surgical judgment? *Acad Med*. 2012;87(7):934-941.

36. Hennessey IA, Hewett P. Virtual reality versus box laparoscopic simulators in trainee selection and aptitude testing. *Surg Laparosc Endosc Percutan Tech*. 2014;24(4):318-321.

37. Mohammadi Y, Lerner MA, Sethi AS, Sundaram CP. Comparison of laparoscopy training using the box trainer versus the virtual trainer. *J Soc Laparoendosc Surg*. 2010;14(2):205-212.

38. Diesen DL, Erhunmwunsee L, Bennett KM, et al. Effectiveness of laparoscopic computer simulator versus usage of box trainer for endoscopic surgery training of novices. *J Surg Educ*. 2011;68(4):282-289.

39. Aydin A, et al. The role of simulation in urological training—a quantitative study of practice and opinions. *Surgeon*. 2015 [Epub ahead of print].

40. Forster JA, et al. Surgical simulators in urological training–views of UK Training Programme Directors. *BJU Int*. 2012;110(6):776-778.

41. De Win G, Everaerts W, De Ridder D, Peeraer G. Laparoscopy training in Belgium: results from a nationwide survey, in urology, gynecology, and general surgery residents. *Adv Med Educ Pract*. 2015;6:55-63 (eCollection 2015).

42. Yiasemidou M, Tomlinson J, Glassman D, Johnson J, Gough MJ. Should simulation be compulsory for trainees in all surgical specialties? *BMJ STEL*. 2014;1 (1):A68-A69.

43. Blaschko SD, Brooks HM, Dhuy SM, Charest-Shell C, Clayman RV, McDougall EM. Coordinated multiple cadaver use for minimally invasive surgical training. *JSLS*. 2007;11(4):403-407.

44. Ahmed K, Aydin A, Dasgupta P, Khan MS, McCabe JE. A novel cadaveric simulation program in urology. *J Surg Educ*. 2015;72(4):556-565.

45. UK Human Tissue Act 2004; Available at: ⟨http://www.legislation.gov.uk/ukpga/2004/30/contents⟩ Cited 30.01.16.

SUPPLEMENTARY MATERIAL

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.jsurg.2016.07.011.

46. Thiel W. The preservation of the whole corpse with natural color. *Ann Anat*. 1992;174(3):185-195.

47. Joy J, McLeod G, Lee N, et al. Quantitative assessment of Thiel soft-embalmed human cadavers using shear wave elastography. *Ann Anat*. 2015;202:52-56.

48. Boza C, León F, Buckel E, et al. Simulation-trained junior residents perform better than general surgeons on advanced laparoscopic cases. *Surg Endosc*. 2016 [Epub ahead of print].

49. Celentano V. Need for simulation in laparoscopic colorectal surgery training. *World J Gastrointest Surg*. 2015;7(9):185-189.

50. A statement from the Association of Surgeons in Surgery. Available at: ⟨http://www.asit.org/assets/documents/Simulation_in_Surgical_Training___ASiT_Statement.pdf⟩ Cited 09.07.15.

51. Melnyk BM, Fineout-Overholt E. Evidence-Based Practice in Nursing & Healthcare: A Guide to Best Practice. 2005. 10.