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Surgery and COVID-19: a rapid scoping review of the impact of the first wave of COVID-19 on surgical services

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ABSTRACT

Objectives To understand how surgical services have been reorganised during and following public health emergencies, particularly the first wave of the COVID-19 pandemic, and the consequences for patients, healthcare providers and healthcare systems.

Design A rapid scoping review.

Setting We searched the MEDLINE, Embase and grey literature sources for documents and press releases from governments and surgical organisations or associations.

Participants Studies examining surgical service delivery during public health emergencies including COVID-19, and the impact on patients, providers and healthcare systems were included.

Primary and secondary outcome measures Primary outcomes were strategies implemented for the reorganisation of surgical services. Secondary were the impacts of reorganisation and resuming surgical services, such as: adverse events (including morbidity and mortality), primary care and emergency department visits, length of hospital and ICU stay, and changes to surgical waitlists.

Results One hundred and thirty-two studies were included in this review; 111 described reorganisation of surgical services, 55 described the consequences of reorganising surgical services; and 6 reported actions taken to rebuild surgical capacity in public health emergencies. Reorganisations of surgical services were grouped under six domains: case selection/triage, personal protective equipment (PPE) regulations and practice, workforce composition and deployment, outpatient and inpatient patient care, resident and fellow education, and the hospital or clinical environment. Service reorganisations led to large reductions in non-urgent surgical volumes, increases in surgical wait times and impacted medical training (ie, reduced case involvement) and patient outcomes (eg, increases in pain). Strategies for rebuilding surgical capacity were scarce but focused on the availability of staff, PPE and patient readiness for surgery as key factors to consider before resuming services.

Conclusions Reorganisation of surgical services in response to public health emergencies appears to be context dependent and has far-reaching consequences that must be better understood in order to optimise future health system responses to public health emergencies.

Strengths and limitations of this study

- This rapid scoping review provides an exhaustive and rigorous summary of the academic and grey literature regarding modifications to surgical services in response to public health emergencies, especially the first wave of COVID-19.
- This study did not limit studies based on location or language of publication to ensure contributions from worldwide voices in the context of a worldwide pandemic.
- Both quantitative and qualitative outcomes were included, with a mix of inductive and deductive data abstraction approaches to provide a comprehensive understanding of surgical services during public health emergencies.
- Studies with potential relevance to this question are emerging at an unprecedented rate in response to the COVID-19 pandemic, and as such, some may not be included in the current review.

INTRODUCTION

The novel SARS-CoV-2 (COVID-19) virus has spread across the globe with unrelenting speed. At the time of writing, over 88 million cases have been confirmed with 1.9 million fatalities.[1] To protect the most vulnerable in our societies, efforts to curb further escalation (eg, travel restrictions and physical distancing) have had a focal objective: to prevent surges that could overwhelm healthcare including shortages in personal protective equipment (PPE), ventilators and hospital capacity.

Medical institutions have taken steps to maximise staff, PPE, ventilators and intensive care unit (ICU) capacity in case public health efforts to 'flatten the curve' are insufficient. Most notably, surgical programmes have suspended non-urgent (or 'elective') surgical procedures. Non-urgent surgeries are often defined as procedures for which a delay of 3 months or longer would not result in significant adverse effects to the patient.[2 3] These changes have thrust patients, providers

and healthcare organisations into previously unexplored territory.

While governing bodies such as colleges and academies of surgery have made recommendations to alter surgical service delivery in response to COVID-19, they have not always provided explicit instructions on how programmes should operationalise the recommendations. As such, approaches to surgical triage and service delivery remain unclear: who has done what, where and why? Furthermore, the impacts of adopting these recommendations on surgical programmes, and more importantly, the physical and psychological well-being of patients and healthcare providers have only been hypothesised.[4] Lastly, once COVID-19 begins to release its grip on the world and the postpandemic recovery begins, programmes will be tasked with rebuilding the surgical capacity necessary to reschedule and tackle the backlog of postponed procedures. Evidence distilled from the experiences of others in the context of COVID-19 and other public health emergencies (ie, H1N1, Ebola and SARS) is needed to guide approaches to surgical service delivery.

To enable evidence-informed reorganisation and resumption of non-urgent surgeries during COVID-19 and for future public health emergencies, we conducted a rapid scoping review to identify and map the available literature. Our objective was to understand how surgical services have been reorganised during and following public health emergencies, particularly the first wave of the COVID-19 pandemic, and the consequences of these changes for patients, healthcare providers and healthcare systems.

METHODS

Study design

This scoping review followed the Joanna Briggs Institute methodology and Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews checklist.[5 6] The rapidly evolving situation of the current COVID-19 pandemic demanded a similarly rapid evidence synthesis. Therefore, methodological concessions recommended by the WHO and Cochrane guidance for rapid reviews were made.[7 8] Specifically, following a pilot exercise involving triplicate review and consensus for 50 abstracts only a 25% random sample of the remaining abstracts were reviewed in duplicate. Furthermore, while language limitations were not applied to the search, manuscripts not written in English that could not be translated by members of the research team were not eligible for data extraction, although their references were still included. This review addressed three research questions to achieve our objective: (1) how have surgical services been reorganised in response to public health emergencies, especially the first wave of the COVID-19 pandemic?; (2) what are the patient-level, healthcare provider-level and system-level consequences of reorganising surgical services?; and (3) what approaches have been used for resuming surgical services?

Search strategy

The search strategy was developed by two investigators (CO and KS) and refined by others with context expertise in surgery and literature review methodology (JN-K and AK-R). The search strategy included subject headings, keywords and synonyms identifying public health emergencies in general and specific public health emergencies (Ebola, SARS-CoV1, H1N1 and MERS) and surgery and as tailored for each database (online supplemental appendix A). Given the exploratory nature of the review, we did not filter by study design or publication type, and since the impacts of a pandemic spans many countries, there were no language restrictions.

