Author/s:
Simoes, JFF;Li, E;Glasbey, JC;Omar, OM;Arnaud, AP;Blanco-Colino, R;Burke, J;Chaudhry, D;Cunha, MF;Elhadi, M;Gallo, G;Gujjuri, RR;Kaafarani, HMA;Lederhuber, H;Minaya-Bravo, A;Morton, D;Pata, F;Tsoulfas, G;Venn, ML;Bhangu, A;Nepogodiev, D;Isik, A;Kloppers, C;Mccaul, JA;Mehraj, A;Mitul, AR;Moszkowicz, D;Mugla, N;Porcu, A;Quante, M;Di Saverio, S;Singh, P;Solli, P;Spinelli, A;Townend, P;Van Ramshorst, GH;Yildiz, A;Zamvar, V;Abbott, T;Siaw-Acheampong, K;Adamina, M;Ademuyiwa, AO;Agarwal, A;Alameer, E;Alderson, D;Alakaloko, F;Alser, O;Augestad, KM;Ayasra, F;Bankhead-Kendall, BK;Barlow, E;Benson, RA;Brar, A;Breen, KA;Buarque, IL;Caruana, EJ;Chaar, M;Chakrabortee, S;Cox, D;Cukier, M;Davidson, GH;Dawson, BE;Desai, A;Drake, TD;Edwards, JG;Evans, JP;Farik, S;Fiore, M;Fitzgerald, JE;Ford, S;Ghosh, D;Ataíde Gomes, GM;Griffiths, EA;Halkias, C;Harrison, EM;Heritage, E;Hutchinson, PJ;Jenkinson, MD;Jones, CS;Kamarajah, SK;Keller, DS;Khatri, C;Keatley, JM;Kolias, A;Lawani, I;Lawday, S;Leventoglu, S;Löffler, MW;Martin, J;Mashbari, HN;Mazingi, D;Mckay, SC;Metallidis, S;Mohan, HM;Moore, R;Moug, S;Ng-Kamstra, JS;Niquen, M;Ntirenganya, F;Outani, O

Title:
COVID-19-related absence among surgeons: Development of an international surgical workforce prediction model

Date:
2021-03-01

Citation:
Simoes, J. F. F., Li, E., Glasbey, J. C., Omar, O. M., Arnaud, A. P., Blanco-Colino, R., Burke, J., Chaudhry, D., Cunha, M. F., Elhadi, M., Gallo, G., Gujjuri, R. R., Kaafarani, H. M. A., Lederhuber, H., Minaya-Bravo, A., Morton, D., Pata, F., Tsoulfas, G., Venn, M. L. ,... Outani, O. (2021). COVID-19-related absence among surgeons: Development of an international surgical workforce prediction model. Bjs Open, 5 (2), pp.zraa021-. https://doi.org/10.1093/bjsopen/zraa021.

Persistent Link:
https://hdl.handle.net/11343/281852

OXFORD

BJS Open, 2020, **5(1)**, zraa021
DOI: 10.1093/bjsopen/zraa021
Review Article

COVID-19-related absence among surgeons: development of an international surgical workforce prediction model

COVIDSurg Collaborative

Members of the COVIDSurg Collaborative are co-authors of this study and are listed in *Appendix S1*

**Correspondence to:* Dr Elizabeth Li, National Institute for Health Research Global Health Research Unit on Global Surgery, Heritage Building, University of Birmingham, Mindelsohn Way, Birmingham B15 2TH, UK (e-mail: yan.elizabeth.li@gmail.com)

Abstract

Background: During the initial COVID-19 outbreak up to 28.4 million elective operations were cancelled worldwide, in part owing to concerns that it would be unsustainable to maintain elective surgery capacity because of COVID-19-related surgeon absence. Although many hospitals are now recovering, surgical teams need strategies to prepare for future outbreaks. This study aimed to develop a framework to predict elective surgery capacity during future COVID-19 outbreaks.

Methods: An international cross-sectional study determined real-world COVID-19-related absence rates among surgeons. COVID-19-related absences included sickness, self-isolation, shielding, and caring for family. To estimate elective surgical capacity during future outbreaks, an expert elicitation study was undertaken with senior surgeons to determine the minimum surgical staff required to provide surgical services while maintaining a range of elective surgery volumes (0, 25, 50 or 75 per cent).

