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The perceived global impact of the COVID-19 pandemic on doctors' medical and surgical training: an international survey

Running title: COVID-19 and doctors' training

Keywords: COVID-19, medical education, medical training, surgical training, doctors, impact, international

Authors (in order of publication):

TMS Collaborative*

*The article to be published under the above single corporate authorship title. The full author list is displayed in Appendix A and is to be published electronically. All names in Appendix A must be PubMed citable

Affiliations: See Appendix A

Availability of data and materials: All relevant data and results included in this article have been published along with the article and its supplementary information files. Anonymised data can be obtained on reasonable request from the corresponding author.

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Author contributions: See Appendix A. The paper was written by the writing committee. The survey design, operations management and data analysis were performed by writing committee and steering committee. The remaining collaborators recruited participants for the survey.

Ethical approval: Research ethics committee approval was not required for this non-experimental cross sectional survey and this was confirmed using the UK Health Research Authority "Is my study research?" online decision tool (<http://www.hra-decisiontools.org.uk/research>; Supplementary Document 1). Informed consent was obtained from all participants and recorded

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electronically at the start of the survey. Data was processed confidentially, anonymously and in compliance with the General Data Protection Regulations (GDPR) of the European Union.

Statistical analysis:

Statistical analysis was performed by Dr Kasun Wanigasooriya and Dr Ryan Laloo.

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Conflict of interest: None

Corresponding author: Mr Ryan Laloo (MBChB, MRCS, PG Cert).

Email: ryan.laloo@doctors.org.uk

Phone: 07904019581

Appendix A:

Corporate authorship title: The TMS Collaborative

The PubMed citable author list - in order of publication

Writing committee (citable)

Ryan Laloo (1) (2)

Rama Santhosh Karri (1) (3)

Kasun Wanigasooriya (1) (4)

William Beedham (1) (4)

Steering committee (citable)

Adnan Darr (1) (3)

Georgia R. Layton (1) (5)

Peter Logan (1) (6)

Yanyu Tan (1) (7)

Devender Mittapalli (1) (8)

Tapan Patel (9)

Collaborative authors (citable)

Vivaswan Dutt Mishra (10)
Osama Faleh Odeh (11)
Swathi Prakash (12)
Salma Elnoamany (13)
Sri Ramya Peddinti (14)
Elorm Adzoa Daketsey (15)
Shardool Gadgil (16)
Ahmad Bouhuwaish (17)
Ahmad Ozair (18)
Sanchit Bansal (19)
Muhammed Elhadi (20)
Aditya Amit Godbole (21)
Ariana Axiaq (22)
Faateh Ahmad Rauf (23)
Ashna Ashpak (24)

- (1) The Master Surgeon Trust, Worcestershire, United Kingdom
- (2) Leeds Vascular Institute, Leeds General Infirmary, Leeds, United Kingdom.
- (3) The Royal Wolverhampton NHS Trust, Wolverhampton, United Kingdom
- (4) College of Medical and Dental Science, University of Birmingham, United Kingdom
- (5) Department of Cardiac Surgery, University Hospitals of Leicester NHS Trust. United Kingdom
- (6) Walsall Healthcare NHS Trust, Walsall. United Kingdom
- (7) North East Deanery, United Kingdom
- (8) University Hospitals Plymouth NHS Trust, Plymouth, United Kingdom
- (9) Baroda Medical College, India
- (10) Motilal Nehru Medical College, Allahabad, India
- (11) Faculty of Medicine, The University of Jordan, Amman, Jordan
- (12) HCG Cancer Centre, Bangalore, India
- (13) Faculty of Medicine, Menoufia University, Menoufia, Egypt
- (14) Indira Gandhi Medical College and Research Institute , Puducherry, India
- (15) Ysbyty Gwynedd, Betsi Cadwaladr University Health Board, Gwynedd, Bangor, North Wales
- (16) Lokmanya Tilak municipal medical college, Mumbai, India

- (17) Faculty of Medicine Tobruk University, Tobruk, Libya
- (18) Faculty of Medicine, King George's Medical University, Lucknow, Uttar Pradesh, India.
- (19) Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi, India
- (20) Faculty of Medicine, University of Tripoli, Tripoli, Libya
- (21) Bharati Vidyapeeth (Deemed to be University) Medical College, Dhankawadi, Pune, India.
- (22) School of Medicine, Faculty of Life Sciences, Queen's University Belfast, Belfast, UK
- (23) Combined Military Hospital Lahore Medical College, Lahore, Pakistan
- (24) School of Medicine, University of Central Lancashire, Preston, Lancashire, United Kingdom.

MR RYAN LALOO (Orcid ID : 0000-0001-6447-0763)

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The perceived global impact of the COVID-19 pandemic on doctors' medical and surgical training: an international survey

Running title: COVID-19 and doctors' training

Abstract

Introduction

The COVID-19 pandemic has resulted in a significant burden on healthcare systems causing disruption to medical and surgical training of doctors globally.

Aims and objectives

This is the first international survey assessing the perceived impact of the COVID-19 pandemic on training of doctors of all grades and specialties.

Methods

An online global survey was disseminated using Survey Monkey® between 4th August 2020 and 17th November 2020. A global network of collaborators facilitated participant recruitment. Data was collated anonymously with informed consent and analysed using univariate and adjusted multivariable analysis.