We used the search strategy to search MEDLINE (including Epub Ahead of Print, In-Process & Other Non-Indexed Citations) and Embase from inception until 8 May 2020. Anticipating pertinent information may not be published (ie, joint statements, recommendations and guidelines from surgical colleges); we supplemented the database search with a structured grey literature search including targeted website searching, advanced and general Google searching and contact with knowledge experts (online supplemental appendix A).[9] The reference lists of included studies were screened for relevant studies not otherwise captured.

Study selection

Titles and abstracts were reviewed by one of two independent reviewers with a third independent reviewer screening 25% of randomly selected references in duplicate. Full texts of studies considered potentially eligible at title/abstract screening phase by at least one reviewer were reviewed in duplicate by two reviewers for eligibility. Any disagreement between reviewers at the full-text screening phase was resolved through discussion and did not necessitate a third reviewer. If studies were excluded at the full-text screening phase, the reason for exclusion was noted. Full-text articles meeting eligibility criteria were included, and data were abstracted using a standardised data abstraction form (online supplemental appendix B). At both stages of screening, a pilot sample of 50 articles were jointly reviewed by both reviewers to ensure reliable application of eligibility criteria between reviewers.

Study eligibility

Studies were eligible for inclusion if they discussed alterations to surgical services during public health emergencies and reported: (1) reorganisation of surgical services, (2) impact of reorganising surgical services on patients, healthcare providers or healthcare system or (3) approaches to resuming surgical capacity. Studies of any design or publication date were eligible for inclusion. Studies in any language were eligible, but consistent with rapid review methods, studies not easily translated by authors were excluded from the data synthesis, although citations are still provided. Studies were excluded if they described: only urgent interventions arising during a hospital admission (eg, emergency tracheostomy and

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caesarean section), settings beyond in-patient acute care (eg, outpatient clinics including dental clinics), changes to surgical service delivery not made in direct response to a public health emergency and healthcare services not specifically related to surgical service.

Notably, our intention was to include guidelines that made recommendations regarding provision of surgical services; however, a high-quality review of guidelines was published[10] during the preparation of this review and as such, we chose to exclude guidelines.

Data extraction

Data were abstracted by one reviewer and verified by a second reviewer, using a standardised data abstraction form (online supplemental appendix B). Data included: date of publication, country, study design, definition of non-urgent surgery, characteristics of study sample (if applicable) and outcomes of interest for the three research questions, detailed further.

Outcomes of interest

Our primary outcomes were reorganisation of surgical services, impact of reorganisation and resuming surgical services. We intentionally included a broad array of outcomes and used an inductive approach to data abstraction to gain a comprehensive understanding of surgical services and the impact during public health emergencies.

We collected qualitative data from studies reporting on changes to surgical programming, conceptualised into five categories: changes to triage criteria or case selection, changes to PPE practices, workforce changes, changes to patient care, changes to resident and fellow education and environmental changes. Qualitative and quantitative data on the impact of reorganisation of surgical services was organised by impact on: patients, providers and healthcare system. To illustrate temporal changes, data preceding, during and after the precipitating event, were collected whenever possible. Quantitative variables of interest included: adverse events (including morbidity and mortality), primary care and emergency department visits, number of hospital and ICU admissions, length of hospital and ICU stay, number of surgical procedures performed and number of procedures cancelled, care costs and wait times for non-urgent surgery. Qualitative variables included narrative description of patient or physician experience, written descriptions of changes to physician remuneration or comments surrounding surgical waitlist composition. Qualitative data were also collected on details of efforts to rebuild capacity to surgical services.

Study quality (risk of bias) assessment

Given the aim of a rapid scoping review is not to appraise evidence but to map the available literature,[11] quality appraisal of included studies was not performed.

Data synthesis, analysis and reporting

Consistent with our objectives and scoping review methodology,[12] we did not to perform quantitative analysis but did use descriptive statistics to summarise quantitative outcomes. We characterised and mapped the available emerging evidence using an inductive qualitative approach. Specifically, two authors (CO and KS) familiarised themselves with the included studies and, throughout the data extraction process, continuously identified and specified recurrent categories emerging from the data. This was a non-linear process that continued until both authors were satisfied that the selected categories represented all important aspects of the evidence. The final categories are presented. Data were synthesised and presented separately for each of the three research questions.

Patient and public involvement

Patients and the public were not involved in study design, execution or interpretation.

Statement of ethics approval

Ethics approval was not required because this study did not involve humans or animals, but rather only included published data.

RESULTS

Search results

A total of 3 013 unique scholarly articles and 106 sources of grey literature were identified, of which 702 were considered eligible for full-text review. After full-text review, 120 studies and five documents from the grey literature were included. Screening of the reference lists of included articles led to seven additional studies being included for a total of 132 included studies. Thirty-seven studies contributed data to more than one of the research questions resulting in the qualitative synthesis of 111 studies assessing alterations to service delivery, 55 studies evaluating the consequences of these changes and 6 studies enumerating their procedures for rebuilding capacity (table 1). The flow of evidence sources within the study is detailed in figure 1. One Spanish language study was translated for inclusion,[13] but two studies could not be readily translated; therefore, they are not included in the synthesis.[14 15]

Description of studies

The majority of included studies were published in 2020 about COVID-19 (87.9%, n=116); fewer studies were related to other public health emergencies: SARS (7.58%, n=10), Ebola (2.27%, n=3), H1N1(1.52%, n=2) and MERS (0.76%, n=1). Over two-thirds of the included studies (74.2%) emerged from the countries hit earliest by COVID-19: China (14.4%, n=19), Singapore (8.33%, n=11), Italy (19.7%, n=26) and the USA (31.8%, n=41). While many studies described the experiences of their surgical departments as a whole, oncology (15.9%, n=21), orthopaedics (13.6%, n=18) and neurosurgery (11.4%, n=15) were the specialties most prominently represented. Summaries of descriptive study information are shown in figure 2.