Results: Based on data from 364 hospitals across 65 countries, the COVID-19-related absence rate during the initial 6 weeks of the outbreak ranged from 20.5 to 24.7 per cent (mean average fortnightly). In weeks 7–12, this decreased to 9.2–13.8 per cent. At all times during the COVID-19 outbreak there was predicted to be sufficient surgical staff available to maintain at least 75 per cent of regular elective surgical volume. Overall, there was predicted capacity for surgeon redeployment to support the wider hospital response to COVID-19.

Conclusion: This framework will inform elective surgical service planning during future COVID-19 outbreaks. In most settings, surgeon absence is unlikely to be the factor limiting elective surgery capacity.

Introduction

The COVID-19 pandemic has had a significant impact on elective surgical care. A global scale projection estimated that 28.4 million elective operations will be cancelled during initial COVID-19 outbreaks[1]. Perioperative COVID-19 is associated with significantly increased morbidity and mortality[2,3], so routine operations have been postponed, avoiding patients being exposed to the risk of in-hospital SARS-CoV-2 infection[4–6]. Hospitals have also cancelled elective operations to release critical care capacity for patients with COVID-19, and surgeons have been redeployed to support the hospital response in other areas, including critical care, acute medicine, and emergency departments[6,7].

Surgeons may be at increased risk of SARS-CoV-2 exposure and illness because of aerosolization in surgical smoke and contaminated tissues[5,8–14]. In addition to COVID-19 sickness, some surgeons may need to self-isolate, shield, or take care of family members, further depleting staffing of surgical services[15,16]. Orthopaedic teams from China have reported sickness rates of up to 20 per cent. A large-scale multispecialty international assessment of surgeon sickness rates during the SARS-CoV-2 pandemic has not been undertaken previously.

Many hospitals are now recovering from the initial impact of COVID-19, but future outbreaks are likely to happen[17]. To avoid growing backlogs of postponed operations, surgical services must plan to provide sufficient staff to be able to maintain elective surgery during upcoming outbreaks. This study aimed to determine the COVID-19-related absence rate among surgeons, and to develop a framework for predicting workforce capacity needed for elective surgery capacity during future COVID-19 outbreaks.

Methods

The methodology is summarized in *Fig. 1*. First, an international, multispecialty, cross-sectional study was completed to determine COVID-19-related absence rates. Second, an expert elicitation study was undertaken with senior surgeons to determine the minimum staff required to provide surgical services across a range of scenarios. This informed the development of a framework to predict the number of staff needed to support elective