Results

743 doctors of median age 27 (IQR: 25-30) were included with the majority (56.8%, n=422) being male. Two-thirds of doctors were in a training post (66.5%, n=494), 52.9% (n=393) in a surgical specialty and 53.0% (n= 394) in low- and middle-income countries. Sixty-nine point two percent (n=514) reported an overall perceived negative impact of the COVID-19

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pandemic on their training. A significant decline was noted among non-virtual teaching methods such as face-to-face lectures, tutorials, ward-based teaching, theatre sessions, conferences, simulation sessions and morbidity and mortality meetings ($p \leq 0.05$). Low or middle-income country doctors' training was associated with perceived inadequate supervision while performing invasive procedures under general, local or regional anaesthetic. ($p \leq 0.05$)

Conclusion

In addition to the detrimental impact of the COVID-19 pandemic on healthcare infrastructure, this international survey reports a widespread perceived overall negative impact on medical and surgical doctors' training globally. Ongoing adaptation and innovation will be required to enhance the approach to doctors' training and learning in order to ultimately improve patient care.

Keywords: COVID-19, medical education, medical training, surgical training, doctors, impact, international

What is already known about this topic?

The COVID-19 pandemic has significantly impacted the training of medical and surgical doctors globally due to redeployment and reduced exposure to training opportunities derived from elective surgery, face-to-face clinics and teaching sessions.

What does this article add?

This is the first international survey assessing the perceived impact of the COVID-19 pandemic on training of doctors of all grades and specialties. It highlights that 69.2% of participants reported an overall perceived negative impact of the COVID-19 pandemic on their training. A significant decline was noted among non-virtual teaching methods such as face-to-face lectures, tutorials, ward-based teaching, theatre sessions, conferences, simulation sessions and morbidity and mortality meetings. Low and middle-income country doctors' training was associated with perceived inadequate supervision while performing invasive procedures under general, local or regional anaesthetic.

Introduction

On the 11th March 2020, the World Health Organisation declared a pandemic following an outbreak of the severe acute respiratory syndrome 2 (SARS-CoV-2) virus. This resulted in an almost immediate and significant burden on healthcare systems globally¹⁻⁵, resulting in the implementation of emergency strategies such as cancellation of elective services, and re-allocation of the medical and surgical workforce in order to maintain patient safety.⁶⁻⁹ The medical and surgical workforce were required to rapidly adapt to the dynamic needs of healthcare systems. Social distancing rules limited gatherings and mandated people staying at home except in specific circumstances, thus restricting delivery of traditional training for doctors.

As intensive care units expanded to accommodate the influx of deteriorating patients, many doctors were mobilised from their respective specialties. A proportion of the workforce were requested to remain on standby from home to minimise viral exposure, whilst others were re-deployed to cover rota deficiencies.¹⁰⁻¹² Surgical trainees were occasionally restricted from attending operating lists, with procedures predominantly undertaken by the most senior staff in order to reduce operating time, preserve PPE, whilst minimising viral spread.¹²

In an attempt to salvage training opportunities, online platforms such as Microsoft Teams and Zoom were utilised to deliver virtual lectures, webinars and conferences while simulation models were introduced to facilitate procedural skills training in some centres.¹³⁻¹⁶ It is hypothesised that the impact of the pandemic on doctors' perceived confidence in clinical skills, career progression and mental health is likely to be significant.

The primary aim of this survey was to assess doctors' perceived impact of the COVID-19 pandemic on surgical and medical training and learning globally.

Method

Survey setting and design

This electronic cross-sectional study was designed and conducted as a survey by TMS Collaborative (The Master Surgeon Trust, United Kingdom [UK], HMRC small medical education charity reference: EW03332), and disseminated using the SurveyMonkey (San Mateo, California, USA) online platform between 4th August 2020 and 17th November 2020. Informed consent was obtained from all participants and recorded electronically. Research ethics committee approval was not required and this was confirmed using the UK Health Research Authority "Is my study research?" online decision tool (<http://www.hra-decisiontools.org.uk/research>; Supplementary Document 1).¹⁷ The questionnaire can be found in the supplementary documents (Supplementary Document 2). Data was anonymously collected, stored and analysed in compliance with the General Data Protection Regulations (GDPR) of the European Union.¹⁸

Survey participation

Medical and surgical doctors globally of all grades, aged eighteen or over and currently employed were eligible to participate. Promotional strategies included electronic mail and social media platforms (Facebook, LinkedIn and Twitter) by an international team of volunteer collaborators. Participant email and IP addresses were stored and audited as an internal quality control measure in order to remove duplicates.

Independent variables

This survey collected 19 independent variables including participant demographic data including age, gender and country of residence; current stage of training, specialty/ sub-specialty; a diagnosis of symptomatic COVID-19 infection; redeployment status; a change in clinical responsibility, working hours and teaching modalities (*non-virtual*: lectures, tutorials, ward-based teaching, operating theatre, conferences and simulation sessions; *virtual*: online lectures, tutorials, webinars and conferences).

Participant experiences and outcomes

Data was collected on doctors' perceived impact of the COVID-19 pandemic on their training and learning (Table 3). The impact on their preparation for the next stage of training, confidence in clinical and procedural skills and choice of future career speciality were also evaluated. Changes in the levels of clinical supervision relating to clinical tasks (clerking/ admissions, clinical procedures under local/ regional/ general anaesthesia and independently assessing or managing acutely unwell patients) was crucially elicited. The overall perceived impact of the pandemic on training and learning was scored using a Likert scale.

Data analysis

Data was collated using Excel (Microsoft, Redmond, Washington, USA) and non-parametric data represented as median and interquartile range (IQR). Categorical data was summarised in tables as proportions and percentages. Countries of residence were based on data from the World Bank and categorised as low-, middle- or high-income.¹⁹ Doctors' responses in the form of Likert scales and categorical ranges were combined to generate binary data.

