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Surgery & COVID-19: A rapid scoping review of the impact of COVID-19 on surgical services during public health emergencies

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ABSTRACT ***(275/300 words)***

Background: Healthcare systems globally have been challenged by the COVID-19 pandemic, necessitating the reorganization of surgical services to free capacity within healthcare systems.

Objectives: To understand how surgical services have been reorganized during and following public health emergencies, and the consequences of these changes for patients, healthcare providers and healthcare systems.

Methods: This rapid scoping review searched academic databases and grey literature sources to identify studies examining surgical service delivery during public health emergencies including COVID-19, and the impact on patients, providers and healthcare systems. Recommendations and guidelines were excluded. Screening was completed in partial (title, abstract) or complete (full text) duplicate following pilot reviews of 50 articles to ensure reliable application of eligibility criteria.

Results: One hundred and thirty-two studies were included in this review; 111 described reorganization of surgical services, 55 described the consequences of reorganizing surgical services and six reported actions taken to rebuild surgical capacity in public health emergencies. Reorganizations of surgical services were grouped under 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. Service reorganizations led to large reductions in non-urgent surgical volumes, increases in surgical wait times, and impacted medical training (i.e., reduced case involvement) and patient outcomes (e.g.,

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: Reorganization 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 optimize future health system responses to public health emergencies.

ARTICLE SUMMARY

Strengths and limitations of the 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 COVID-19.
- This study did not limit studies based on location or language of publication to ensure a worldwide pandemic had contributions from worldwide voices.
- 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.

Original protocol for the study: As requested, the original unpublished protocol for this study is included as a supplementary file.

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INTRODUCTION

The novel SARS-CoV-2 (COVID-19) virus has spread across the globe with unrelenting speed. At the time of writing, over 16 million cases have been confirmed with 650,000 fatalities.[1] To protect the most vulnerable in our societies, efforts to curb further escalation (e.g., travel restrictions, 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 maximize staff, PPE, ventilators, and intensive care unit (ICU) capacity in case public health efforts to 'flatten the curve' are insufficient. Most notably, surgical programs have suspended non-urgent (or 'elective') surgical procedures. Non-urgent surgeries are often defined as procedures for which a delay of three months or longer would not result in significant adverse effects to the patient.[2 3] These changes have thrust patients, providers, and healthcare organizations 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 programs should operationalize the recommendations. As such, approaches to surgical triage and service delivery remain unclear: who has done what where, and why? Further, the impacts of adopting these recommendations on surgical programs, and more importantly, the physical and psychological well-being of patients and healthcare providers have only been hypothesized.[4] Lastly, as COVID-19 begins to release its grip on the world and the post-pandemic recovery begins, programs will be tasked with rebuilding the surgical capacity necessary to reschedule and resume the backlog of postponed procedures. Evidence distilled from the experiences of others in the context of COVID-19 and

other public health emergencies (i.e., H1N1, Ebola, SARS) is needed to guide approaches to surgical service delivery.

To enable evidence-informed reorganization and resumption of non-urgent surgeries post-COVID-19 and for future public health emergencies, we conducted a rapid scoping review to synthesize relevant and available literature. Our aim was to understand how surgical services were reorganized in response to COVID-19 and other public health emergencies; how reorganization impacted patients, healthcare providers, and health systems; and what approaches have been taken to resume surgical service delivery.

METHODS

Study Design

This scoping review followed the Joanna Briggs Institute methodology and Preferred Reporting Items for Systematic reviews and Meta-Analysis extension for Scoping Reviews (PRISMA-ScR) 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 World Health Organization and Cochrane guidance for rapid reviews were made.[7 8] This review addressed three questions: 1) How have surgical services been reorganized in response to public health emergencies? 2) What are the patient-, healthcare provider-, and system-level consequences of reorganizing surgical services? and 3) What approaches were used for resuming surgical services?

Search Strategy

The search strategy was developed by two investigators (CO, KS) and refined by others with context expertise in surgery and literature review methodology (JNK, AKR). The search strategy included subject headings, keywords, and synonyms identifying public health emergencies in general and specific public health emergencies (Ebola, SARS-CoV1, H1N1, MERS), and surgery; and were tailored for each database (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 May 8, 2020. Anticipating pertinent information may not be published (i.e., 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 (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 standardized data abstraction form (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) reorganization of surgical services, 2) impact of reorganizing 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 (e.g., emergency tracheostomy, caesarean section), settings beyond in-patient acute care (e.g., outpatient clinics including dental clinics), surgical services beyond a public health emergency without comparison to public health emergencies, 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 standardized data abstraction form (Appendix B). Data included: date of publication, country,

study design, definition of non-urgent surgery, characteristics of study sample (if applicable), outcomes of interest for the three research questions, detailed below.

Outcomes of Interest

Our primary outcomes were reorganization of surgical services, impact of reorganization 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, conceptualized 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 reorganization of surgical services was organized 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 was 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

Study and sample data were summarized narratively in a data table and using descriptive statistics where appropriate. We decided *a priori* to use a random effects model for meta-analysis if there was sufficient data on the impact of changes to surgical services to pool, however this was not feasible. Instead, descriptive statistics were used to synthesize the quantitative outcomes. Data were synthesized and presented separately for each of the three research questions.

Patient and Public Partnership

Patients and the public were not involved in the conception or analysis of this review.

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 six 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,[12] but two studies could not be readily translated therefore they are not included in the synthesis.[13 14]

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), orthopedics (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.

Reorganization of Surgical Service

A number of themes emerged from the 108 studies describing reorganization of surgical services. Nearly all studies reported partial, with most reporting full cessation of non-urgent surgeries at their centre, albeit with varying definitions of "non-urgent" (e.g., can be safely postponed for 3 months) and "urgent" (e.g., 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.

1. Changes to Case Selection and Triage Procedures. The "where" of surgery is described above; however, the issue of what patients can safely undergo which 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 contamination. 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 (e.g., patient characteristics, acuity, imaging) to a larger group representing many surgical specialties to reach consensus on each case.

2. 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 post-operative suture or staple removal were granted in-person visits under strict conditions including mask wearing, negative symptom check, history or temperature pre-screening. 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 not only follow-up with returning

patients but to also 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.

3. 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 (i.e. corridors, 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[15] and Italy during COVID-19.[16]

Impact of Reorganizing 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 summarized below with data for all studies relevant to this question shown in 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.[17]

Changes in Resident/Fellow Involvement in Surgical Activities. Four studies[18-21] 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 [22-26] reported data for this outcome. One centre reported a 64% increase in length of their minor colorectal surgery waitlist[25] and another centre (head and neck oncological surgery program) reported a 500% increase in latency from diagnosis to surgery.[26] One study reported no waitlist deaths during the COVID-19 pandemic[24] while another saw a small decrease in the number of weekly waitlist deaths.[23] A single study identified more patients leaving their renal transplantation waitlist due to mortality or clinical deterioration.[22]

Changes in Patient Pain, Anxiety, and Depression. Two studies[27 28] 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,[29] 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 prioritization.[30] Among studies that changed their surgical triage practices, patients were prioritized for surgery based on procedure acuity or urgency (i.e., risk to patients if surgery were further delayed), resource intensity, and procedural complexity. Four studies[31-34] noted that prior to resuming non-urgent surgeries, availability of the staff, (Operating Room) ORs, PPE, and testing was necessary to prepare for a large and complicated surgical backlog.

DISCUSSION

This review identified over 3,000 evidence sources, 132 of which were included. Approaches to reorganizing surgical services varied between studies and centers, 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 wellbeing or changes in healthcare utilization 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 fits all" approach does not exist. Changes to surgical services likely depends on the characteristics of specific centers 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 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.[35-41] 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 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.[18-21] 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.[42] Studies examining the effects of surgical service alterations on patients noted negative effects on mental health outcomes,[27 28] pain,[27] and an increased incidence of death among surgical patients.[22 23 43]

Very few studies described specific actions undertaken to rebuild and resume pre-public 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 organizing child care and requesting time away from their job during a pandemic, are needed. Interestingly, one study reported 14% of surgical patients initiated the cancellation of their surgery,[27] 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 World Health Organization and Cochrane's guidance on conducting rapid reviews,[7 8] with the intent of balancing rigor 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, it is possible 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. Notably, this review did not identify evidence from any low or middle-income countries who may face unique challenges during a pandemic compared to 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 organizations 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 which 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

which should be the focus of research moving forward to provide an evidence-based approach to managing surgical patients in future public health emergencies.