Received: July 13, 2020. **Accepted:** September 9, 2020

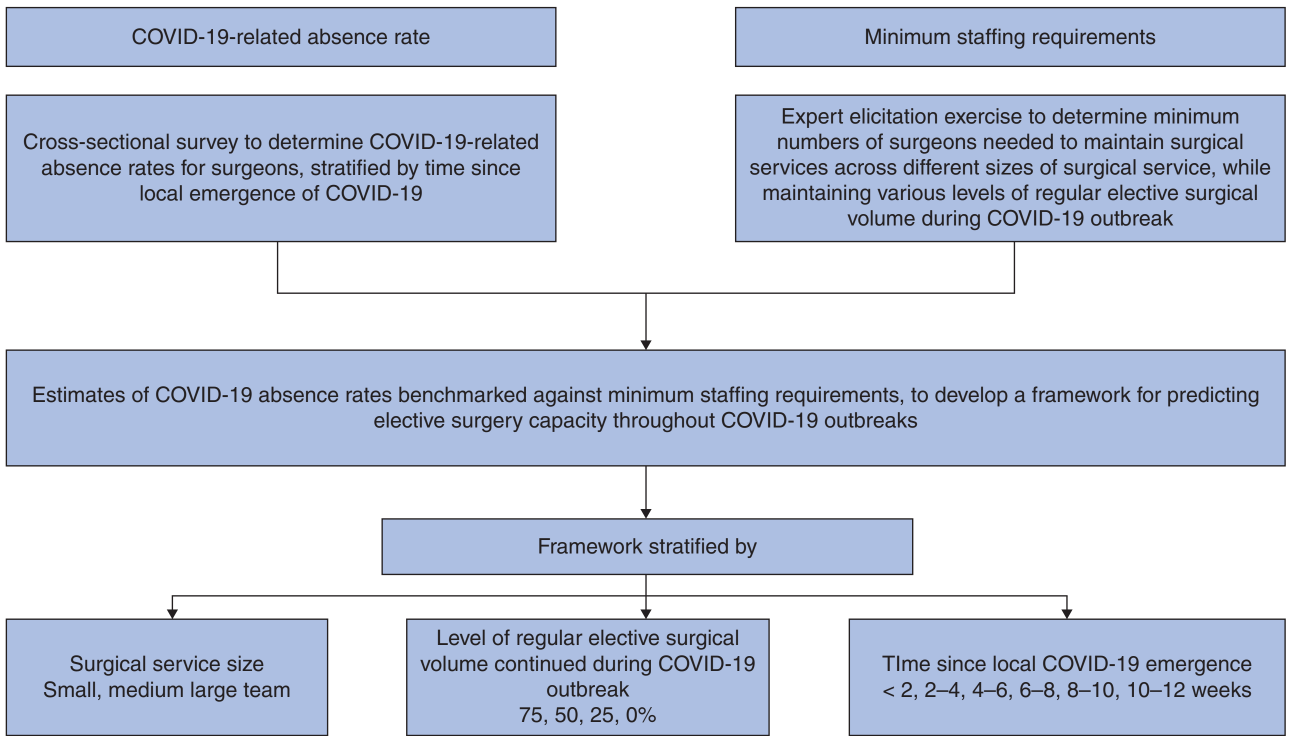

Fig. 1 Methodology used to build prediction framework

surgery capacity during future outbreaks in a range of scenarios. Data were collected using REDCap, a secure, web-based electronic data capture tool, hosted at the University of Birmingham (Birmingham, UK).

Cross-sectional study of COVID-19-related absence rates

Surgeons were invited to participate in a cross-sectional study of COVID-19-related absences through the international, multispecialty COVIDSurg research network's e-mail list and social media platforms (Twitter: @CovidSurg; Instagram: @CovidSurg). The surgeons were invited to participate in an online survey that was open from 25 March 2020 to 15 April 2020. Surgeons across all surgical specialties in any country affected by a COVID-19 outbreak were eligible to participate. Surgeons were defined as medical doctors with any level of training whose main clinical activity was within a surgical department. This included junior doctors in training, non-training grade doctors, and senior surgeons (consultant or attending surgeons).

Participants were asked to report the COVID-19-related absence rate for their current surgical team at the time of survey completion. COVID-19-related absence was defined as inability to attend work activities owing to: sickness (COVID-19 symptoms with or without a confirmatory swab test); or other COVID-19 related absence, including self-isolation after recent contact with a person known to have COVID-19, shielding owing to pregnancy or a pre-existing medical condition, or care of sick or dependent family members. The participants were asked to report surgeon sickness rates and other COVID-19-related absence rates, as defined above. Total surgeon absence rate within teams was obtained by summing the two figures.

Participants were also asked to classify their hospital as: currently treating patients with suspected COVID-19; previously (but not currently) having treated patients with COVID-19; or never having treated patients with COVID-19. Hospitals that were currently treating patients with suspected COVID-19 were further classified by CRITCON level[18]. CRITCON assesses hospital capacity, strain the hospital is under, and resource availability; an increase in CRITCON level indicates escalating systemic stress in the hospital (level 0, business as usual; level 1, normal winter; level 2, unprecedented; level 3, full stretch; level 4, emergency) (*Table S1*).

Responses from different surgical specialty teams within a particular hospital were treated as independent data inputs (independent responses), as they represented separate team structures, often with different sized teams. If the same surgical team submitted multiple responses within a 14-day period, the reported absence rates were averaged and the response date was considered to be the midpoint between response dates. If there were multiple responses submitted from the same team more than 14 days apart, these were treated as separate data inputs to allow any changes in COVID-19-related absence rates to be captured as the outbreak progressed. A detailed flow chart describing this methodology can be found in *Fig. S1*. Invalid and incomplete responses were excluded at the beginning of the analysis. A response was considered incomplete if there were no data on absence rates, country or date of response (as these data were needed to define the time since local emergence of the outbreak). A response was excluded as invalid if the reported absence rates exceeded 100 per cent, as this would indicate an error in data entry.

The interval from the first COVID-19 case in the local community until the time of the participants' response was determined. To calculate this, the date of local COVID-19 emergence was recorded at the lowest possible administrative level (city, region, country) (*Table S2*). Responses were stratified into 2-weekly intervals from the time of local COVID-19 emergence.