Statistical analysis was performed using SPSS (IBM, New York, USA). Univariate (un-adjusted) analysis was performed using χ^2 -tests to assess the association among 19 independent variables (Table 1 and Table 2) and doctors reported overall negative impact on training and learning. Univariate (un-adjusted) analysis was used to assess the association among doctors' training experiences (Table 3) and training status or economic status of country of residence. Multivariable (adjusted) analysis using a binary logistic regression analysis was performed among the 19 independent variables and perceived overall negative impact on training and learning (Table 4). These results were displayed as odds ratios (OR) and 95% confidence intervals. A *p*-value of <0.05 was defined as the level of statistical significance.

Results

The median age of our cohort was 27 (IQR: 25-30). Male doctors accounted for 56.8% (n=422) of participants. Two-thirds of all doctors were in a training post (66.5%, n=494) while 33.5% doctors (n=808) were in a non-training post. The majority of respondents within the cohort (82.9%, n=616) were categorised as junior doctors (foundation year, house officers, senior house officers, core medical trainees, core surgical trainees) whilst only 17.1% (n=127) were categorised as senior doctors (registrars, ST3 and above or equivalent). More than half of respondents (52.9%, n=393) were working within a surgical speciality,

whilst 47.1% were working in a non-surgical specialty. Increased working hours were reported for 35.0% (n=260); 36.3% (n=270) reported undergoing redeployment and 56.0% (n=416) reported increased clinical responsibility. Doctors from low and middle-income countries comprised 53.0% (n=394) of the study cohort while 47.0% (n=349) worked in high-income countries. A full list of participant countries of residence is included in Supplementary Document 3. 19.0% (n=141) reported contracting symptomatic Covid-19 infection at the time this survey was completed.

Doctors reported a perceived decline in face-to-face lectures (66.5%, n=494), tutorials (54.8%, n=407), ward-based teaching (62.3% n=463), morbidity and mortality meetings (38.8%, n=288), operating theatre sessions (61.0%, n=453), conferences (64.9%, n=482) and simulation sessions (45.1%, n=335). However, doctors reported a perceived increase in the utilisation of virtual learning resources (79.4%, n=590) and webinars (75.1%, n=558). Less than half of all doctors reported postponement of examinations (41.2%, n=306).

Over two-thirds of respondents reported an overall perception that preparation for their next stage of training was adversely affected (68.5%, n=509), as was a decision regarding future career pathway (54.5%, n=405). Career progression was perceived to be negatively affected in over half of responses collated (56.3%, n=418). An overwhelming majority of doctors (72.0%, n=535) reported reduced confidence in performing clinical skills, coupled with perceived reduced overall supervision when clerking patients (40.8%, n=303). Respondents reported a perception of inadequate supervision while performing invasive procedures under general anaesthetic (18.8%, n=140), invasive procedures under local anaesthetic (28.0%, n=208), and managing acute emergencies (38.1%, n=283).

Factors associated with an overall negative impact on doctors' training.

Overall, 69.2% (n=514) doctors reported a perceived overall negative impact of the Covid-19 pandemic on their medical or surgical training and learning. Factors associated with an overall perceived negative impact on training and learning in a univariate analysis included: doctors in a training post, a decline in face-to-face lectures, tutorials, ward-based teaching, operating theatre sessions, conferences, simulation sessions and morbidity and mortality meetings ($p < 0.05$; Table 1 and Table 2). Age, gender, seniority of doctors, specialty, redeployment status, increased clinical responsibility, increased working hours, economic status of resident country, COVID-19 infection status and increased online lectures and

webinars did not significantly affect the overall perceived negative impact of the COVID-19 pandemic on doctors' training and learning.

Covariate adjusted binary logistic regression analysis was performed for 743 participants and 19 independent variables (Table 1 and Table 2) comparing participants who reported a perceived overall negative impact on training as the outcome variable. Associated factors included: doctors in a training post (OR 1.5 (1.0-2.1); $p=.027$), decreased ward based teaching (OR 1.7 (1.2-2.5); $p=.007$), decreased face-to-face lectures (OR 1.6 (1.0-2.4); $p=.034$) and decreased conferences (OR 2.0 (1.4-3.0); $p<0.001$) (Table 4).

Doctors' experiences during the COVID-19 pandemic

Univariate analysis demonstrated that when compared to doctors working in high-income countries, the doctors residing in low- or middle-income countries were associated with a greater perceived negative impact on their choice of career specialty (61.7% vs 46.4%), postponement of the next stage of training (66.8% vs 44.8%) and perceived inadequate supervision while performing invasive procedure under general anaesthesia (22.8% vs 14.3%), local or regional anaesthesia (31.7% vs 23.8%) ($p<0.001$; Table 3). Doctors who were not in a training post were associated with a postponement in the next stage of their career while doctors currently in a training post were associated with a perceived negative impact on preparation for their next stage of training ($p<0.001$).

Discussion

Amongst the 743 doctors surveyed, the majority of participants reported a perceived overall negative impact of the COVID-19 pandemic on their training and learning with associated factors including: doctors in a training post, a decline in face-to-face lectures, tutorials, ward-based teaching, theatre sessions, conferences, simulation sessions and morbidity and mortality meetings.