Author Contributions

CO contributed to the design and conceptualization of the review, analysis and interpretations of the data, and drafting and revising the manuscript; JSN contributed to the design of the review, interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; AKR contributed to the design of the review, interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; JCD contributed to the interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; JW contributed to the interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; JR contributed to the interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; MB contributed to the interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; KMS contributed to the design and conceptualization of the review, analysis and interpretations of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript.

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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
Alverez-Gallego	2020	Spain	COVID-19	General			
Ammar	2020	USA	COVID-19	Neurosurgery			
Amparore	2020	Italy	COVID-19	Urology		Changes in clinical and surgical resident involvement	
Ansarin	2020	Italy	COVID-19	Oncology (Head & 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	Orthopedics			
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	2020	USA	COVID-19	Orthopedics		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	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	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		
Chee	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 & Neck)		Number of surgical cancellations
D'Apolito	2020	Italy	COVID-19	Orthopedics		Changes in surgical volume
de Vries	2020	Netherlands	COVID-19	Transplant		Changes in transplantation volumes
Ding	2020	Singapore	COVID-19	Orthopedics		
Dominguez-Gil	2020	Spain	COVID-19	Transplant		Changes in transplantation volumes
Doussot	2020	France	COVID-19	Oncology		Changes in surgical volume
Dowdell	2020	USA	COVID-19	Orthopedics		
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	2020	Italy	COVID-19	Neurosurgery		Changes in surgical volume
Fontanella	2020	Italy	COVID-19	Neurosurgery		
Giorgi	2020	Italy	COVID-19	Spinal		
Givi	2020	USA	COVID-19	Oncology (Head & Neck)		Changes in fellow educational programming
Gomez-Barrena	2020	Spain	COVID-19	Orthopedics		Changes in surgical volume
Gouveia	2020	Portugal	COVID-19	Vascular		
Guerci	2020	Italy	COVID-19	General		
Gupta	2020	India	COVID-19	Oncology (Head & Neck)		
Haines	2003	China	SARS	Obstetrics		
Hemingway	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	Orthopedics		
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	2020	Italy	COVID-19	Transplant		Changes in transplantation volumes	
Lee	2020	China	COVID-19	Oncology (Head & Neck)		Changes in surgical wait times	
Leong Tan	2020	Singapore	COVID-19	Vascular			
Li	2020	China	COVID-19	Transplant			
Liebensteiner	2020	Austria	COVID-19	Orthopedics			
Liu	2003	Singapore	SARS	Anesthesia			
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	—			Prioritization first of patients who would be at increased risk with further delay, followed by those waiting longest
Meneghini	2020	USA	COVID-19	Orthopedics			
Meyer	2020	France	COVID-19	Neurosurgery		Changes in surgical volume	
Morgan	2020	UK	COVID-19	Orthopedics			
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 & Neck)			
Patel	2020	USA	COVID-19	Otolaryngology			
Pelt	2020	USA	COVID-19	Orthopedics		Number of surgical postponements	Surgeries prioritized based on complexity and predicted LOS, scheduling only completed if appropriate PPE and screening available.
Pittet	2020	Switzerland	COVID-19	—		Changes in surgical volume	
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 & Neck)		Changes in surgical volume	
Randelli	2020	Italy	COVID-19	Orthopedics			
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	Orthopedics			
Schull	2007	Canada	SARS	—		Changes in surgical volume	
Schwarzkopf	2020	USA	COVID-19	Orthopedics			
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	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	Anesthesia			
Tan	2020	Singapore	COVID-19	Urology		Changes in surgical and consultation volumes	
Tan	2020	China	COVID-19	Neurosurgery			
Tay	2020	Singapore	COVID-19	Orthopedics		Changes in surgical volumes	
Tay	2020	Singapore	COVID-19	Orthopedics			
Thaler	2020	Austria	COVID-19	Orthopedics			
Tolone	2020	Italy	COVID-19	—			
Too	2020	Singapore	COVID-19	Interventional Radiology			
Topf	2020	USA	COVID-19	Oncology (Head & Neck)			
Tsui	2005	China	SARS	Cardiac			
Tzeng	2020	USA	COVID-19	Oncology			
Unal	2020	Turkey	COVID-19	Vascular			
Vaccaro	2020	USA	COVID-19	Orthopedics		Changes in physician remuneration and staffing	
Valenza	2020	Italy	COVID-19	Oncology		Changes in surgical volumes	
van de Haar	2020	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	2020	Italy	COVID-19	Oncology (Breast)		Changes in surgical volumes	
Vlantis	2004	China	SARS	Otolaryngology		Changes in outpatient and surgical volumes	
Walker	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	Anesthesia	■■■■	
Wu	2020	China	COVID-19	Oncology (Head & Neck)	■■■■■■	
Xiaolei	2020	China	COVID-19	Ophthalmology		
Zangrillo	2020	Italy	COVID-19	—	■■■■■	
Zarzaur	2020	USA	COVID-19	—	■■■	
Zeng	2020	China	COVID-19	Oncology (Head & Neck)	■■■■	
Zizzo	2020	Italy	COVID-19	—	■■	
Zoia	2020	Italy	COVID-19	Neurosurgery	■■■■	

Domains of change to surgical services, represented numerically:
■ Changes to case selection and surgical triage
■ Changes to PPE protocols and practices
■ Changes to the surgical workforce.
■ Changes to inpatient and outpatient care
■ Changes to resident and fellow education
■ Changes to the environment

Abbreviations: — =data not provided, COVID-19=Coronavirus Disease 2019, ED=Emergency department, GI=Gastrointestinal; LOS=Length of stay, PPE=Personal protective equipment, SARS=Severe Acute Respiratory Syndrome

Table 2. Reorganization of surgical services, by domain.

Change Domain	Number of Studies (%)	Examples of Change
Triage or Case Selection	80 (74.7)	1. Prioritization of patients based on pre-defined levels of acuity; 2. Virtual multidisciplinary meetings or tumor 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 (i.e., 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 (e.g., 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 (e.g., 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 maximize 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 (e.g., only admitted to OR during low-risk/non-aerosolizing procedures).
Environment	70 (64.8)	1. Dedication of wards (hallways, 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 (e.g., cubicles, distanced waiting room chairs) implemented.