Expert elicitation of minimum staffing requirements

Surgeons were selected from across the international COVIDSurg network to participate in an expert elicitation exercise on the basis of their experience of managing surgical services. A structured elicitation exercise was undertaken, with the experts asked to estimate the minimum number of surgeons needed to maintain surgical services across 12 scenarios. These scenarios were based on three different sizes of surgical service (small, total 20 surgeons on staff; medium, total 35 surgeons; large, total 50 surgeons), and on maintaining four different levels of regular elective surgical volume during the COVID-19 outbreak (0, 25, 50 or 75 per cent of regular elective surgical volume continued). Minimum surgical services included emergency surgery duties the surgeons would normally undertake, as well as the ongoing elective surgical activities within the different scenarios presented. The questions answered by the expert surgeons for this elicitation exercise are available in *Appendix S2*.

Development of framework

The estimates of COVID-19 absence rates from the cross-sectional study were benchmarked against the minimum staffing requirements from the expert elicitation exercise, to develop a framework for predicting the availability of staff for elective surgery capacity throughout COVID-19 outbreaks (*Fig. 1*). The framework was stratified by surgical service size, level of regular elective surgical volume during the COVID-19 outbreak, and time since local COVID-19 emergence. The framework included the following components.

COVID-19-related absence

Reported mean average rates of COVID-19-related absence were mapped on to the three surgical team sizes to estimate the number of surgeons away from work because of COVID-19.

Non-COVID-19-related absence

A further 10 per cent of the total number of available surgeons was subtracted to account for baseline work absence (sick leave for disease other than COVID-19, annual leave, all other reasons for absence regardless of the pandemic)[19].

Surgeons required by surgical service

The experts were presented with three surgical service sizes (20, 35 or 50 surgeon staff) and a range of ongoing elective activity (0, 25, 50 or 75 per cent) and asked to provide the minimum number of surgeons required to sustain services in each scenario. The mean average from the expert elicitation for each scenario was taken for use in the model.

Surgeons available to work

The number of surgeons within each size of surgical service available to attend work was calculated by taking the baseline surgical service size and subtracting the number of surgeons absent owing to COVID-19 and the number of absent for non-COVID-19-related reasons.

Surgeons available for redeployment

The number of surgeons available for redeployment was defined as number of surgeons available to work but not required to maintain the surgical service, and therefore available for redeployment to another part of the hospital. This was determined by subtracting the minimum number of surgeons required to run the surgical services from the total number of surgeons available to work.

Sensitivity analysis

A sensitivity analysis of hospitals at CRITCON level 2 or greater was performed to understand the behaviour of the prediction model in hospitals where critical care capacity is reduced (unprecedented levels, full stretch or last resource).

Statistical analysis

Differences in COVID-19-related absence rates between different COVID-19 hospital status groups and across CRITCON levels were assessed using linear regression models, with two-sided $P < 0.050$ considered statistically significant. Analyses were conducted using Stata® version 16.0 (StataCorp, College Station, Texas, USA).

Results

COVID-19-related absence rates

There were a total of 451 data inputs (*Fig. S1*). Data were captured across 364 hospitals and 65 countries (*Table S3*). A total of 13 surgical specialties contributed to the study: colorectal surgery, acute-care surgery, upper gastrointestinal and hepatobiliary, orthopaedics, paediatric surgery, otolaryngology and head and neck, vascular, obstetrics and gynaecology, urology, plastic surgery, neurosurgery, cardiothoracic, and maxillofacial and oral surgery. Overall, 61 responses (13.5 per cent) were from hospitals that had not admitted patients with COVID-19, 329 (72.9 per cent) were from hospitals currently treating patients with COVID-19, and 60 (13.3 per cent) were from hospitals that had previously treated COVID-19 but did not have patients with COVID-19 at the time of response. Of 329 hospitals currently treating patients COVID-19, 236 (71.7) were at CRITCON levels of unprecedented critical care demand or worse (levels 2–4).

Over the first 6 weeks of outbreaks, the fortnightly averaged COVID-19-related absence rates ranged from 20.5 to 24.7 per cent (*Fig. 2*). This decreased to 9.2–13.8 per cent during weeks 7–12. Both surgeon absence owing to sickness and other COVID-19-related reasons followed a similar trend (*Table S4*). Absence rates among senior surgeons were mildly higher than those in junior surgeons but followed the same upward trend in the first 6 weeks, with a decrease thereafter (*Table S5*). COVID-19-related absence rates were broadly consistent across countries when stratified by time since local COVID-19 emergence (*Table S6*).

No significant difference was found in absence rates between hospitals currently treating COVID-19 and those not currently treating patients with COVID-19. Among hospitals currently treating COVID-19, there was no statistically significant difference in COVID-19-related absence rates between CRITCON levels ($P = 0.814$) (*Table S7*). The COVID-19-related absence rate was 18.0 (95 per cent c.i. 14.7 to 21.3) per cent in hospitals at CRITCON level 0, 21.0 (18.4 to 23.6) per cent at level 1, 23.7 (22.2 to 25.2) per cent at level 2, 19.9 (18.3 to 21.4) per cent at level 3, and 20.6 (17.1 to 24.1) per cent at level 4 (*Fig. 3*).