With rising concerns for the quality of medical and surgical training amongst doctors worldwide, the workforce has witnessed tremendous adaptation and innovation.²⁰ Digital resources such as video teleconferencing, virtual lectures, grand rounds, case conferences, journal clubs, webinars and e-books have been shown to supplement traditional bedside teaching and enhance both theoretical knowledge and technical skill acquisition.²¹ This has

recently been utilised in a flipped classroom model to enhance training efficacy through a global exchange of knowledge.^{22,23} With the ease of access to information, it is equally imperative that doctors seek high quality online educational content from reputable sources. Surgical simulators and virtual reality platforms have the ability to enhance technical skill among doctors with the benefit of reflection and discussion in a risk-free environment.^{13,24,25}

As the majority of face-to-face academic conferences were cancelled, trainees missed out on the opportunity to present and discuss their research findings, thus impacting their learning. With the increasing utilisation of virtual conference platforms such as MedAll, conferences have resumed and are once again providing trainees with the opportunity to share knowledge globally.²⁶ In this survey, a decline in conferences was associated with doctors being twice as likely to report an overall negative impact on training and learning.

The Royal College of Surgeons had suspended examinations by March 16th 2020.²⁷ The 2020 UK GMC survey highlighted that 80% of doctors reported limited access to learning required to facilitate career progression due to the COVID-19 pandemic.²⁸ A review of UK trainee logbooks identified a 50% reduction in operations with trainees as the primary operating surgeon in 2020 compared to 2019.²⁹ The COVIDSTAR survey highlighted that 41% of surgical trainees within the UK and Republic of Ireland underwent redeployment.³⁰ Our findings in this global survey of medical and surgical doctors demonstrated a similar redeployment rate of 36.3%. At the Annual Review of Competency Progression for senior UK surgical trainees, 12% were identified as “delayed due to COVID-19”.³¹ Moving forward, urgent restoration of operating theatre training opportunities will be crucial to achieve surgical competencies required for continued career progression.³² Despite the disruption to training for junior doctors undergoing redeployment to intensive care units and medical wards, the opportunity for enhancing communication and collaboration among different medical teams should not be overlooked as this skill is invaluable for developing higher calibre trainees.^{33,34}

Our survey revealed that a proportion of doctors globally felt inadequately supervised while performing invasive clinical procedures under local or regional anaesthesia (28.0%) and general anaesthesia (18.8%). This perception was more commonly reported among doctors working in low-and middle-income countries compared to high-income countries. Moving forward, it is important that doctors highlight situations where they require additional support

and supervision and communicate those concerns to senior doctors within the clinical teams in order to maintain high standards of patient safety.²⁷ In 2016, a systematic review of postgraduate surgical education in low and middle-income countries highlighted that limited financial resources and trainers at teaching sites alongside competing needs for both clinical and educational trainer responsibilities often limited their ability to provide adequate supervision for surgical trainees compared to high-income countries.³⁵ Cecilio-Fernandes et al recently outlined challenges in using technology for medical education in low and middle-income countries including faculty shortage, areas of unreliable internet connectivity or electricity and difficulty in adapting medical curricula from face-to-face to online delivery.³⁶ The COVID-19 pandemic may have exacerbated these circumstances in areas with limited access to online and simulation learning resources. This may be linked to our survey findings where the majority of doctors working in low and middle-income countries reported a perceived negatively affected choice of future career specialty (61.7%) and postponement of their next career stage (55.8%) due to the pandemic. The opposite trend was observed among doctors from high-income countries where the minority reported a perceived negative impact on choice of career specialty (46.4%) and postponement of next stage of career (44.4%).

The physical fatigue and mental stress associated with working as a healthcare professional during the pandemic has likely contributed to the negative impact on doctors' training.³⁷⁻³⁹ A UK survey of mental health disorders among 2638 healthcare workers in 2020 highlighted prevalence rates of clinically significant symptoms of anxiety, depression and PTSD in 34.3%, 31.2% and 24.5% of the cohort respectively.³⁹ As we emerge from the COVID-19 pandemic, concerted efforts to reconfigure both medical and surgical education and provide ongoing support for doctors' mental health will be paramount in order for trainees to achieve essential skills and milestones. The resumption of outpatient clinic appointments and elective surgery will hopefully facilitate an influx of training opportunities which need to be maximised.⁴⁰ In the UK, current trends being adopted include introducing elective surgical training within the independent sector, individualising training trajectories, expanding e-learning and simulation platforms for all specialties and establishing online examinations.³²

Acknowledgement of the negative impact of the COVID-19 pandemic on doctors' learning and flexibility surrounding doctors' portfolios and learning requirements will be imperative to enable them to achieve their maximum potential moving forward.⁴²⁻⁴⁴ The COVID-19

pandemic is likely to encourage and inspire medical professionals to change their approach to training and learning which will ultimately improve the care we offer to our patients.

Strengths and limitations

To the best of our knowledge, this is the first international survey assessing the perceived impact of the COVID-19 pandemic on both medical and surgical doctors of all grades and specialties. It positively contributes to the existing evidence base to allow clinicians to better understand how training has been impacted in order to inform strategies to enhance the quality of doctors of the future as we emerge from the pandemic.

The external validity of these findings may be limited by the sample size of 743 participants. Although the results demonstrated no statistically significant differences among participant gender, age, stage of training, resident country economic status and specialties, there is a risk of sampling bias within this survey. Participants with negative training experiences may have been more likely to respond, thus affecting the reliability of results. Participants may have also experienced response bias based on the wording of the questionnaire.

Conclusion

Our international survey reports the perceived overall negative impact of the COVID-19 pandemic on medical and surgical doctors' training globally. Lessons learnt in adaptation and innovation will certainly serve as a stimulus to enhance the delivery of training and learning for doctors in order to ultimately improve patient care.

References

1. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The Lancet*. 2020;395(10223):497-506.
2. Lai C, Shih T, Ko W, Tang H, Hsueh P. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges. *International Journal of Antimicrobial Agents*. 2020;55(3):105924.
3. Wu Z, McGoogan J. Characteristics of and Important Lessons From the Coronavirus Disease 2019 (COVID-19) Outbreak in China. *JAMA*. 2020;323(13):1239.