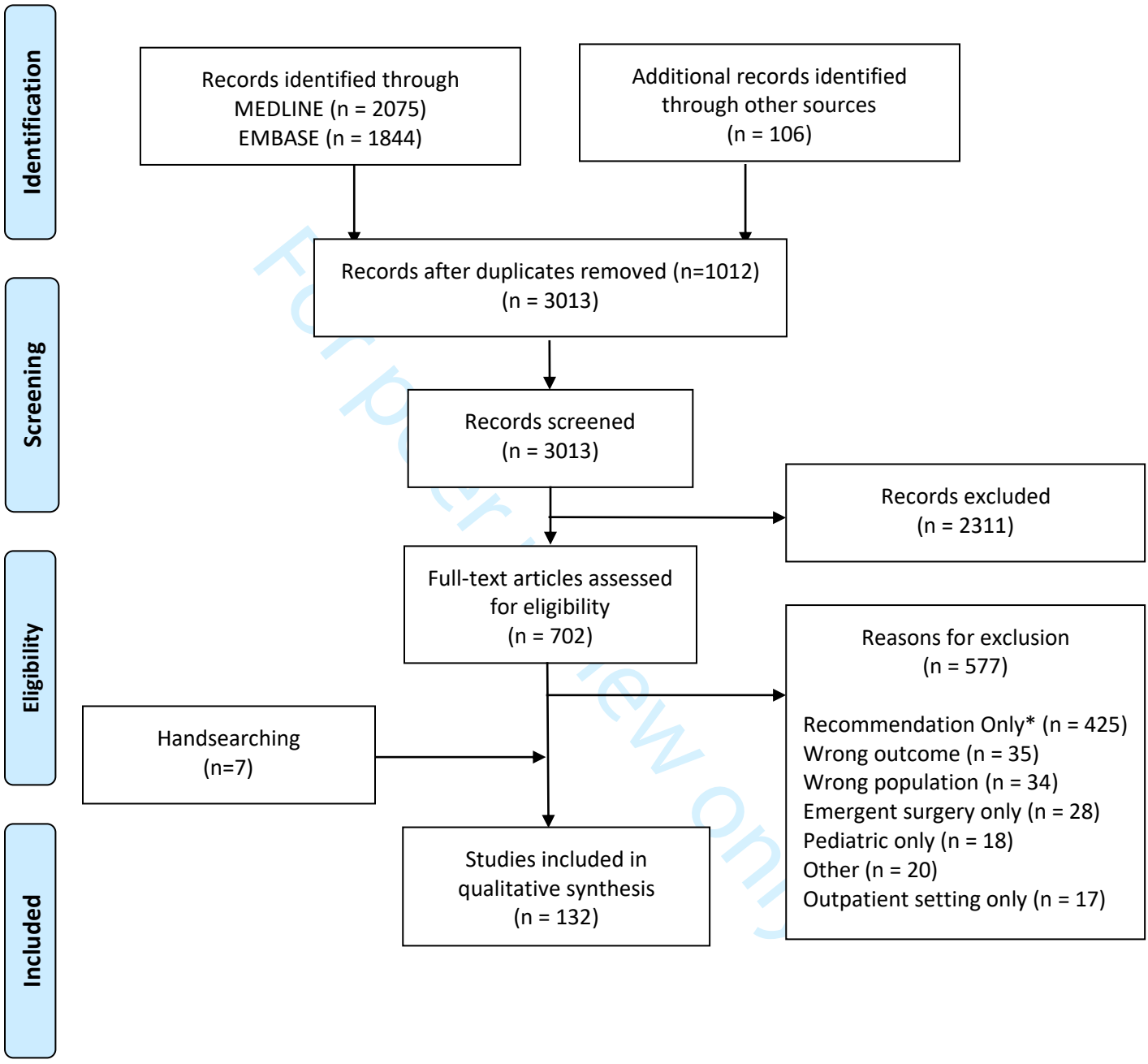
Abbreviations: ICU= Intensive care unit, PPE= Personal protective equipment, PAPR= Powered air purifying respirator, OR= Operating room.

Figure 1. PRISMA Flow diagram.

Figure 2. Summary of study characteristics.

Figure 3. Summary of leading impacts of changes to surgical programming

Figure 1. Flow of studies in the scoping review



*Includes guidelines, recommendation-based reviews, projections or estimations without mention of true changes to surgical programming.

Figure 2. Study characteristics

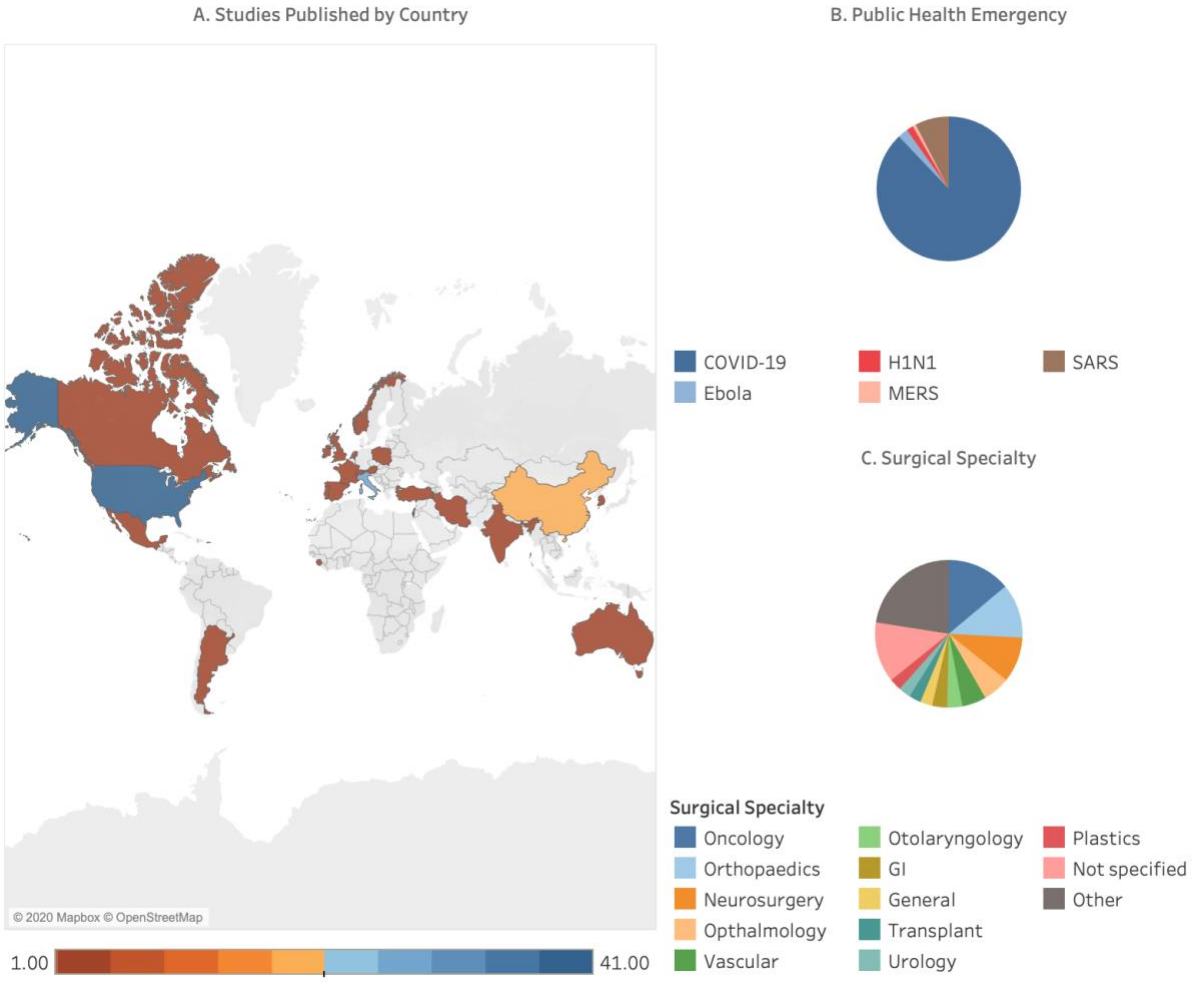


Figure 2. **A.** Country of publication, **B.** Public health emergency discussed, and **C.** Surgical specialty addressed ('Other' includes Cardiac (n=3), Anesthesia (n=3), Electrophysiology (n=3), Obstetrics and Gynecology (n=3), Thoracic (n=2), Interventional Radiology (n=1), and Dermatology (n=1)).