Expert elicitation exercise

Of surgeons invited to participate in the expert elicitation exercise, all 22 responded. Experts represented 12 countries (*Table S3*) and eight surgical specialties (colorectal surgery, acute-care surgery, paediatric surgery, upper gastrointestinal/hepatic surgery, orthopaedics, cardiothoracic, maxillofacial and oral surgery, and general surgery). Depending on the elective surgical volume, the minimum number of surgeons required was determined as 6–12

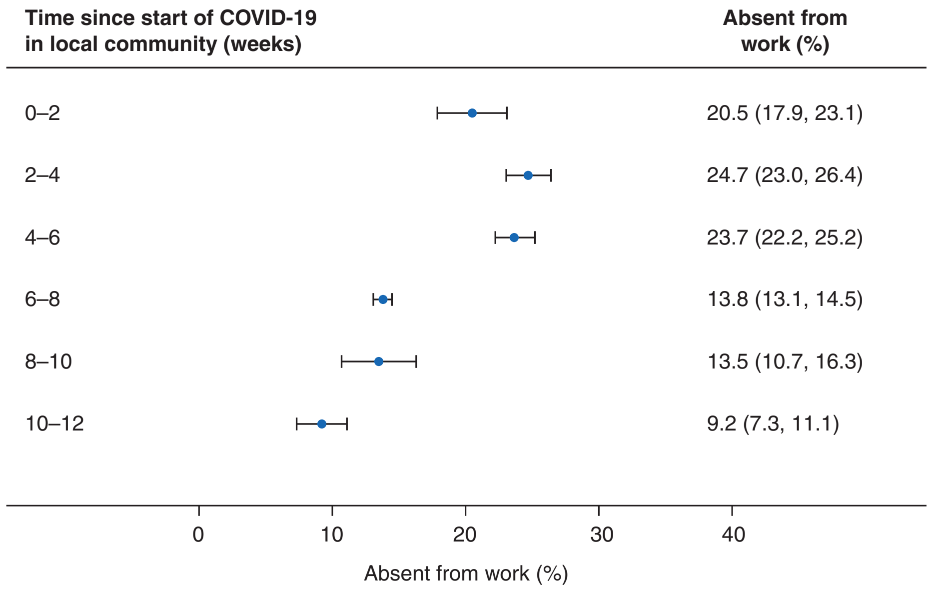

Fig. 2 Proportion of surgical doctors absent from work during pandemic by time since local COVID-19 emergence

Values are mean (95 per cent c.i.).

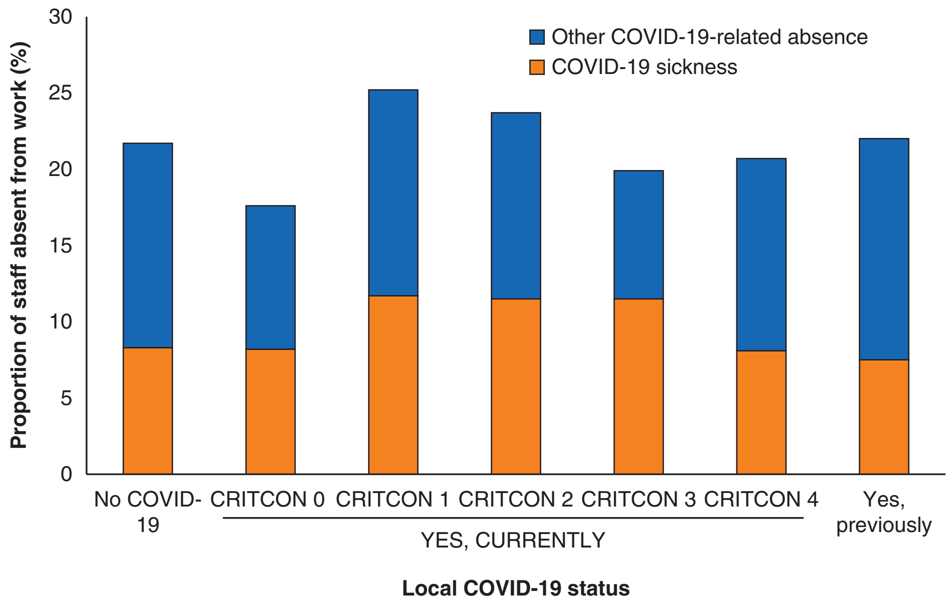

Fig. 3 Proportion of surgical doctors absent from work during pandemic according to COVID-19 status in hospital and CRITCON levels