- Accepted Article
4. Coronavirus Disease (COVID-19) Situation Reports [Internet]. Who.int. 2021 [cited 5 March 2021]. Available from: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>
 5. Adams J, Walls R. Supporting the Health Care Workforce During the COVID-19 Global Epidemic. *JAMA*. 2020;323(15):1439.
 6. Collaborative C. Preoperative nasopharyngeal swab testing and postoperative pulmonary complications in patients undergoing elective surgery during the SARS-CoV-2 pandemic. *European Journal of Surgical Oncology*. 2021;47(1):e4.
 7. Whelehan D, Connelly T, Ridgway P. COVID-19 and surgery: A thematic analysis of unintended consequences on performance, practice and surgical training. *The Surgeon*. 2021;19(1):e20-e27.
 8. Lacobucci G. Covid-19: all non-urgent elective surgery is suspended for at least three months in England. *BMJ*. 2020;:m1106.
 9. Ahmed K, Hayat S, Dasgupta P. Global challenges to urology practice during the COVID-19 pandemic. *BJU International*. 2020;125(6):E5-E6.
 10. Spinelli A, Pellino G. COVID-19 pandemic: perspectives on an unfolding crisis. *British Journal of Surgery*. 2020;107(7):785-787.
 11. Søreide K, Hallet J, Matthews J, Schnitzbauer A, Line P, Lai P et al. Immediate and long-term impact of the COVID-19 pandemic on delivery of surgical services. *British Journal of Surgery*. 2020;107(10):1250-1261.
 12. Bernardi L, Germani P, Del Zotto G, Scotton G, de Manzini N. Impact of COVID-19 pandemic on general surgery training program: An Italian experience. *The American Journal of Surgery*. 2020;220(5):1361-1363.

- Accepted Article
13. Tolu L, Feyissa GT, Ezeh A, Gudu W. Managing Resident Workforce and Residency Training During COVID-19 Pandemic: Scoping Review of Adaptive Approaches. *Adv Med Educ Pract.* 2020;11:527-535.
 14. Martinelli S, Isaak R, Schell R, Mitchell J, McEvoy M, Chen F. Learners and Luddites in the Twenty-first Century. *Anesthesiology.* 2019;131(4):908-928.
 15. Givi B, Moore M, Bewley A, Coffey C, Cohen M, Hessel A et al. Advanced head and neck surgery training during the COVID - 19 pandemic. *Head & Neck.* 2020;42(7):1411-1417.
 16. Laloo R, Giorga A, Williams A, Biyani C, Yiasemidou M. Virtual surgical education for core surgical trainees in the Yorkshire deanery during the COVID-19 pandemic. *Scottish Medical Journal.* 2020;65(4):138-143.
 17. Is my study research? [Internet]. Hra-decisiontools.org.uk. 2021 [cited 5 March 2021]. Available from: <http://www.hra-decisiontools.org.uk/research>
 18. Data protection in the EU [Internet]. European Commission - European Commission. 2021 [cited 5 March 2021]. Available from: https://ec.europa.eu/info/law/law-topic/data-protection/data-protection-eu_en
 19. World Bank Country and Lending Groups – World Bank Data Help Desk [Internet]. Datahelpdesk.worldbank.org. 2021 [cited 5 March 2021]. Available from: <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>
 20. Marcasciano M. Breast surgeons updating on the thresholds of COVID-19 era: results of a multicenter collaborative study evaluating the role of online videos and multimedia sources on breast surgeons education and training. *Eur Rev Med Pharmacol Sci.* 2020;24(14):7845-7854.
 21. Larvin M. E-Learning in surgical education and training. *ANZ Journal of Surgery.* 2009;79(3):133-137.

- Accepted Article
22. Hopkins L, Hampton B, Abbott J, Buery-Joyner S, Craig L, Dalrymple J et al. To the point: medical education, technology, and the millennial learner. *American Journal of Obstetrics and Gynecology*. 2018;218(2):188-192.
 23. Narang A, Velagapudi P, Rajagopalan B, LeBude B, Kithcart A, Snipelisky D et al. A New Educational Framework to Improve Lifelong Learning for Cardiologists. *Journal of the American College of Cardiology*. 2018;71(4):454-462.
 24. Bur A, Gomez E, Newman J, Weinstein G, O'Malley B, Rassekh C et al. Evaluation of high-fidelity simulation as a training tool in transoral robotic surgery. *The Laryngoscope*. 2017;127(12):2790-2795.
 25. Pedowitz R, Marsh L. Motor Skills Training in Orthopaedic Surgery: A Paradigm Shift Toward a Simulation-based Educational Curriculum. *Journal of the American Academy of Orthopaedic Surgeons*. 2012;20(7):407-409.
 26. Edigin E, Eseaton P, Shaka H, Ojemolon P, Asemota I, Akuna E. Impact of COVID-19 pandemic on medical postgraduate training in the United States. *Medical Education Online*. 2020;25(1):1774318.
 27. Ellis R, Hay-David A, Brennan P. Operating during the COVID-19 pandemic: How to reduce medical error. *British Journal of Oral and Maxillofacial Surgery*. 2020;58(5):577-580.
 28. National training surveys [Internet]. Gmc-uk.org. 2021 [cited 5 March 2021]. Available from: <https://www.gmc-uk.org/education/how-we-quality-assure/national-training-surveys>
 29. Joint Committee of Surgical Training, Association of Surgeons in Training, British Orthopaedics Trainees' Association, Confederation of Postgraduate Schools of Surgery. Maximising training: making the most of every training opportunity [Internet]. JCST. 2021 [cited 17 March 2021]. Available from: <https://www.jcst.org/key-documents/>