Table 1 Description of included studies

Author	Year	Country	Public health emergency	Surgical specialty	Changes to surgical services	Impact of changes examined	Resumption of services
Álverez-Gallego[13]	2020	Spain	COVID-19	General			
Ammar	2020	USA	COVID-19	Neurosurgery			
Amparore[19]	2020	Italy	COVID-19	Urology		Changes in clinical and surgical resident involvement	
Ansarin	2020	Italy	COVID-19	Oncology (head and neck)			
Bashir	2020	UK	COVID-19	Vascular			
Ben Abdallah	2020	France	COVID-19	Vascular			
Bernucci	2020	Italy	COVID-19	Neurosurgery		Changes in surgical volume	
Bettinelli	2020	Italy	COVID-19	Orthopaedics			
Bolkan	2014	Norway	Ebola	Obstetrics		Changes in non-Ebola admissions and surgical volumes	
Bolkan	2018	Norway	Ebola	Obstetrics		Changes in non-Ebola admissions and surgical volumes	
Bourlon	2009	Mexico	H1N1	—		Number of surgical cancellations	
Bradford	2003	China	SARS	GI		Changes in admissions and surgical volumes	
Brethauer	2020	USA	COVID-19	GI			Operative cases placed in 'depot' to be rescheduled alongside new teleconsults
Brown[28]	2020	USA	COVID-19	Orthopaedics		Patient pain, anxiety and physical function	
Buckstein	2020	USA	COVID-19	Radiation oncology			
Bundu	2016	Sierra Leone	Ebola	—		Changes in ED/ward admissions and surgical activity	
Burke	2020	USA	COVID-19	Neurosurgery			
Busin[32]	2020	Italy	COVID-19	Ophthalmology		Changes in demand/donations for cornea bank	Set reasonable timelines for patients requiring low acuity surgery. Surgical work schedule extended into evenings and weekends
Cai[20]	2020	USA	COVID-19	Otolaryngology		Changes in resident educational programming	
Cakmak	2020	Turkey	COVID-19	Oncology (breast)		Changes in surgical volume	
Carenzo	2020	Italy	COVID-19	—		Changes in surgical volume	
Cenzato	2020	Italy	COVID-19	Neurosurgery			
Chan	2006	China	SARS	Ophthalmology			

Continued

Table 1 Continued

Author	Year	Country	Public health emergency	Surgical specialty	Changes to surgical services	Impact of changes examined	Resumption of services
Chee[16]	2004	Singapore	SARS	—			
Chew	2020	Singapore	COVID-19	General			
Chisci	2020	Italy	COVID-19	Vascular		Changes in surgical volume	
Civantos	2020	USA	COVID-19	Oncology (head and neck)		Number of surgical cancellations	
D'Apolito[45]	2020	Italy	COVID-19	Orthopaedics		Changes in surgical volume	
de Vries[23]	2020	The Netherlands	COVID-19	Transplant		Changes in transplantation volumes	
Ding	2020	Singapore	COVID-19	Orthopaedics			
Dominguez-Gil[24]	2020	Spain	COVID-19	Transplant		Changes in transplantation volumes	
Doussot	2020	France	COVID-19	Oncology		Changes in surgical volume	
Dowdell	2020	USA	COVID-19	Orthopaedics			
Ducournau	2020	France	COVID-19	Plastics			
Eichberg	2020	USA	COVID-19	Neurosurgery			
Ficarra	2020	Italy	COVID-19	Urology		Proportion of surgical cancellations initiated by patients	
Fontanella[17]	2020	Italy	COVID-19	Neurosurgery		Changes in surgical volume	
Fontanella[17]	2020	Italy	COVID-19	Neurosurgery			
Giorgi	2020	Italy	COVID-19	Spinal			
Givi[21]	2020	USA	COVID-19	Oncology (head and neck)		Changes in fellow educational programming	
Gomez-Barrena	2020	Spain	COVID-19	Orthopaedics		Changes in surgical volume	
Gouveia	2020	Portugal	COVID-19	Vascular			
Guerci	2020	Italy	COVID-19	General			
Gupta	2020	India	COVID-19	Oncology (head and neck)			
Haines	2003	China	SARS	Obstetrics			
Hemingway[22]	2020	USA	COVID-19	Vascular		Changes in clinical and surgical volumes	
Hormati	2020	Iran	COVID-19	GI			
Hu	2020	China	COVID-19	Oncology			
Jean	2020	USA	COVID-19	Neurosurgery		Changes in surgical volume	
Kempa	2020	Poland	COVID-19	Electrophysiology		Changes in surgical volume	
Kessler	2020	USA	COVID-19	Neurosurgery			
Konda	2020	USA	COVID-19	Orthopaedics			

Continued

Table 1 Continued

Author	Year	Country	Public health emergency	Surgical specialty	Changes to surgical services	Impact of changes examined	Resumption of services
Kuo	2010	Argentina	H1N1	Ophthalmology		Changes in clinical and surgical volumes	
Lai	2020	China	COVID-19	Ophthalmology			
Lancaster	2020	USA	COVID-19	—		Changes in surgical volume	
Langer	2020	USA	COVID-19	Plastics			
Lauterio[25]	2020	Italy	COVID-19	Transplant		Changes in transplantation volumes	
Lee[27]	2020	China	COVID-19	Oncology (head and neck)		Changes in surgical wait times	
Leong Tan	2020	Singapore	COVID-19	Vascular			
Li	2020	China	COVID-19	Transplant			
Liebensteiner	2020	Austria	COVID-19	Orthopaedics			
Liu	2003	Singapore	SARS	Anaesthesia			
Mak	2020	China	COVID-19	Plastics			
Marti	2020	Spain	COVID-19	Oncology (breast)			
Maurizi	2020	Italy	COVID-19	Thoracic		Changes in surgical volume	
McBride	2020	Australia	COVID-19	—			
McMillan	2020	Canada	COVID-19	—			Prioritisation first of patients who would be at increased risk with further delay, followed by those waiting longest
Meneghini	2020	USA	COVID-19	Orthopaedics			
Meyer	2020	France	COVID-19	Neurosurgery		Changes in surgical volume	
Morgan	2020	UK	COVID-19	Orthopaedics			
Nair	2020	India	COVID-19	Ophthalmology			
Nassar	2020	USA	COVID-19	General			
Park	2020	USA	COVID-19	Otolaryngology			
Park	2020	South Korea	MERS	—		Changes in surgical volume	
Patel	2020	USA	COVID-19	Oncology (head and neck)			
Patel	2020	USA	COVID-19	Otolaryngology			
Pelt[33]	2020	USA	COVID-19	Orthopaedics		Number of surgical postponements	Surgeries prioritised based on complexity and predicted LOS, scheduling only completed if appropriate PPE and screening available.
Pittet	2020	Switzerland	COVID-19	—		Changes in surgical volume	