*Hospital that had not yet admitted patients with COVID-19. †Hospital that had previously treated patients with COVID-19, but was not currently doing so. ‡Hospital currently treating patients with COVID-19. The CRITCON scoring system is designed to report hospital capacity under conditions of systemic stress: level 0, business as usual; level 1, normal winter; level 2, unprecedented; level 3, full stretch; level 4, emergency. The CRITCON level was collected in hospitals that currently had patients with COVID-19 to define the severity of system stress on hospital capacity.

in small surgical services, 9–20 in medium surgical services, and 12–26 in large surgical services.

Development of prediction framework

Considering real-world absence rates, across small, medium, and large surgical services there would be sufficient staffing available to maintain at least 75 per cent of regular elective surgical volume at all points throughout future COVID-19 outbreaks. In addition, there would potentially be surgeons available for redeployment across most of the scenarios (*Table 1*). A sensitivity analysis was performed for hospitals at CRITCON level 2 or greater, with similar findings in terms of surgeon absence and availability (*Table S8*).

Discussion

This study presents a framework for prediction of elective surgical capacity during COVID-19 outbreaks. It demonstrates that, taking into account COVID-19-related absences, sufficient workforce capacity within surgical services remains to deliver at least 75 per cent of regular elective surgical volume during COVID-19 outbreaks. There is also scope for redeployment of surgeons to contribute to the wider hospital response.

Table 1 Predictive model of available surgeons and volume of elective surgery that can be maintained

Baseline team size	Elective cancellation (%)	Minimum no. of staff needed (from expert survey)	Staff at work based on baseline team size, accounting for absence rates						
				0–2 weeks	2–4 weeks	4–6 weeks	6–8 weeks	8–10 weeks	10–12 weeks
Small ($n = 20$)	25	12	Staff at work	14	13	13	15	15	16
			Available for redeployment*	2	1	1	3	3	4
	50	10	Staff at work	14	13	13	15	15	16
			Available for redeployment*	4	3	3	5	5	6
	75	8	Staff at work	14	13	13	15	15	16
			Available for redeployment*	6	5	5	7	7	8
	100	6	Staff at work	14	13	13	15	15	16
			Available for redeployment*	8	7	7	9	9	10
Medium ($n = 35$)	25	20	Staff at work	24	23	23	27	27	28
			Available for redeployment*	4	3	3	7	7	8
	50	16	Staff at work	24	23	23	27	27	28
			Available for redeployment*	9	7	8	11	11	13
	75	13	Staff at work	24	23	23	27	27	28
			Available for redeployment*	12	10	11	14	14	16
	100	9	Staff at work	24	23	23	27	27	28
			Available for redeployment*	15	13	14	17	17	19
Large ($n = 50$)	25	26	Staff at work	35	33	33	38	38	40
			Available for redeployment*	9	7	7	12	13	15
	50	21	Staff at work	35	33	33	38	38	40
			Available for redeployment*	14	12	12	17	18	20
	75	16	Staff at work	35	33	33	38	38	40
			Available for redeployment*	19	17	17	22	22	24
	100	12	Staff at work	35	33	33	38	38	40
			Available for redeployment*	23	21	21	26	26	28

The expert consultant group was asked to provide the minimum number of surgeons needed for different sized teams (small, 20; medium, 35; large, 50) when there was a 25, 50, 75 or 100 per cent elective surgery cancellation rate. The minimum number of surgeons was applied to the team sizes reported by respondents and was rounded up to prevent underestimation. *Number of surgeons available for redeployment from each team = baseline team – (surgeons absent owing to COVID-19 + surgeons absent for other reasons (vacation, childcare, and all other reasons factored as 10 per cent)) – minimum number of surgeons needed per team. Surgeon absence for other reasons included not only COVID-19-related reasons such as shielding, self-isolation or care for sick dependents, but also baseline absence rates reported by Gianino *et al.*[19]. The 10 per cent baseline absence rates include other vacation leave, childcare, and sick leave for reasons other than COVID. This is compliant with the 1.4 per cent sickness leave rates reported by the National Health Service for February 2020[20].