30. COVID-19 impact on Surgical Training and Recovery Planning (COVID-STAR) – A Cross-Sectional Observational Study. *International Journal of Surgery*. 2021;:105903.
31. Health Education England. Guidance and principles for managing extensions to training during covid-19 (ARCP outcomes 10.1 and 10.2). [Internet]. 2020 [cited 17 March 2021]. Available from: [https://healtheducationengland.sharepoint.com/Comms/Digital/SharedDocuments/Forms/AllItems.aspx?id=%2FComms%2FDigital%2FShared Documents%2Fhee.nhs.uk documents%2FWebsite files](https://healtheducationengland.sharepoint.com/Comms/Digital/SharedDocuments/Forms/AllItems.aspx?id=%2FComms%2FDigital%2FShared%2FDocuments%2Fhee.nhs.uk%2Fdocuments%2FWebsite%2Ffiles)
32. Munro C, Burke J, Allum W, Mortensen N. Covid-19 leaves surgical training in crisis. *BMJ*. 2021;659.
33. Akhtar K, Chen A, Standfield N, Gupte C. The role of simulation in developing surgical skills. *Current Reviews in Musculoskeletal Medicine*. 2014;7(2):155-160.
34. Agha R, Fowler A. The Role and Validity of Surgical Simulation. *International Surgery*. 2015;100(2):350-357.
35. Rickard J. Systematic Review of Postgraduate Surgical Education in Low- and Middle-Income Countries. *World Journal of Surgery*. 2016;40(6):1324-1335.
36. Cecilio-Fernandes D, Parisi M, Santos T, Sandars J. The COVID-19 pandemic and the challenge of using technology for medical education in low and middle income countries [Internet]. Doaj.org. 2021 [cited 16 April 2021]. Available from: <https://doaj.org/article/87c0b562b0cc4794a436cd175ff3c69d>
37. Dimitriu M, Pantea-Stoian A, Smaranda A, Nica A, Carap A, Constantin V et al. Burnout syndrome in Romanian medical residents in time of the COVID-19 pandemic. *Medical Hypotheses*. 2020;144:109972.
38. Blanco-Colino R, Soares A, Kuiper S. Surgical Training During and After COVID-19: A Joint Trainee and Trainers Manifesto. *Ann Surg*. 2020;272(1):e24-e26.

39. Wanigasooriya K, Palimar P, Naumann D, Ismail K, Fellows J, Logan P et al. Mental Health Symptoms in a Cohort of Hospital Healthcare Workers Following the Peak of the COVID-19 Pandemic in the United Kingdom. SSRN Electronic Journal. 2020;.
40. Daodu O, Panda N, Lopushinsky S, Varghese T, Brindle M. COVID-19 – Considerations and Implications for Surgical Learners. Annals of Surgery. 2020;272(1):e22-e23.
41. Dedeilia A, Sotiropoulos M, Hanrahan J, Janga D, Dedeilias P, Sideris M. Medical and Surgical Education Challenges and Innovations in the COVID-19 Era: A Systematic Review. In Vivo. 2020;34(3 suppl):1603-1611.
42. Khan K, Key R, McLellan M, Mahmud S. Impact of the COVID-19 pandemic on core surgical training. Scottish Medical Journal. 2020;65(4):133-137.
43. Hall A, Nousiainen M, Campisi P, Dagnone J, Frank J, Kroeker K et al. Training disrupted: Practical tips for supporting competency-based medical education during the COVID-19 pandemic. Medical Teacher. 2020;42(7):756-761.
44. Ellison E, Spanknebel K, Stain S, Shabahang M, Matthews J, Debas H et al. Impact of the COVID-19 Pandemic on Surgical Training and Learner Well-Being: Report of a Survey of General Surgery and Other Surgical Specialty Educators. Journal of the American College of Surgeons. 2020;231(6):613-626.

	Total	Reported an overall negative impact on training/learning		
		Yes (%)	No (%)	<i>p</i> -value ⁺
	n (%)			
Total	743 (100)	514 (69.2)	229 (30.8)	-
Age (years)				

≤27	514 (69.2)	316 (61.5)	138 (38.5)	
>27	229 (30.8)	198 (86.5)	91 (13.5)	.753
Gender				
Male	422 (56.8)	231 (72.0)	90 (28.0)	
Female	321 (43.2)	283 (67.1)	139 (32.9)	.152
Doctor training status				
Currently in training	494 (66.5)	361 (73.1)	133 (26.9)	
Currently not in training	249 (33.5)	153 (61.4)	96 (38.6)	.001
Doctor grade				
Junior	616 (82.9)	422 (68.5)	194 (31.5)	
Senior	127 (17.1)	92 (72.4)	35 (27.6)	.382
Specialty				
Surgical	393 (52.9)	268 (68.2)	125 (31.8)	
Non-surgical	350 (47.1)	246 (70.3)	104 (29.7)	.538
Redeployed				
Yes	270 (36.3)	198 (73.3)	72 (26.7)	
No	473 (63.7)	316 (66.8)	157 (33.2)	.064
Increased clinical responsibility				
Yes	416 (56.0)	282 (67.8)	134 (32.2)	
No	327 (44.0)	232 (70.9)	95 (29.1)	.355
Increased working hours				
Yes	260 (35.0)	174 (66.9)	86 (33.1)	
No	483 (65.0)	340 (70.4)	143 (29.6)	.329
Resident nation economic status				
Low/middle income	394 (53.0)	265 (67.3)	129 (32.7)	
High income	349 (47.0)	249 (71.3)	100 (28.7)	.228
Contracted symptomatic				

COVID-19 infection*				
Yes	141 (19.0)	93 (66.0)	48 (34.0)	
No	602 (81.0)	421 (69.9)	181 (30.1)	.357

Table 1: Factors associated with doctors-reported overall negative impact on training/learning during the Covid-19 pandemic

⁺ Pearson χ^2 statistical test used for univariate analysis to obtain *p*-values.