Continued

Table 1 Continued

Author	Year	Country	Public health emergency	Surgical specialty	Changes to surgical services	Impact of changes examined	Resumption of services
Prachand	2020	USA	COVID-19	—		Number of surgical cancellations	
Price	2020	USA	COVID-19	Dermatology			
Qadan	2020	USA	COVID-19	Oncology (GI/ hepatobiliary)			
Ralli	2020	Italy	COVID-19	Otolaryngology			
Rampinelli	2020	Italy	COVID-19	Oncology (head and neck)		Changes in surgical volume	
Randelli	2020	Italy	COVID-19	Orthopaedics			
Ricciardi	2020	Italy	COVID-19	Neurosurgery			
Ross	2020	USA	COVID-19	—		Changes in clinical volumes	
Rubin	2020	USA	COVID-19	Electrophysiology		Changes in lab capacity and consultation volumes	
Rubin	2020	USA	COVID-19	Electrophysiology			
Salengar	2020	USA	COVID-19	Cardiac		Changes in surgical volume	
Sarpong	2020	USA	COVID-19	Orthopaedics			
Schull	2007	Canada	SARS	—		Changes in surgical volume	
Schwarzkopf	2020	USA	COVID-19	Orthopaedics			
Scullen	2020	USA	COVID-19	Neurosurgery			
Seese	2020	USA	COVID-19	Cardiac		Changes in surgical volume	
Sethi	2020	USA	COVID-19	GI		Changes in surgical and consultation volumes	
Shen[31]	2020	China	COVID-19	—			Scheduling resumed following consideration of reduced risk of imported transmission and growing waitlist
Shih	2020	China	COVID-19	Ophthalmology		Changes in surgical volume	
Shokri	2020	USA	COVID-19	Plastics		Changes in surgical volume	
Sobel	2020	USA	COVID-19	Urology			
Sun	2020	China	COVID-19	Neurosurgery		Emergency surgeries performed	
Tan	2004	Singapore	SARS	Anaesthesia			
Tan	2020	Singapore	COVID-19	Urology		Changes in surgical and consultation volumes	
Tan	2020	China	COVID-19	Neurosurgery			
Tay	2020	Singapore	COVID-19	Orthopaedics		Changes in surgical volumes	
Tay	2020	Singapore	COVID-19	Orthopaedics			

Continued

Table 1 Continued

Author	Year	Country	Public health emergency	Surgical specialty	Changes to surgical services	Impact of changes examined	Resumption of services
Thaler	2020	Austria	COVID-19	Orthopaedics			
Tolone	2020	Italy	COVID-19	—			
Too	2020	Singapore	COVID-19	Interventional radiology			
Topf	2020	USA	COVID-19	Oncology (head and neck)			
Tsui	2005	China	SARS	Cardiac			
Tzeng	2020	USA	COVID-19	Oncology			
Unal	2020	Turkey	COVID-19	Vascular			
Vaccaro[30]	2020	USA	COVID-19	Orthopaedics		Changes in physician remuneration and staffing	
Valenza	2020	Italy	COVID-19	Oncology		Changes in surgical volumes	
van de Haar	2020	The Netherlands	COVID-19	Oncology			
Various	2020	Canada	COVID-19	—		Number of surgical postponements	Calling patients to assess their ability to reschedule, contracting private facilities with focus on urgent surgeries, patients waiting twice their clinical benchmarks or surgeries with minimal LOS
Various	2020	Ireland	COVID-19	—			
Vicini[18]	2020	Italy	COVID-19	Oncology (breast)		Changes in surgical volumes	
Vlantis	2004	China	SARS	Otolaryngology		Changes in outpatient and surgical volumes	
Walker[34]	2020	USA	COVID-19	—		Number of surgical cancellations	Assess readiness of staff to safely resume high volumes of surgery and ensured availability of rapid in-house testing
Wan	2004	China	SARS	Thoracic		Patient anxiety and depression	
Wasser	2020	Israel	COVID-19	Ophthalmology			
Williams	2020	USA	COVID-19	Ophthalmology		Number of surgeries rescheduled	
Wong	2020	Singapore	COVID-19	Anaesthesia			
Wu	2020	China	COVID-19	Oncology (head and neck)			
Xiaolei	2020	China	COVID-19	Ophthalmology			
Zangrillo	2020	Italy	COVID-19	—			
Zarzaur	2020	USA	COVID-19	—			

Continued

Table 1 Continued

Author	Year	Country	Public health emergency	Surgical specialty	Changes to surgical services	Impact of changes examined	Resumption of services
Zeng	2020	China	COVID-19	Oncology (head and neck)	purple, orange, green, blue		
Zizzo	2020	Italy	COVID-19	—	purple, green		
Zoia	2020	Italy	COVID-19	Neurosurgery	purple, yellow, green, red		

Domains of change to surgical services, represented numerically:
- (purple) Changes to case selection and surgical triage.
- (orange) Changes to PPE protocols and practices.
- (yellow) Changes to the surgical workforce.
- (green) Changes to inpatient and outpatient care.
- (blue) Changes to resident and fellow education.
- (red) Changes to the environment.