Figure 3. Summary of the impacts of alterations to surgical services

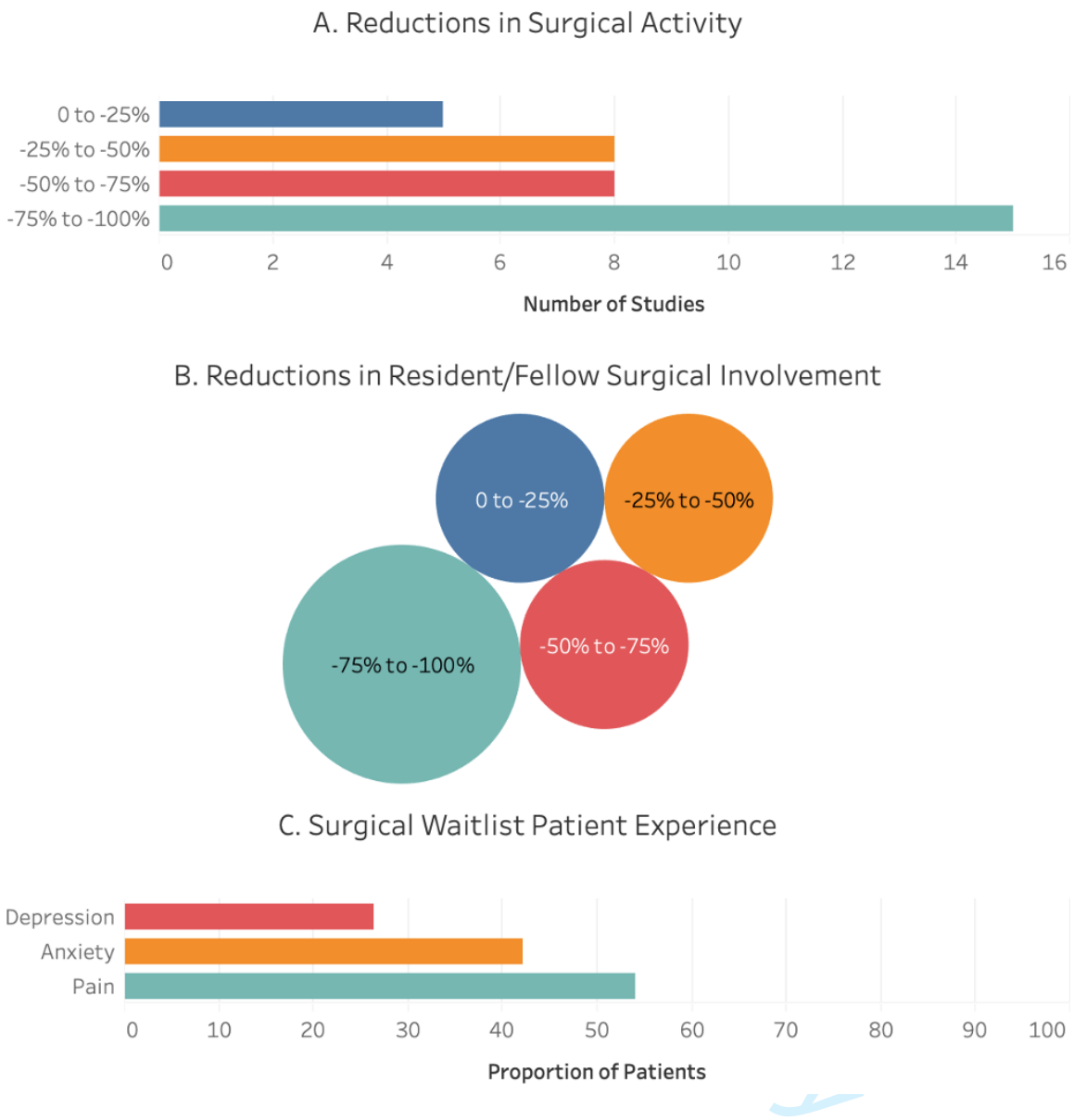


Figure 3. A summary of the impacts of alterations to surgical services during public health emergencies on **A.** Overall surgical activity (n=37 studies), **B.** Resident and fellow involvement in surgery (n=5 studies) where circle size represents the number of studies contributing to that quartile, and **C.** Patient experience (n=2 studies).

Appendix A. Search Strategy

Database: Ovid MEDLINE (R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily <1946 to May 08, 2020>

Search Strategy:

1 exp Disease Outbreaks/ (96117)
2 (pandemic* or epidemic* or outbreak* or out break*).mp. (230774)
3 1 or 2 (231940)
4 exp Coronavirus (13456)
5 coronavirus infections/ or severe acute respiratory syndrome/ (11068)
6 Coronaviridae Infections/ (900)
7 coronaviridae/ or coronavirus/ (3916)
8 Influenza a virus, h1n1 subtype/ or Influenza a virus, h3n2 subtype/ or influenza a virus, h5n1 subtype/ (22141)
9 Hemorrahagic Fever, Ebola/ (5316)
10 SARS Virus/ (3038)
11 Middle East Respiratory Syndrome Coronavirus/ (1034)
12 (pneumonia.mp. or exp pneumonia/) and Wuhan.mp. (661)
13 (coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV or h1n1 or h3n2 or h5n1 or avian influenza or avian flu or swine influenza or swine flu or SARS or ebola* or middle east respiratory syndrome or MERS).mp. (77950)
14 (wuhan) adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV).mp. (190)
15 (coronavir*) adj2 (infection*).mp. (8441)
16 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 (79915)
17 General Surgery/ (38626)
18 Orthopedic Procedures/ (25371)
19 Traumatology/ (3474)
20 Neurosurgery/ (14892)
21 Obstetrics/ (22533)
22 Anesthesia/ (62587)
23 surgical procedures, operative/ or exp elective surgical procedures/ (68085)
24 exp Arthroplasty, Replacement/ (54362)
25 (general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anesthesia or anaesthesia).mp. (748651)
26 (surger* or operation* or procedure*).mp. (3638036)
27 ((elective or non-urgent) adj2 (surg* or procedure*)).mp. (31794)
28 (surg* adj2 (procedure* or planning or triage or operation* or resource* or backlog or re-organiz* or postpone* or cancel* or capacit* or wait time*)).mp. (444474)
29 ((clinic* or hospital) adj2 (process* or procedure* or triage or planning or performance* or capacit*)).mp. (69185)
30 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 (4101483)
31 3 and 16 and 30 (2075)

Database: EMBASE <1974 to 2020 May 08>

Search Strategy:

1	exp epidemic/ (103292)
2	exp pandemic/ (12990)
3	1 or 2 (114458)
4	pandemic influenza/ (4748)
5	exp severe acute respiratory syndrome/ (8505)
6	exp coronaviridae/ or coronaviridae infection/ (14928)
7	coronavirinae/ (2093)
8	Coronavirus infection/ (3397)
9	avian influenza virus/ or "influenza a virus (h1n1)"/ or "influenza a virus (h3n2)"/, "influenza a virus (h5n1)"/ (7466)
10	Ebola hemorrhagic fever/ (5712)
11	exp SARS coronavirus/ (5823)
12	Middle East respiratory syndrome/ (935)
13	(pneumonia.mp. or exp pneumonia/) and Wuhan.mp. (512)
14	(coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV).mp. (92353)
15	(wuhan adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV)).mp. (161)
16	(coronavir* adj2 infection*).mp. (4793)
17	4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 (96712)
18	general surgery/ (15070)
19	orthopedic surgery/ (32672)
20	traumatology/ (10653)
21	neurosurgery/ (59847)
22	obstetrics/ (34886)
23	anesthesiological procedure/ (1785)
24	elective surgery/ (34038)
25	replacement arthroplasty/ or exp arthroplasty/ (73583)
26	(general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anaesthesia or anesthesia).mp. (966732)
27	(surger* or operation* or procedure*).mp. (5402047)
28	((elective or non-urgent adj2 (surg* or procedure*)).mp. (52808)
29	(surg* adj2 (procedure* or planning or triag* or operation* or resource* or backlog or re-organiz* or postpon* or cancel* or capacit* or wait time*)).mp. (187480)
30	((clinic* or hospital) adj2 (process* or procedure* or triag* or planning or performance* or capacit*)).mp. (83715)
31	18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 (5948860)
32	3 and 17 and 31 (1844)