*Includes all with symptoms and diagnosed on a PCR swab test, antibody test, or by a clinician or self-diagnosed based on symptoms as per the World Health Organisation criteria.

	Total	Reported an overall negative impact on training/learning		
		n(%)	Yes (%)	No (%)
Total	743 (100)	514 (69.2)	229 (30.8)	
Non-virtual teaching methods				
Lectures				
<i>Declined</i>	494 (66.5)	376 (76.1)	118 (23.9)	
<i>Did not report a decline*</i>	249 (33.5)	138 (55.4)	111 (44.6)	<0.001
Tutorials				
<i>Declined</i>	407 (54.8)	304 (74.7)	103 (25.3)	
<i>Did not report a decline*</i>	336 (45.2)	210 (62.5)	126 (37.5)	<0.001
Ward-based teaching sessions				
<i>Declined</i>	463 (62.3)	350 (75.6)	113 (24.4)	
<i>Did not report a decline*</i>	280 (37.7)	164 (58.6)	116 (41.4)	<0.001
Theatre sessions				

<i>Declined</i>	453 (61.0)	331 (73.1)	122 (26.9)	
<i>Did not report a decline*</i>	290 (39.0)	183 (63.1)	107 (36.9)	0.004
Conferences				
<i>Declined</i>	482 (64.9)	370 (76.8)	112 (23.2)	
<i>Did not report a decline*</i>	261 (35.1)	144 (55.2)	117 (44.8)	<.0001
Simulation sessions				
<i>Declined</i>	335 (45.1)	256 (76.4)	79 (23.6)	
<i>Did not report a decline*</i>	408 (54.9)	258 (63.2)	150 (36.8)	<0.001
Morbidity and Mortality meetings				
<i>Declined</i>	288 (38.8)	213 (74.0)	75 (26.0)	
<i>Did not report a decline*</i>	455 (61.2)	301 (66.2)	154 (33.8)	0.025
Virtual teaching methods				
Online lectures				
<i>Increased</i>	590 (79.4)	413 (70.0)	177 (30.0)	
<i>Did not report an increase**</i>	153 (20.6)	101 (66.0)	52 (34.0)	0.341
Webinars				
<i>Increased</i>	558 (75.1)	396 (71.0)	162 (29.0)	
<i>Did not report an increase**</i>	185 (24.9)	118 (63.8)	67 (36.2)	0.067

Table 2: Changes in teaching methods during the pandemic and association with doctors reported overall negative impact on medical and surgical training.

⁺ Pearson χ^2 statistical test used for univariate analysis to obtain *p*-values.

* Includes all participants who reported increased, significantly increased, no change and not applicable

** Includes all participants who reported decreased, significantly decreased, no change and not applicable.

	Total	Resident of low/middle income country			Doctor currently in training programme		
		n(%)	Yes (%)	No (%)	p-value ⁺	Yes (%)	No (%)
Total		394 (100.0)	349 (100.0)		494 (100.0)	249 (100.0)	
Examinations							
<i>Reported postponement</i>	306 (41.2)	166 (42.1)	140 (40.1)		199 (40.3)	107 (43.0)	
<i>Did not report a postponement</i>	437 (58.8)	228 (57.9)	209 (59.9)	.577	295 (59.7)	142 (57.0)	0.482
Choice of career specialty							
<i>Negatively affected</i>	405 (54.5)	243 (61.7)	162 (46.4)		262 (53.0)	143 (57.4)	
<i>Not negatively affected</i>	338 (45.5)	151 (38.3)	187 (53.6)	<.001	232 (47.0)	106 (42.6)	0.256
Postponement of next stage of career							
<i>Reported negatively affected</i>	418 (56.3)	263 (66.8)	155 (44.4)		262 (53.0)	156 (62.7)	
<i>Did not report being affected</i>	325 (43.7)	131 (33.2)	194 (55.6)	<.001	232 (47.0)	93 (37.3)	0.013
Preparation for next stage of							

training							
<i>Reported preparation affected</i>	509 (68.5)	282 (71.6)	227 (65.0)		367 (74.3)	142 (57.0)	
<i>Did not report being affected</i>	234 (31.5)	112 (28.6)	122 (35.0)	.056	127 (25.7)	107 (43.0)	<0.001
Confidence in clinical skills							
<i>Reported negatively affected</i>	535 (72.0)	294 (74.6)	241 (69.1)		367 (74.3)	168 (67.5)	
<i>Did not report negatively affected</i>	208 (28.0)	100 (25.4)	108 (30.9)	.092	127 (25.7)	81 (32.5)	0.051
Clerking patients without adequate supervision							
<i>Reported</i>	303 (40.8)	169 (42.9)	134 (38.4)		209 (42.3)	94 (37.8)	
<i>Did not report</i>	440 (59.2)	225 (57.1)	215 (61.6)	.213	285 (57.7)	155 (62.2)	0.233
Performing invasive procedures under GA without adequate supervision							
<i>Reported</i>	140 (18.8)	90 (22.8)	50 (14.3)		87 (17.6)	53 (21.3)	
<i>Did not report</i>	603 (81.2)	304 (77.2)	299 (85.7)	.003	407 (82.4)	196 (78.7)	0.227
Performing invasive procedures							

under LA or RA without adequate supervision							
<i>Reported</i>	208 (28.0)	125 (31.7)	83 (23.8)		140 (28.3)	68 (27.3)	
<i>Did not report</i>	535 (72.0)	269 (68.3)	266 (76.2)	.016	354 (71.7)	181 (72.7)	0.768
Assessing or managing acutely unwell patients without adequate supervision							
<i>Reported</i>	283 (38.1)	182 (46.2)	101 (28.9)		190 (38.5)	93 (37.3)	
<i>Did not report</i>	460 (61.9)	212 (53.8)	248 (71.1)	<.001	304 (61.5)	156 (62.7)	0.768

Table 3: Doctors experiences during the pandemic by resident

nation economic status and training status.