—, data not provided; ED, emergency department; GI, gastrointestinal; LOS, length of stay; PPE, personal protective equipment; SARS, severe acute respiratory syndrome.

Reorganisation of surgical service

A number of categories emerged from the 108 studies describing reorganisation of surgical services. Nearly all studies reported partial, with most reporting full cessation of non-urgent surgeries at their centre, although with varying definitions of 'non-urgent' (eg, can be safely postponed for 3 months) and 'urgent' (eg, patient would have adverse outcome if not completed within 7 days). Changes to service delivery were focused on six domains: case selection/triage, PPE regulations and practice, workforce composition and deployment, outpatient and inpatient patient care, resident and fellow education, and the hospital or clinical environment (table 2). The three domains that were most frequently reported (case selection/triage, patient care and workforce) are described in greater detail below.

Changes to case selection and triage procedures. The countries and surgical specialties most effected by pandemic-related changes to service delivery are described above; however, the issue of which patients can safely undergo what surgical procedures was also discussed in the included studies. We identified cancelling or postponing 'non-urgent' surgeries was almost universal. Most often hospitals cancelled surgeries via telephone or text message, but some studies identified that patients initiated their own surgical cancellations due to concerns with safety and nosocomial infection. While urgent surgeries were triaged according to routine practice, new triage decisions were made for non-urgent (including oncology) procedures. Methods for triaging non-urgent procedures varied across studies, from the use of guideline supported checklists of eligible procedures to virtual multidisciplinary meetings where the treating surgeon presented details of the case (eg, patient characteristics, acuity and imaging) to a larger group representing many surgical specialties to reach consensus on each case.

Changes to patient care. Sixty-two studies reported complete cessation or marked reduction of in-person, non-urgent outpatient clinic visits. In these studies, only urgent patients and those requiring postoperative suture or staple removal were granted in-person visits under strict conditions including mask wearing, negative symptom check, history or temperature prescreening. Studies specific to COVID-19 almost universally filled the resulting care gap for patients deemed 'non-urgent' using telephone or video-based telemedicine. Interfaces used include, but were not limited to, Zoom, WeChat, Facetime, telephone and SMS text messaging. A reported advantage of telemedicine was the ability to follow-up with returning patients and to continue consultations and establish contact with new patients who would require care when non-urgent surgeries resumed. While some admitted a historical reluctance to transition to video-based telemedicine and reported early concerns with their ability to establish secure connections with patients, frequently their worries faded with use and many reported telemedicine would remain integrated in their practices beyond the pandemic.

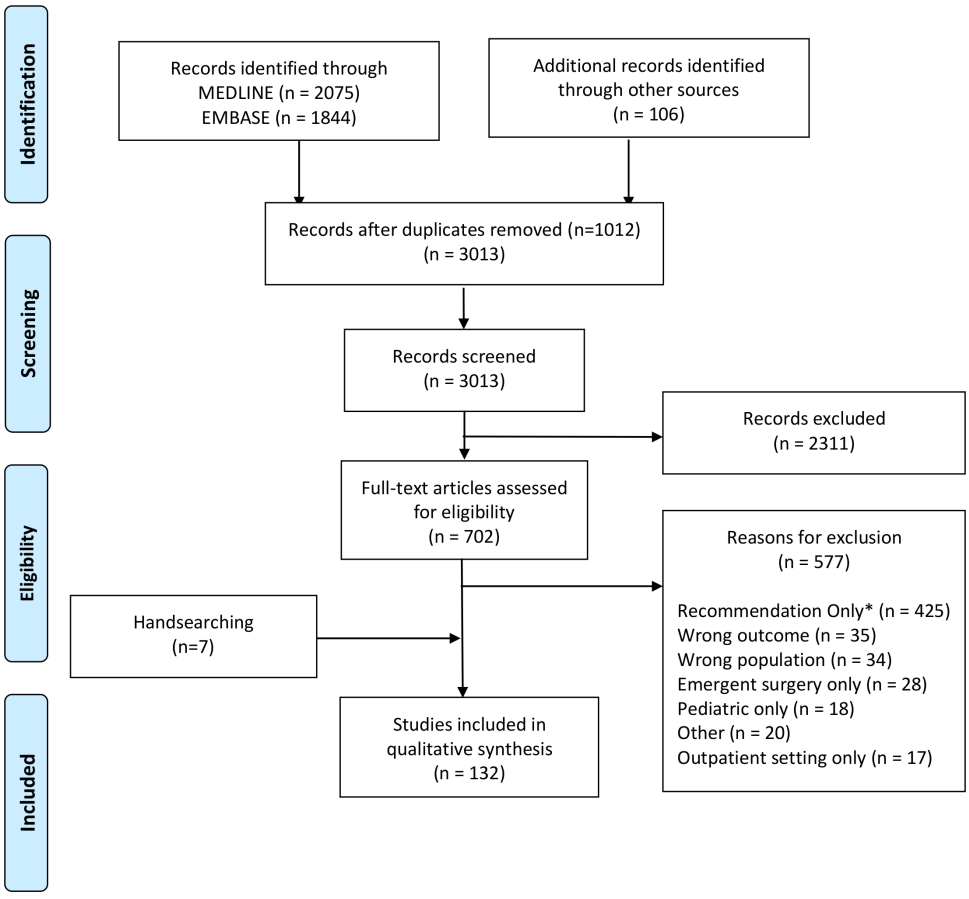

Figure 1 PRISMA flow diagram. *Includes guidelines, recommendation-based reviews, projections or estimations without mention of true changes to surgical programming. PRISMA,Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Changes to the workforce. Fourteen of the included studies describe changing the workforce into a minimum of two teams: a 'contaminated' team providing care to infected patients and a 'clean' team managing those not infected. When these teams were kept separate from one another both inside and outside of the hospital setting, surgical departments were able to continue managing the inevitable emergencies (as well as non-urgent procedures in some settings) without cross contamination during the public health emergencies. New work rotations and shift schedules were created to ensure this structure was sustainable, often with extra healthcare providers designated to replace those with exposures and to provide adequate time off to prevent burnout. This practice was only possible with wards, operating rooms and pathways (ie, corridors and elevators) that are separated under the same 'clean' and 'contaminated' designation. In the most extreme case, entire hospitals were designated for each patient group, as was done by Singapore during SARS[16] and Italy during COVID-19.[17]