Database	Pandemic terms Pandemic, epidemic	Disease terms COVID-19, SARS, MERS, pandemic flu (h1n1, h3n2, h5n1), ebola	Surgical terms Non-urgent/elective surgery (general, orthopedic, anesthesia, trauma, neurosurgery, obstetrics)
MEDLINE	exp Disease Outbreaks/ OR (pandemic* or epidemic* or outbreak* or out break*).mp.	exp Coronavirus OR coronavirus infections/ or severe acute respiratory syndrome/ OR Coronaviridae Infections/ OR coronaviridae/ or coronavirus/ OR Influenza a virus, h1n1 subtype/ or Influenza a virus, h3n2 subtype/ or influenza a virus, h5n1 subtype/ OR Hemorrahagic Fever, Ebola/ OR SARS Virus/ OR Middle East Respiratory Syndrome Coronavirus/ OR (pneumonia.mp. or exp pneumonia/) and Wuhan.mp. OR (coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV or h1n1 or h3n2 or h5n1 or avian influenza or avian flu or swine influenza or swine flu or SARS or ebola* or middle	General Surgery/ OR Orthopedic Procedures/ OR Traumatology/ OR Neurosurgery/ OR Obstetrics/ OR Anesthesia/ OR surgical procedures, operative/ or exp elective surgical procedures/ OR exp Arthroplasty, Replacement/ OR (general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anesthesia or anaesthesia).mp. OR (surger* or operation* or procedure*).mp. OR ((elective or non-urgent) adj2 (surg* or procedure*)).mp. OR (surg* adj2 (procedure* or planning or triage or operation* or resource* or backlog or re-organiz* or postpone* or cancel* or capacit* or wait time*)).mp.

		east respiratory syndrome or MERS).mp. OR (wuhan) adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV).mp. OR (coronavir*) adj2 (infection*).mp.	OR ((clinic* or hospital) adj2 (process* or procedure* or triage or planning or performance* or capacit*)).mp.
EMBASE	exp epidemic/ OR exp pandemic/	pandemic influenza/ OR exp severe acute respiratory syndrome/ OR exp coronaviridae/ or coronaviridae infection/ OR coronavirinae/ OR Coronavirus infection/ OR avian influenza virus/ or "influenza a virus (h1n1)"/ or "influenza a virus (h3n2)"/, "influenza a virus (h5n1)"/ OR Ebola hemorrhagic fever/ OR exp SARS coronavirus/ OR Middle East respiratory syndrome/ OR (pneumonia.mp. or exp pneumonia/) and Wuhan.mp. OR (coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV).mp. OR	general surgery/ OR orthopedic surgery/ OR traumatology/ OR neurosurgery/ OR obstetrics/ OR anesthesiological procedure/ OR elective surgery/ OR replacement arthroplasty/ or exp arthroplasty/ OR (general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anaesthesia or anesthesia).mp. OR (surger* or operation* or procedure*).mp. OR ((elective or non-urgent adj2 (surg* or procedure*)).mp. OR (surg* adj2 (procedure* or planning or triag* or operation* or resource* or backlog or re-organiz* or postpon* or cancel* or

		(wuhan adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV)).mp. OR (coronavir* adj2 infection*).mp.	capacit* or wait time*)).mp. OR ((clinic* or hospital) adj2 (process* or procedure* or triag* or planning or performance* or capacit*)).mp.

GREY LITERATURE SEARCH PLAN

Developed in reference to Guide from the University of Toronto (Stapleton, Fuller & Lenton)

STEP 1) Targeted Website Browsing. Will be using any combination of standard terms "coronavirus" OR "Covid-19" OR "Surgery" OR "non-urgent surgery" OR "elective surgery" OR "guidelines")

NON-GOVERNMENT GROUPS

World Health Organization (https://www.who.int)
Center for Disease Control and Prevention (https://www.cdc.gov)
European Centre for Disease Prevention and Control (https://www.ecdc.europa.eu/en)

GOVERNMENTS/HEALTH SYSTEMS

Canada (https://www.canada.ca/en.html)

- BC (https://www2.gov.bc.ca/gov/content/home)
- AB (https://www.alberta.ca/index.aspx)
- SK (https://www.saskatchewan.ca)
- MB (https://www.gov.mb.ca)
- ON (https://www.ontario.ca/page/government)
- QC (https://www.quebec.ca/en/)
- NB (https://www2.gnb.ca)
- NS (https://beta.novascotia.ca)
- NL & LB (https://www.gov.nl.ca)
- PEI (https://www.princeedwardisland.ca/en)
- Yukon (https://yukon.ca)
- NWT (https://www.gov.nt.ca)
- Nunavut (https://www.gov.nu.ca)

Australia (https://www.australia.gov.au)
Italy (http://www.governo.it)
Singapore (https://www.gov.sg)
China (https://www.gov.cn/english/)
USA (https://www.usa.gov)

GENERAL SURGICAL GROUPS/COLLEGES

Royal College of Physicians and Surgeons of Canada (http://www.royalcollege.ca)
American College of Surgeons (https://www.facs.org)
European Surgical Association (https://www.europeansurgicalassociation.org)
College of Surgeons, Singapore (https://www.ams.edu.sg/colleges/CSS/home)
French Surgical Association
German Society of Surgery (https://www.dgch.de/index.php?id=118)
Italian Society of Surgery (SIC) and Italian Association of Hospital Surgeons (ACOI)
Philippine College of Surgeons (https://www.pcs.org.ph)
Royal Australasian College of Surgeons (https://www.surgeons.org)
Royal College of Surgeons of England (https://www.rcseng.ac.uk)
Royal College of Surgeons of Ireland (https://www.rcsi.com/dublin/)
Spanish Society of Surgery (Associacion Espanola de Cirujanos) (https://www.aecirujanos.es)
Swedish Surgical Society (http://www.svenskkirurgi.se)
The Association of Surgeons of South Africa (http://www.surgeon.co.za)
The Pan African Association of Surgeons (http://www.africansurgeons.com)

STEP 2) Advanced Google Searching. Targeting above sites will assess 5 pages of Google Search past last click. Will be using standard and consistent terms "coronavirus" OR "Covid-19" OR "Surgery" OR "non-urgent" OR "guidelines")

STEP 3) General Search Engine (Google) Search with same terms as above, assessing 5 pages past last click for relevance.

STEP 4) Contact with Knowledge Experts.

Source and Site	Search Terms	Potentially Relevant Results
Health Groups		
World Health Organization (https://www.who.int, Advanced Search)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	10
Center for Disease Control and Prevention (https://www.cdc.gov)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	8
European Centre for Disease Prevention and Control (https://www.ecdc.europa.eu/en)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	3
Governments		
Government of Canada (https://www.canada.ca/en.html)	[contains all words] elective surgery covid	4

	[contains all words] non-urgent surgery covid	
Government of BC (https://www2.gov.bc.ca/gov)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	2
Government of AB (https://www.alberta.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	2
Government of SK (https://www.saskatchewan.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	6
Government of MB (https://www.gov.mb.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	4
Government of ON (https://www.ontario.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of QC (https://www.quebec.ca/en/)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of NB (https://www2.gnb.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of NS (https://beta.novascotia.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of NL & LB (https://www.gov.nl.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of PEI (https://www.princeedwardisland.ca)	[contains all words] elective surgery covid	2

	[contains all words] non-urgent surgery covid	
Government of Yukon (https://yukon.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of NWT (https://www.gov.nt.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of Nunavut (https://www.gov.nu.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of Australia (https://www.australia.gov.au)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of Italy (http://www.governo.it)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of Singapore (https://www.gov.sg)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of China ((https://www.gov.cn/english/)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
United States Government (https://www.usa.gov)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Surgical Colleges/Associations		
Royal College of Physicians and Surgeons of Canada (http://www.royalcollege.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0

American College of Surgeons (https://www.facs.org)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	23
European Surgical Association (https://www.europeansurgicalassociation.org)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
College of Surgeons, Singapore (https://www.ams.edu.sg)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	3
German Society of Surgery (https://www.dgch.de/index.php?id=118)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Philippine College of Surgeons (https://www.pcs.org.ph)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	11
Royal Australasian College of Surgeons (https://www.surgeons.org)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	12
Royal College of Surgeons of England (https://www.rcseng.ac.uk)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	7
Royal College of Surgeons of Ireland (https://www.rcsi.com/dublin/)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	8
Spanish Society of Surgery (Associacion Espanola de Cirujanos) (https://www.aecirujanos.es)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Swedish Surgical Society (http://www.svenskkirurgi.se)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0

The Association of Surgeons of South Africa (http://www.surgeon.co.za)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
The Pan African Association of Surgeons (http://www.africansurgeons.com)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
	Total	111

Appendix B. Data Abstraction Form

This form has been developed by adopting and customizing the 'Data collection form- RCTs and NRS' produced by The Cochrane Collaboration. Customization includes the addition of new sections, as well as the omission of sections not relevant to the review.