An estimated 28.4 million elective operations have been cancelled owing to COVID-19[1], including 5.3 million in Europe and Central Asia, and 4.5 million in North America. Although this was an appropriate response during the initial COVID-19 impact, it is not a sustainable approach during future outbreaks. To prevent a deterioration in population health, safe elective surgery must continue during future COVID-19 outbreaks. The framework presented can be used for surgical teams to plan their elective activities, using their own team size and the available human resources. Infrastructure availability (such as operating theatre and ward space) and patient-level risk also need to be considered when deciding the volume of elective surgery to be maintained in upcoming surges.

Surgeons' absence rates varied as the outbreak progressed, following a similar pattern to the expected number of cases in communities throughout an outbreak[21]. However, absence rates did not correlate with the level of strain on hospital resources and bed capacity, as measured by CRITCON. A variety of factors can influence staff infection rates at particular time points, such as testing policies or staff protection strategies. Additionally, the CRITCON grading system was created for UK hospitals and might be difficult to apply to a broad range of countries. Hospitals that were no longer admitting patients with COVID-19 still experienced surgeon absence, suggesting that SARS-CoV-2 transmission in the community might be one of the main drivers of surgeons' sickness.

Furthermore, during the majority of the outbreak (first 10 weeks), the proportion of surgeons absent owing to isolation, shielding, and family care was higher than the proportion sick with COVID-19 (*Table S4*). Future recommendations regarding staff selection for testing and the ideal length of isolation could influence work absence[22]. Emerging evidence of antibody testing may allow more surgeons to be available safely, but further evidence is needed regarding reinfection rates[23].

This study had limitations. First, sickness and absence rates might have been affected by factors not assessed in this study. Specific measures to mitigate SARS-CoV-2 spread were not reported, and could have influenced absence rates, both for sickness prevalence (such as social distancing measures), isolation rates (testing availability) and family care (national or local lockdown forcing active adults to take care of dependents). Team management strategies already in place were not collected, and might have influenced absence rates, such as rota adaptations, workforce redistributions, and 'hot' and 'cold' units. Second, the minimum number of surgeons needed might have been influenced by experts' backgrounds, such as specialty, whether they work in a high- or low-income country, and whether they work in a central *versus* district hospital. The way that emergency volume was factored in was not fixed, and this might have been underestimated by surgeons working in teams where elective procedures make up the majority of the work (for example in cancer centres) and overestimated in hospitals where emergency surgery is the predominant activity (such as trauma centres).

The framework developed in this study is a starting point for surgical team management during future outbreaks. Decisions regarding maintaining elective surgery should take into consideration the available surgical staff but also hospital resource use, particularly theatre space and critical care capacity. Different surgical specialties might be able to cope differently with surgeon absence; for example, an ophthalmology service may be able to accommodate more absenteeism without effecting surgical volume than a hepatobiliary surgery service. In addition, selection of staff for redeployment to support other departments should take into consideration the different roles of junior and senior doctors within surgical teams.

This prediction model is a guide, and its application should be tailored according to local resources and service needs. These may vary based on staff demographics (older surgeons are more likely to self-isolate), emergency surgery workload, and surgical specialty.

Funding

National Institute for Health Research (NIHR) Global Health Research Unit, NIHR 16.136.79
Association of Coloproctology of Great Britain and Ireland
Bowel and Cancer Research
Bowel Disease Research Foundation
Association of Upper Gastrointestinal Surgeons
British Association of Surgical Oncology
British Gynaecological Cancer Society
European Society of Coloproctology
NIHR Academy
Sarcoma UK
Vascular Society for Great Britain and Ireland
Yorkshire Cancer Research

Acknowledgements

This report was funded by a National Institute for Health Research (NIHR) Global Health Research Unit Grant (NIHR 16.136.79) using UK aid from the UK Government to support global health research; the Association of Coloproctology of Great Britain and Ireland, Bowel and Cancer Research, Bowel Disease Research Foundation; Association of Upper Gastrointestinal Surgeons; British Association of Surgical Oncology; British Gynaecological Cancer Society; European Society of Coloproctology; NIHR Academy; Sarcoma UK; Vascular Society for Great Britain and Ireland; and Yorkshire Cancer Research. The funders had no role in the study design, data collection, analysis and interpretation, or writing of this report. The views expressed are those of the authors and not necessarily those of the National Health Service, the NIHR, or the UK Department of Health and Social Care.

Disclosure. The authors declare no conflict of interest.

Supplementary material

Supplementary material is available at *BJS Open* online.