Impact of reorganising surgical services

Of the 55 studies with data relevant to this question, 42 were focused on changes in surgical volumes with six reporting changes to surgical waitlist time or composition, four underlining changes to resident and fellow involvement in surgery and two showing changes in patient pain, anxiety and depression. These recurring outcome measures are summarised below with data for all studies relevant to this question shown in (online supplemental appendix C).

Changes in surgical volumes. Thirty-seven studies provided data for this outcome, with 37.8% (n=14) reporting a greater than 75% reduction and 70.3% (n=26) reporting a greater than 50% reductions in their overall or site specific non-urgent surgical volumes (figure 3A). Not all studies reported reductions, as one study from an oncology 'hub' hospital in Italy reported a 20% increase in their surgical volumes, likely due to more cases being diverted to their hospital during the COVID-19 pandemic.[18]

Changes in resident/fellow involvement in surgical activities. Four studies[19–22] reported on this outcome; two survey-based case series, one resident-level case study and one study containing both survey and case log data. The reductions in surgical involvement for residents are shown by quartile in figure 3B.

Changes to waitlist length and composition. Five studies[23–27] reported data for this outcome. One centre reported a 64% increase in length of their minor colorectal surgery waitlist[26] and another centre (head and neck oncological surgery programme) reported a 500% increase in latency

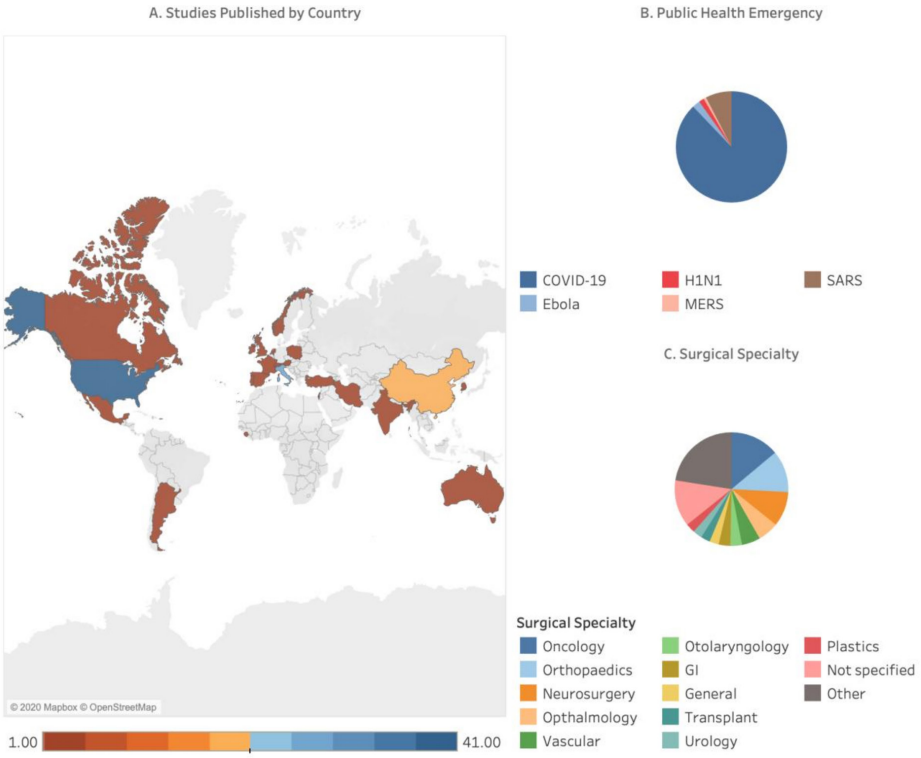

Figure 2 Summary of study characteristics. (A) Country of publication, (B) public health emergency discussed and (C) surgical specialty addressed ('other' includes cardiac (n=3), anaesthesia (n=3), electrophysiology (n=3), obstetrics and gynaecology (n=3), thoracic (n=2), interventional radiology (n=1) and dermatology (n=1)).

from diagnosis to surgery.[27] One study reported no waitlist deaths during the COVID-19 pandemic,[25] while another saw a small decrease in the number of weekly waitlist deaths.[24] A single study identified more patients leaving their renal transplantation waitlist due to mortality or clinical deterioration.[23]

Changes in patient pain, anxiety and depression. Two studies[28 29] reported pain, anxiety and depression among more than half of waitlist patients; 42.1% experienced anxiety and 26.3% experienced depression (figure 3C). The leading reported cause of patient anxiety was a lack of knowledge about when their surgeries would be rescheduled. Other than a single study describing the negative financial effects of the COVID-19 pandemic,[30] impacts on healthcare providers and their practices were rarely discussed.

Rebuild surgical capacity

A total of seven studies reported the experience of rebuilding surgical capacity in their departments, hospitals or systems; all studies referred to the COVID-19 pandemic. One study from China reported reopening non-urgent surgeries with close consideration of risk for imported transmission but did not provide further detail of triage or prioritisation.[31] Among studies that changed their surgical triage practices, patients were prioritised for surgery based on procedure acuity or urgency (ie, risk to patients if surgery were further delayed), resource intensity and procedural complexity. Four studies[32–35] noted that prior to resuming non-urgent surgeries, availability of the staff operating rooms, PPE and testing was necessary to prepare for a large and complicated surgical backlog.