Notes on using data extraction form:

- Be consistent in the order and style you use to describe the information for each report.
- Record any missing information as unclear or not described, to make it clear that the information was not found in the study report(s), not that you forgot to extract it.
- Include any instructions and decision rules on the data collection form, or in an accompanying document. It is important to practice using the form and give training to any other authors using the form.

1. General Information

1. Date form completed (dd/mm/yyyy)	/ /
2. Name of person extracting data	☐ Connor M. ORielly ☐ Khara M. Sauro
3. Contact details of person extracting data	
4. Title of Article/Abstract (that data are extracted from)	
5. Study ID (plus surname of author and year of study publication)	
6. Study country of origin	
7. Study funding source	
8. Possible conflicts of interest	☐ Reported ☐ Not Reported
9. Notes:	

2. Eligibility

Study Characteristics	Inclusion Criteria	Location in text (page#/fig#/table#)
10. Type of study (design)	☐ Case Study ☐ Case Series ☐ Observational	

11. Population description		
12. Focused diseases/conditions		
13. Types of outcome measures		
14. Decision (with reasons for either inclusion or exclusion)	☐ Include ☐ Exclude If Exclude, explain:	
15. Notes		

IF STUDY IS EXCLUDED FROM REVIEW, DO NOT CONTINUE

2. Population and setting

	Description	Location in text (page#/fig#/table#)
16. Population description		
17. Source/setting of the population (e.g., urban, rural, ethnic group)		
18. Method(s) of recruitment of participants	☐ Random ☐ Non-Random Method:	
19. Notes:		

3. Methods

	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)

20. Aim of study		
21. Design (e.g., cross-sectional, RCT, CCT)	☐ Case Study ☐ Case Series ☐ Observational	
22. Sampling technique (e.g., random or convenience)	☐ Random ☐ Non-Random	
23. Study start date (dd/mm/yyyy)	/ /	
24. Study end date/duration (dd/mm/yyyy)	/ / **OR** Duration:	
25. Notes:		

4. Participants

	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
26. Total number of participants/Sample size		
27. Age		
28. Sex	☐ Both Sexes ☐ Males ☐ Females	
29. Genders Represented		
30. Country		
31. Predominant medical complaint		
32. Co-morbidities (if any)		
33. Definition of 'Frequent use' (if any)		

34. Notes:

5. Outcomes

Keep only the tables for outcomes relevant to this particular study, duplicate tables as necessary.

Outcome 1: Alterations to surgical programming (RQ1)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
35. Outcome definition		
36. Time points measured		
37. Domains of change	☐ Surgical triage ☐ PPE ☐ Workforce ☐ Patient care ☐ Environmental	
38. Unit of measurement	☐ Group ☐ Individual	
39. Notes:		

Outcome 2: Patient-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
40. Specify Outcome		
41. Outcome definition		
42. Time points measured		
43. Unit of Measurement	☐ Group ☐ Individual	
44. Unit of measurement		
45. Notes:		

Outcome 3: System-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
46. Specify Outcome		
47. Outcome definition		
48. Time points measured		
49. Unit of Measurement	☐ Group ☐ Individual	
50. Unit of measurement		
51. Notes:		

Outcome 4: Practitioner-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
52. Specify Outcome		
53. Outcome definition		
54. Time points measured		
55. Unit of Measurement	☐ Group ☐ Individual	
56. Unit of measurement		
57. Notes:		

Outcome 5: Alterations to rebuild capacity (RQ3)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
58. Outcome definition		
59. Time points measured		

60. Domains of change	☐ Surgical triage ☐ PPE ☐ Workforce ☐ Patient care ☐ Environmental	
61. Unit of measurement	☐ Group ☐ Individual	
62. Notes:		

6. Results and findings

Keep only the tables for outcomes relevant to this particular study, duplicate tables as necessary.

Outcome 1: Alterations to surgical programming (RQ1)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
63. Subgroup (if applicable, e.g., age/sex specific reporting)		
64. Results		
65. Response/non-response rate		
66. Unit of analysis (i.e., individual or group)		
67. Notes:		

Outcome 2: Patient-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
68. Subgroup (if applicable, e.g., age/sex specific reporting)		
69. Results		
70. Response/non-response rate		
71. Unit of analysis (i.e., individual or group)		
72. Notes:		

Outcome 3: System-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
73. Subgroup (if applicable, e.g., age/sex specific reporting)		
74. Results		
75. Response/non-response rate		
76. Unit of analysis (i.e., individual or group)		
77. Notes:		

Outcome 4: Practitioner-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
78. Subgroup (if applicable, e.g., age/sex specific reporting)		
79. Results		
80. Response/non-response rate		
81. Unit of analysis (i.e., individual or group)		
82. Notes:		

Outcome 5: Alterations to rebuild capacity (RQ3)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
83. Subgroup (if applicable, e.g., age/sex specific reporting)		
84. Results		
85. Response/non-response rate		
86. Unit of analysis (i.e., individual or group)		
87. Notes:		

Research Questions informed by this study ***(tick only boxes matching the outcome tables kept above)***

☐ Changes to surgical programming in response to public health emergency

☐ Impacts of changes to surgical programming
☐ Actions to rebuild surgical capacity post-public health emergency

7. Strengths, limitations and mitigation strategy

	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
88. Strengths		
89. Limitations		
90. Strategies to overcome limitations		
91. Notes:		

8. Conclusion and other information

	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
92. Key conclusions of study authors		
93. Notes:		

Appendix C. Complete list of references for included studies

1. Alvarez Gallego M, Gortazar de Las Casas S, Pascual Miguelanez I, et al. SARS-CoV-2 pandemic on the activity and professionals of a General Surgery and Digestive Surgery Service in a tertiary hospital. *Cir Esp* 2020 doi: 10.1016/j.ciresp.2020.04.001 [published Online First: 2020/04/28]
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BACKGROUND

The novel coronavirus (COVID-19) has spread across the globe with unrelenting speed. At the time of writing over 4 million cases have been confirmed, among them more than 200,000 fatalities[1]. In addition to protecting those most vulnerable in our societies, efforts to curb further disease escalation (e.g., travel restrictions, physical distancing measures) have had a focal objective: prevent case surges that could overwhelm healthcare institutions or further aggravate existing shortages in personal protective equipment (PPE), ventilators, and hospital capacity.

Medical institutions have themselves also taken steps to maximize the availability of staff, PPE, ventilators and intensive care unit (ICU) capacity in the case that external 'curve flattening' practices are not sufficient. Most notably, surgical programs have suspended non-urgent (or elective) surgical procedures, often defined as procedures for which a delay of three (3) months or longer would not result in any significant adverse effect to the patient[2,3]. These changes span nearly all surgical specialties from oncology to orthopedics and have thrusted patients, providers and programs into previously unexplored territory.

While the governing bodies of surgical practice have recommended alterations to non-urgent surgical service delivery, they have not always provided explicit instructions on how programs should approach the change. As such, different groups have likely taken different approaches to surgical triage and service delivery and it remains unclear who has done what where, and why? Further, the impacts of postponing non-urgent surgeries on the physical, psychological, emotional and professional well-being of patients and practitioners are either anecdotal or unknown[4]. Lastly, as COVID-19 begins to release its grip on the world and a level of post-pandemic normalcy returns, programs will be tasked with rebuilding the surgical capacity necessary to reschedule and resume postponed procedures. Evidence on the experiences of other

groups doing so in the context of COVID-19 and other public health emergencies (i.e., H1N1, Ebola, SARS) will be paramount in guiding subsequent approaches.