References

1. COVIDSurg Collaborative. Elective surgery cancellations due to the COVID-19 pandemic: global predictive modelling to inform surgical recovery plans. *Br J Surg* 2020; DOI:10.1002/bjs.11746 [Epub ahead of print]
2. COVIDSurg Collaborative. Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infection: an international cohort study. *Lancet* 2020;**396**:27–38
3. Lei S, Jiang F, Su W, Chen C, Chen J, Mei W *et al*. Clinical characteristics and outcomes of patients undergoing surgeries during the incubation period of COVID-19 infection. *EClinicalMedicine* 2020;**21**:100331
4. COVIDSurg Collaborative. Global guidance for surgical care during the COVID-19 pandemic. *Br J Surg* 2020;**107**:1097–1103
5. De Simone B, Chouillard E, Di Saverio S, Pagani L, Sartelli M, Biffl W *et al*. Emergency surgery during the COVID-19 pandemic: what you need to know for practice. *Ann R Coll Surg Engl* 2020,**102**:323–332
6. Soreide K, Hallet J, Matthews JB, Schnitzbauer AA, Line PD, Lai PBS *et al*. Immediate and long-term impact of the COVID-19 pandemic on delivery of surgical services. *Br J Surg* 2020; DOI: 10.1002/bjs.11670 [Epub ahead of print]
7. Willan J, King AJ, Jeffery K, Bienz N. Challenges for NHS hospitals during covid-19 epidemic. *BMJ* 2020;**368**:m1117
8. Mowbray N, Ansell J, Horwood J, Cornish J, Rizkallah P, Parker A *et al*. Safe management of surgical smoke in the age of COVID-19. *Br J Surg* 2020;**107**:1406–1413
9. Coccolini F, Tartaglia D, Puglisi A, Lodato M, Chiarugi M. SARS-CoV-2 is present in peritoneal fluid in COVID-19 patients. *Ann Surg* 2020;272:e240
10. Gupta S, Parker J, Smits S, Underwood J, Dolwani S. Persistent viral shedding of SARS-CoV-2 in faeces—a rapid review. *Colorectal Dis* 2020;**22**:611–620
11. Guo X, Wang J, Hu D, Wu L, Gu L, Wang Y *et al*. Survey of COVID-19 disease among orthopaedic surgeons in Wuhan, People's Republic of China. *J Bone Joint Surg Am* 2020;**102**:847–854
12. Abdelrahman T, Beamish A, Brown C, Egan R, Evans T, Ryan Harper E *et al*. Surgery during the COVID-19 pandemic: operating room suggestions from an international Delphi process. *Br J Surg* 2020;**107**:1450–1458
13. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J *et al*. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA* 2020;**323**:1061–1069
14. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. *JAMA* 2020;**323**:1239–1242
15. Adams JG, Walls RM. Supporting the health care workforce during the COVID-19 global epidemic. *JAMA* 2020;**323**:1439–1440
16. Buerhaus PI, Auerbach DI, Staiger DO. Older clinicians and the surge in novel coronavirus disease 2019 (COVID-19). *JAMA* 2020;**323**:1777–1778
17. Leung K, Wu JT, Liu D, Leung GM. First-wave COVID-19 transmissibility and severity in China outside Hubei after control measures, and second-wave scenario planning: a modelling impact assessment. *Lancet* 2020;**395**:1382–1393
18. NHS England. *CRITCON Levels: NHS England (London) Pressure Surge Guidance*. https://www.londonccn.nhs.uk/managing-the-unit/capacity-escalation/critcon/ (accessed 11 May 2020)
19. Gianino MM, Politano G, Scarmozzino A, Charrier L, Testa M, Giacomelli S *et al*. Estimation of sickness absenteeism among Italian healthcare workers during seasonal influenza epidemics. *PLoS One* 2017;**12**:e0182510
20. NHS Digital. *NHS Sickness Absence Rates February 2020, Provisional Statistics*. https://digital.nhs.uk/data-and-information/publications/statistical/nhs-sickness-absence-rates/february-2020-provisional-statistics (accessed 11 May 2020)
21. WHO. *WHO Coronavirus Disease (COVID-19) Dashboard*. https://covid19.who.int (accessed 27 May 2020)
22. Petherick A. Developing antibody tests for SARS-CoV-2. *Lancet* 2020;**395**:1101–1102
23. Li Z, Yi Y, Luo X, Xiong N, Liu Y, Li S *et al*. Development and clinical application of a rapid IgM-IgG combined antibody test for SARS-CoV-2 infection diagnosis. *J Med Virol* 2020;**92**:1518-1524