DISCUSSION

This review identified over 3000 evidence sources, 132 of which were included. Approaches to reorganising surgical services varied between studies and centres, but the cancellation or postponement of non-urgent surgeries such as arthroplasty surgeries for chronic joint pain, coronary artery bypass graft surgery for asymptomatic individuals and primary gastric bypass surgery was nearly universal.[2] The most frequently reported change to surgical services was modified triage criteria for surgical cases, workforce and approach to patient care. Many studies reported a decrease in surgical volumes due to public health emergencies, while a few reported the non-surgical impacts such as patient well-being or changes in healthcare utilisation beyond the surgical wards. Very few studies described their experience resuming surgical services after a public health emergency.

The varied approaches to providing surgical services during a public health emergency identified in this review illustrate that a 'one size fits all' approach does not exist. Changes to surgical services likely depends on the characteristics of specific centres and their patients. While several guidelines have been published with recommendations on how to provide surgical care during COVID-19, we chose to exclude guidelines and recommendations

Table 2 Reorganisation of surgical services by domain

Change domain	Number of studies (%)	Examples of change
Triage or case selection	80 (74.7)	1. Prioritisation of patients based on predefined levels of acuity. 2. Virtual multidisciplinary meetings or tumour boards. 3. Creation of specialty-specific lists outlining surgery-eligible and ineligible ailments, often with inclusion of case-by-case category. 4. Postponement based on high-risk patient characteristics (ie, older age, multimorbidity) and expected need for ICU.
PPE	63 (58.3)	1. Hospital wide surgical mask mandate for staff and attendees. 2. Standard level of PPE outlined for all patient encounters with enhanced PPE (eg, addition of N95 or PAPR, head and shoe covering) protocol for specific procedures or care of infected patients. 3. Refresher instruction courses provided to all hospital staff. 4. Trained observer supervising all perioperative donning and doffing of PPE to ensure safety and compliance.
Workforce	70 (64.8)	1. Separation of clinical staff into rotating 'clean' and 'dirty' teams caring for exclusively for non-infected and infected patients, respectively. 2. Temperature and symptom screening of staff with mandated quarantine periods in cases of unprotected exposure. 3. Case discussions, handover and clinical staff meetings transitioned to virtual format. 4. Redeployment of staff to hospital areas requiring support (eg, ICU), often paired with virtual training to ensure comfortable transition.
Patient care	95 (88.0)	1. Complete cancellation or transition to telemedicine for all non-urgent and routine perioperative clinical visits. 2. Patient temperature, symptom and travel history screening before entry to clinic (relevant for urgent surgical patients). 3. Preference for endovascular or minimally invasive surgical approaches when possible, use of conservative care when possible (oncology). 4. Restrictions on number of accompanying persons or visitors (often zero with some allowing maximum of 1).
Resident/fellow education	35 (32.4)	1. Changes to resident/fellow team structure and rotation schedules to ensure continued coverage of department and maximise resident/fellow safety. 2. Redeployment of residents to non-specialty areas requiring clinical support. 3. Curriculum and conferences shifted to online format to allow continued e-learning for off-duty trainees. 4. Trainees involvement in surgical care of infected persons ceased or altered (eg, only admitted to OR during low-risk/non-aerosolising procedures).
Environment	70 (64.8)	1. Dedication of wards (hallways and elevators), ORs or entire hospitals to treat for only those infected or not infected. 2. Use of negative-pressure OR when possible. 3. Transformation of surgical wards, ORs and outpatient clinics into patient care areas to increase surge capacity. 4. Double occupancy patient rooms reduced to single occupancy or physical measures (eg, cubicles, distanced waiting room chairs) implemented.

ICU, intensive care unit; OR, operating room; PAPR, powered air purifying respirator; PPE, personal protective equipment.

from this review for two reasons: (1) a high-quality review of surgical recommendations for the response to COVID-19 was published by one of the authors just prior to this study[10] and (2) because there is abundant evidence suggesting guidelines and recommendations for practice are frequently not implemented into clinical practice.[36–42] Some of the guideline recommendations in the review by Søreide *et al*[10] were implemented within the included studies in the present review, such as creating areas within-hospital for 'clean' and 'contaminated' cases and workforce redeployment to critical care. However, other recommendations were infrequently noted, such as the dedicated use of isolated, negative pressure ORs for patients with COVID-19. These resource intensive