To address the aforementioned knowledge gaps, we will conduct a rapid review of the literature to synthesize evidence on how surgical resources were allocated in response to COVID-19 and other public health emergencies, how these reallocations impacted patients, practitioners and broader health systems, and what approaches have been taken to rebuild, reorganize and resume surgical service delivery. This review will not only help explain how international surgical programs responded to this unprecedented emergency and what the consequences were, but will also provide the evidence-base necessary to guide responses to this current and any future pandemic event.

METHODS

Study Design

The planned review will answer three questions: (1) How have surgical resources been allocated in response to COVID-19, (2) What are the patient- and system-level consequences of reorganizing surgical resources, and (3) How have resources been reorganized to resume surgical services? We will focus on surgeries identified as "elective" or "non-urgent'. However, to avoid limiting study eligibility unnecessarily no set definition for this term will be used and we will instead report the definition used by each included study.

Search Strategy

An electronic search strategy was developed by the investigators (CO, KS) prior to being reviewed and refined by collaborators with context expertise in surgery and literature review

(JNK, AKR). The search strategy includes subject headings, keywords and synonyms identifying the public health emergencies of interest as well as the surgical specialties likely affected by COVID-19 (Appendix A). Headings and keywords were adapted for use in each database. Given the diversity of the research questions related to this review no study design or publication type constraints will be applied to the search. Further, since (by definition) the impacts of a pandemic span many countries, no language restrictions will be applied. However, to deliver on the study objectives in a timely fashion, studies not easily translated by members of the research team will be subsequently excluded from the review.

We will conduct comprehensive searches of Ovid MEDLINE (including Epub Ahead of Print, In-Process & Other Non-Indexed Citations) and EMBASE from database inception onwards. Since much of the information related to the questions of this review is likely unpublished (i.e., joint statements, recommendations and guidelines from surgical colleges) we will also complete a detailed grey literature search. An *a priori* designed plan for this search has been developed (Appendix B) and will follow methodological recommendations by including targeted website searching, advanced and general Google searching and contact with knowledge experts[5]. Further, the reference lists from all included studies will be examined for any additional relevant studies not captured in the formal database and grey literature searches.

Study Selection

In accordance with recommendations from the Cochrane Methods Group and World Health Organization Alliance for Health Policy and Systems Research, the titles and abstracts of all retrieved items will be reviewed by one of two independent researchers (CO, KM) with a third, independent researcher (KS) serving as duplicate reviewer for a random 25% sample of all

references[6,7]. Eligibility criteria varies such that the relevance of studies is determined by the research question to which they pertain. For the first question on how surgical resources have been allocated we will include any study that examines or discusses organization of surgical resources and patients during COVID-19 or other public health emergency (i.e., triage criteria, allocation of hospital resources if they include surgery, PPE for the operating room staff). To address the second question – consequences of reorganizing surgical resources- we will include any studies that examine patient- and/or system-level surgical outcomes during COVID-19 or other public health emergencies (i.e., adverse events, length of stay, ICU admissions). Lastly, to determine how resources have been organized to resume non-urgent surgical services we will include any study that examines resuming surgical services after COVID-19 or another public health emergency.

Full texts of studies not excluded in the title and abstract phase will then be reviewed in duplicate by the same researchers to ensure applicability to any of the research questions. Any articles identified as meeting the pre-specified eligibility criteria at this stage will be included in the final review. Interrater agreement on inclusion for the 25% sample of titles and abstracts reviewed in duplicate as well as the full texts will be measured with a Cohen's kappa (κ) statistic and corresponding 95% confidence interval. At all stages of the review an unbiased third party will be available to resolve any sustained disagreements between reviewers. The full study selection process including reasons for full text exclusions will be reported using a Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram[8].

Outcomes of Interest

Study information will be collected to answer the research questions of steps taken to respond to emergencies and rebuild capacity (see data extraction section below), but these questions are not outcome oriented and as such specific outcomes data for these questions will not be collected. However, the second research question surrounding the consequences of altering non-urgent surgical programming will require the collection of both quantitative and qualitative outcomes in order to provide the desired holistic understanding of impacts. Specifically, we will assess patient-level outcomes including the incidence of adverse events (i.e., negative event leading to patient harm and caused by management (or lack thereof) rather than the underlying condition of the patient), mortality, and quotes discussing emotional and psychological impacts of delays. We will also evaluate impacts on the healthcare system using measures of resource utilization such as number of emergency department visits, number of visits to a healthcare provider, length of hospital or ICU stay, as well as qualitative statements from practitioners and hospital administrators.

Data Extraction

Any relevant study and outcome data will be extracted from included studies by one researcher using a standardized data abstraction form. For all studies this form will guide the collection of information including date of publication, country where study was conducted, study design, definition of elective or non-urgent surgery, and characteristics of study sample (if applicable). The data extraction form is also designed to collect information specific to each of the three research questions such as selected surgical triage criteria, patient and health system-level outcomes, and detailed emergency response plans. A second independent researcher will review all data abstraction forms to verify their completion and accuracy.

Study Quality (Risk of Bias) Assessment

This rapid review will aim to synthesize quantitative outcomes whenever possible but will largely involve scoping the available evidence on surgical service delivery during public heath emergencies. Given this broad aim and the decision to include all study designs, quality appraisal for the included studies is not feasible and will not performed.

Data Synthesis, Analysis and Reporting

Study and sample information will be described in a narrative review and summarized in a data table. We do not anticipate being able to conduct a meta-analysis of quantitative outcomes and will instead synthesize outcomes data qualitatively with support from descriptive statistics whenever possible. Any summary tables for outcomes will be stratified by the three research questions to maximize clarity. Any within-study comparisons (e.g., incidence of adverse events in patients with delayed versus non-delayed surgery) will be considered significant at a two-tailed p-value <0.05.

Ethics and Dissemination

This review will only include secondary data sources and as such there are no applicable ethical considerations. Following completion, this review will become an integral part of evidence-based guidelines to support decisions about allocating resources and organizing surgical care in the era of COVID-19 and during subsequent public health emergencies. The rapid review will also be submitted to peer-reviewed journals to reach the target audiences of patients, policy makers, practitioners and surgical program administrators.

Limitations

The rapidly evolving nature of surgical programming during the COVID-19 situation demands an equally rapid synthesis and dissemination of key evidence. A rapid review therefore supersedes a traditional systematic review, but with this decision come methodological limitations. First, it is possible that much of the identified evidence emerges from non-traditional sources and grey literature and as a result, may be of a lower methodological quality than that from peer-reviewed sources. However, the goal of this review is not to evaluate quantitative outcomes at potential risk of bias but to instead collate the diversity of available information from surgical programs worldwide to inform decision-making. As such the potential negative impacts of lower study quality are of less concern. Secondly, the landscape of evidence specific to COVID-19 changes daily. While the selection of a set date for literature search is important for reporting and review reproducibility, it may lead to the omission of relevant information released beyond this date. We believe, however, that a current date selected for the literature search will span a period of time where some countries are in the process of recovering their surgical services while others remain in the throes of the pandemic. This will maximize the chances that sufficient evidence to answer all research questions is up to date and available.

CONCLUSION

This paper describes the methodology for a planned rapid review that will synthesize evidence on the changes to, impacts of, and recovery of non-urgent surgical service delivery during COVID-19 and other public health emergencies. As post-pandemic normalcy begins to return and non-urgent surgeries resume, the evidence from this review will inform

recommendations for allocating and organizing care while mitigating any potential negative impacts resulting from changes in service delivery.