⁺ Pearson χ^2 statistical test used for univariate analysis to obtain *p*-values.

Risk factor	Overall negative impact on doctor's training/learning. OR (95%CI), <i>p</i>-value
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Age <27	1.1 (0.7-1.6); $p=0.744$
Female gender	1.4 (1.0-1.9); $p=0.084$
Doctor in training	1.5 (1.0-2.1); $p=0.027$
Junior doctor	0.8 (0.5-1.4); $p=0.459$
Low/Middle income country	1.0 (0.7-1.5); $p=0.798$
COVID infection	0.8 (0.5-1.2); $p=0.311$
Redeployment	1.1 (0.8-1.7); $p=0.510$
Increased clinical responsibility	0.8 (0.6-1.2); $p=0.379$
Increased working hours	0.8 (0.5-1.1); $p=0.186$
Decreased tutorials (non-virtual)	0.9 (0.6-1.3); $p=0.522$
Decreased ward-based teaching	1.7 (1.2-2.5); $p=0.007$
Decreased theatre opportunities	1.0 (0.7-1.5); $p=0.809$
Decreased simulation training	1.3 (0.9-1.9); $p=0.170$
Decreased lectures (non-virtual)	1.6 (1.0-2.4); $p=0.034$
Increased online lectures	0.9 (0.6-1.4); $p=0.546$
Increased webinars	1.3 (0.8-2.0); $p=0.252$
Decreased morbidity and mortality meetings	0.8 (0.6-1.2); $p=0.361$
Decreased conferences	2.0 (1.4-3.0); $p<0.001$
Surgical specialties	0.9 (0.7-1.3); $p=0.631$

Table 4: Adjusted analysis of factors associated with doctors reporting an overall negative impact on training/learning during the COVID-19 pandemic.

Binary logistic regression analysis was performed with 19 independent variables. Significant results have been highlighted in bold.

Appendix A:

Corporate authorship title: The TMS Collaborative

The PubMed citable author list - in order of publication

Writing committee (citable)

Ryan Laloo (1) (2)

Rama Santhosh Karri (1) (3)

Kasun Wanigasooriya (1) (4)

William Beedham (1) (4)

Steering committee (citable)

Adnan Darr (1) (3)

Georgia R. Layton (1) (5)

Peter Logan (1) (6)

Yanyu Tan (1) (7)

Devender Mittapalli (1) (8)

Tapan Patel (9)

Collaborative authors (citable)

Vivaswan Dutt Mishra (10)

Osama Faleh Odeh (11)

Swathi Prakash (12)

Salma Elnoamany (13)

Sri Ramya Peddinti (14)

Elorm Adzoa Daketsey (15)

Shardool Gadgil (16)

Ahmad Bouhuwaish (17)

Ahmad Ozair (18)

Sanchit Bansal (19)

Muhammed Elhadi (20)

Aditya Amit Godbole (21)

Ariana Axiaq (22)

Faateh Ahmad Rauf (23)

Ashna Ashpak (24)

(1) The Master Surgeon Trust, Worcestershire, United Kingdom

(2) Leeds Vascular Institute, Leeds General Infirmary, Leeds, United Kingdom.

(3) The Royal Wolverhampton NHS Trust, Wolverhampton, United Kingdom

(4) College of Medical and Dental Science, University of Birmingham, United Kingdom

(5) Department of Cardiac Surgery, University Hospitals of Leicester NHS Trust. United Kingdom

(6) Walsall Healthcare NHS Trust, Walsall. United Kingdom

(7) North East Deanery, United Kingdom

(8) University Hospitals Plymouth NHS Trust, Plymouth, United Kingdom

(9) Baroda Medical College, India

(10) Motilal Nehru Medical College, Allahabad, India

(11) Faculty of Medicine, The University of Jordan, Amman, Jordan

(12) HCG Cancer Centre, Bangalore, India

(13) Faculty of Medicine, Menoufia University, Menoufia, Egypt

(14) Indira Gandhi Medical College and Research Institute , Puducherry, India

(15) Ysbyty Gwynedd, Betsi Cadwaladr University Health Board, Gwynedd, Bangor, North Wales

- Accepted Article
- (16) Lokmanya Tilak municipal medical college, Mumbai, India
 - (17) Faculty of Medicine Tobruk University, Tobruk, Libya
 - (18) Faculty of Medicine, King George's Medical University, Lucknow, Uttar Pradesh, India.
 - (19) Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi, India
 - (20) Faculty of Medicine, University of Tripoli, Tripoli, Libya
 - (21) Bharati Vidyapeeth (Deemed to be University) Medical College, Dhankawadi, Pune, India.
 - (22) School of Medicine, Faculty of Life Sciences, Queen's University Belfast, Belfast, UK
 - (23) Combined Military Hospital Lahore Medical College, Lahore, Pakistan
 - (24) School of Medicine, University of Central Lancashire, Preston, Lancashire, United Kingdom.