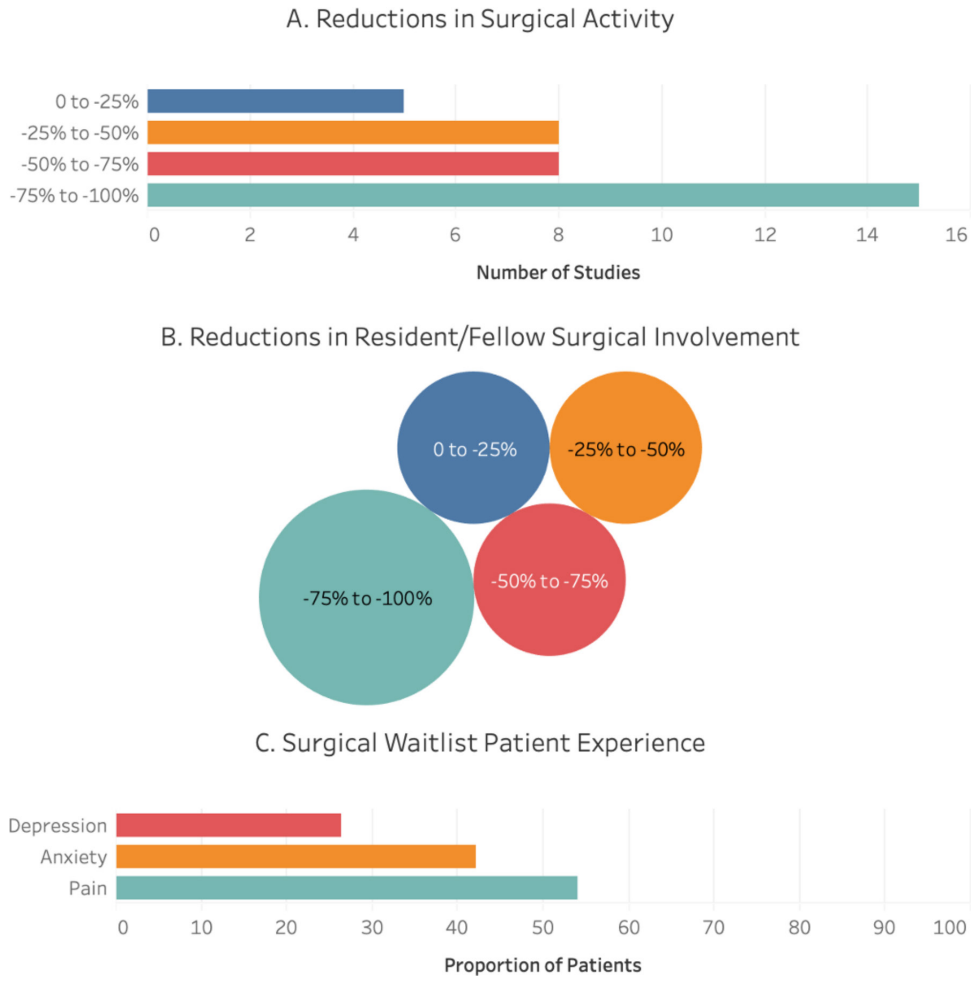

Figure 3 Summary of leading impacts of changes to surgical programming. A summary of the impacts of alterations to surgical services during public health emergencies on: (A) overall surgical activity (n=37 studies), (B) resident and fellow involvement in surgery (n=5 studies) where circle size represents the number of studies contributing to that quartile and (C) patient experience (n=2 studies).

practices may not have been attainable under the pressures of managing public health emergencies and may not be feasible in low-resource settings.

Changes to surgical services, such as cancelling or postponing non-urgent surgeries may be necessary to manage public health emergencies to reduce the risk of contamination and increase capacity within hospitals. However, the impact of these changes remains poorly understood. Many studies reported decreases in surgical volumes, but few other variables were explored with regards to the impact on patients, providers and healthcare systems. Five studies examined the impact of changes to surgical services among physicians and trainees and found that training was compromised in some specialties.[19–22] The finding that medical training was compromised is particularly important for understanding the downstream and long-term repercussions of the response to public health emergencies; decreases in surgical volumes and clinical hours for trainees could have negative and unintended effects on the future quality and safety of patient care.[43] Notably, the impacts of public health emergencies on medical training and education were almost exclusively evaluated for residents and fellows, failing to consider the limited access that current medical undergraduate students continue to encounter when trying to explore surgical specialties. This is unlikely to affect the quality of patient care but may present later in the form of decreased career satisfaction and engagement, both of which have been associated with burnout.[44] Studies examining the effects of surgical service alterations on patients noted negative effects on mental health outcomes,[28 29] pain[28] and an increased incidence of death among surgical patients.[23 24 45]

Very few studies described specific actions undertaken to rebuild and resume prepublic health emergencies surgical capacity. This may be due to the fact that most included studies examined the ongoing COVID-19 pandemic, or because few places have implemented specific plans to date. Included studies did describe consideration of system-level factors like availability of PPE and ORs. However, more patient-centric considerations such as organising childcare and requesting time away from their job during a pandemic are needed. Additionally, research suggesting that surgical capacity can be rebuilt with sufficient PPE and OR space may be falling victim to the lack of identified evidence exploring the

well-being of the surgical workforce. Resolving surgical backlogs by increasing available resources relies on the high functioning of a workforce of surgeons and allied practitioners not overtaken by burnout and stress, something that has not yet been borne out in the COVID-19 research. In other specialties involved with the care of surgical patients, moral distress has seen a marked increase making it reasonable to believe these same emotional impacts will be felt by members or surgical teams globally. Patient perspectives will also play a role in the rebuild; one study reported 14% of surgical patients initiated the cancellation of their surgery,[28] which suggests patient readiness for surgery during and post COVID-19 should be considered. For evidence to inform policy, additional research is needed to understand the impacts of different approaches for resuming surgical services.

This study is, to our knowledge, the first comprehensive scoping review of evidence around reallocation of surgical services during public health emergencies. While this study has several strengths, including a comprehensive search of academic and grey literature sources, and a mix of inductive and deductive data abstraction approaches, there are some limitations that should be considered when interpreting our findings. We modified the Joanna Briggs methodology for scoping reviews,[5] according to the WHO and Cochrane's guidance on conducting rapid reviews,[7 8] with the intent of balancing rigour with a timely and policy responsive review of the literature. Also, given that the evidence around the COVID-19 pandemic is growing at an unprecedented rate, we are aware that additional studies have been published since we ran our search strategy, especially around resuming surgical services. In order to mitigate this limitation, an ongoing effort to pivot this study into a living review is underway to ensure the data presented is up to date. This will involve rerunning the MEDLINE, Embase and grey literature search strategies every 2 months in order to incorporate new evidence into the existing manuscript. Notably, this review did not identify evidence from any low-income or middle-income countries who may face unique challenges during a pandemic compared with high-income countries described in our review. It is also likely that during the global pandemic, many healthcare institutions have been focused on coping with COVID-19 instead of publishing their experiences; we hope more organisations will add their experience to the literature.

In conclusion, we report early evidence of the operational changes that have occurred internationally in response to public health emergencies that could inform the ongoing response to COVID-19 and future public health emergencies. This study identified a gap in our understanding of the impact of these changes on patients, providers and the healthcare system that should be the focus of research moving forward to provide an evidence-based approach to managing surgical patients in future public health emergencies.

Original protocol for the study

The original unpublished protocol for this study is included as a supplementary file (online supplemental appendix D).

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