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Appendices

Appendix A: Ovid MEDLINE Electronic Search Strategy

Database: Ovid MEDLINE (R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily <1946 to May 08, 2020>

Search Strategy:

1 exp Disease Outbreaks/ (96117)
2 (pandemic* or epidemic* or outbreak* or out break*).mp. (230774)
3 1 or 2 (231940)
4 exp Coronavirus (13456)
5 coronavirus infections/ or severe acute respiratory syndrome/ (11068)
6 Coronaviridae Infections/ (900)
7 coronaviridae/ or coronavirus/ (3916)
8 Influenza a virus, h1n1 subtype/ or Influenza a virus, h3n2 subtype/ or influenza a virus, h5n1 subtype/ (22141)
9 Hemorrahagic Fever, Ebola/ (5316)
10 SARS Virus/ (3038)
11 Middle East Respiratory Syndrome Coronavirus/ (1034)
12 (pneumonia.mp. or exp pneumonia/) and Wuhan.mp. (661)
13 (coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV or h1n1 or h3n2 or h5n1 or avian influenza or avian flu or swine influenza or swine flu or SARS or ebola* or middle east respiratory syndrome or MERS).mp. (77950)
14 (wuhan) adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV).mp. (190)
15 (coronavir*) adj2 (infection*).mp. (8441)
16 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 (79915)
17 General Surgery/ (38626)
18 Orthopedic Procedures/ (25371)
19 Traumatology/ (3474)
20 Neurosurgery/ (14892)
21 Obstetrics/ (22533)
22 Anesthesia/ (62587)
23 surgical procedures, operative/ or exp elective surgical procedures/ (68085)
24 exp Arthroplasty, Replacement/ (54362)
25 (general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anesthesia or anaesthesia).mp. (748651)
26 (surger* or operation* or procedure*).mp. (3638036)
27 ((elective or non-urgent) adj2 (surg* or procedure*)).mp. (31794)
28 (surg* adj2 (procedure* or planning or triage or operation* or resource* or backlog or re-organiz* or postpone* or cancel* or capacit* or wait time*)).mp. (444474)
29 ((clinic* or hospital) adj2 (process* or procedure* or triage or planning or performance* or capacit*)).mp. (69185)

30 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 (4101483)
31 3 and 16 and 30 (2075)

Appendix B: Grey Literature Search Plan

GREY LITERATURE SEARCH PLAN

Developed in reference to Guide from the University of Toronto (Stapleton, Fuller & Lenton)

STEP 1) Targeted Website Browsing. Will be using any combination of standard terms "coronavirus" OR "Covid-19" OR "Surgery" OR "non-urgent surgery" OR "elective surgery" OR "guidelines")

NON-GOVERNMENT GROUPS

World Health Organization (https://www.who.int)
Center for Disease Control and Prevention (https://www.cdc.gov)
European Centre for Disease Prevention and Control (https://www.ecdc.europa.eu/en)

GOVERNMENTS/HEALTH SYSTEMS

Canada (https://www.canada.ca/en.html)

- BC (https://www2.gov.bc.ca/gov/content/home)
- AB (https://www.alberta.ca/index.aspx)
- SK (https://www.saskatchewan.ca)
- MB (https://www.gov.mb.ca)
- ON (https://www.ontario.ca/page/government)
- QC (https://www.quebec.ca/en/)
- NB (https://www2.gnb.ca)
- NS (https://beta.novascotia.ca)
- NL & LB (https://www.gov.nl.ca)
- PEI (https://www.princeedwardisland.ca/en)
- Yukon (https://yukon.ca)
- NWT (https://www.gov.nt.ca)
- Nunavut (https://www.gov.nu.ca)

Australia (https://www.australia.gov.au)
Italy (http://www.governo.it)
Singapore (https://www.gov.sg)
China (https://www.gov.cn/english/)
USA (https://www.usa.gov)

GENERAL SURGICAL GROUPS/COLLEGES

Royal College of Physicians and Surgeons of Canada (http://www.royalcollege.ca)
American College of Surgeons (https://www.facs.org)
European Surgical Association (https://www.europeansurgicalassociation.org)

College of Surgeons, Singapore (https://www.ams.edu.sg/colleges/CSS/home)
French Surgical Association
German Society of Surgery (https://www.dgch.de/index.php?id=118)
Italian Society of Surgery (SIC) and Italian Association of Hospital Surgeons (ACOI)
Philippine College of Surgeons (https://www.pcs.org.ph)
Royal Australasian College of Surgeons (https://www.surgeons.org)
Royal College of Surgeons of England (https://www.rcseng.ac.uk)
Royal College of Surgeons of Ireland (https://www.rcsi.com/dublin/)
Spanish Society of Surgery (Associacion Espanola de Cirujanos) (https://www.aecirujanos.es)
Swedish Surgical Society (http://www.svenskkirurgi.se)
The Association of Surgeons of South Africa (http://www.surgeon.co.za)
The Pan African Association of Surgeons (http://www.africansurgeons.com)

STEP 2) Advanced Google Searching. Targeting above sites will assess 5 pages of Google Search past last click. Will be using standard and consistent terms “coronavirus” OR “Covid-19” OR “Surgery” OR “non-urgent” OR “guidelines”)

STEP 3) General Search Engine (Google) Search with same terms as above, assessing 5 pages past last click for relevance.

STEP 4) Contact with Knowledge Experts.

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	Page 1: Title
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	Page 3: Abstract
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	Pages 5,6: Introduction
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	Page 6: Introduction
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	Not registered given rapid nature of review.
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	Page 8: Methods- Study Eligibility
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	Page 6: Methods- Search Strategy
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Appendix A
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	Pages 7.8: Methods- Study Selection
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	Page 9: Methods- Data Extraction
Data items	11	List and define all variables for which data	Page 9: Methods-

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
		were sought and any assumptions and simplifications made.	Outcomes of Interest
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	Page 10: Methods- Study Quality (ROB) Assessment
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	Page 10: Methods- Data Synthesis, Analysis and Reporting
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Pages 10,11: Results- Search Results & Figure 1: PRISMA Flow chart
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Page 11: Results- Description of Studies & Table 1 (Individual) & Figure 2 (Summary)
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Table 1
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	Pages 11-16: Results- Reorganization of Surgical Services & Impact of Reorganizing Surgical Services & Rebuild Surgical Capacity
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	Pages 16 to 18: Discussion
Limitations	20	Discuss the limitations of the scoping review process.	Page 18, 19: Discussion
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	Page 19: Discussion
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	NA

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.
* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).
‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

BMJ Open

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

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

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Keywords: public health emergency, surgical services, healthcare resource utilization, health services

ABSTRACT ***(278/300 words)***

Objectives: To understand how surgical services have been reorganized during and following public health emergencies, and the consequences of these changes for patients, healthcare providers and healthcare systems.

Design: A rapid scoping review.

Setting: We searched the MEDLINE and Embase online academic, and conducted a grey literature sources for documents, memos, and press releases from governments and surgical organizations 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. Recommendations and guidelines were excluded.

Primary and secondary outcome measures: Primary outcomes were strategies implemented for the reorganization of surgical services. Secondary were the impacts of reorganization 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 reorganization of surgical services, 55 described the consequences of reorganizing surgical

services and six reported actions taken to rebuild surgical capacity in public health emergencies. Reorganizations of surgical services were grouped under 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. Service reorganizations led to large reductions in non-urgent surgical volumes, increases in surgical wait times, and impacted medical training (i.e., reduced case involvement) and patient outcomes (e.g., 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: Reorganization 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 optimize future health system responses to public health emergencies.

ARTICLE SUMMARY

Strengths and limitations of the 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 1.9M fatalities.[1] To protect the most vulnerable in our societies, efforts to curb further escalation (e.g., travel restrictions, 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 maximize staff, PPE, ventilators, and intensive care unit (ICU) capacity in case public health efforts to 'flatten the curve' are insufficient. Most notably, surgical programs have suspended non-urgent (or 'elective') surgical procedures. Non-urgent surgeries are often defined as procedures for which a delay of three months or longer would not result in significant adverse effects to the patient.[2 3] These changes have thrust patients, providers, and healthcare organizations 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 programs should operationalize the recommendations. As such, approaches to surgical triage and service delivery remain unclear: who has done what where, and why? Further, the impacts of adopting these recommendations on surgical programs, and more importantly, the physical and psychological well-being of patients and healthcare providers have only been hypothesized.[4] Lastly, once COVID-19 begins to release its grip on the world and the post-pandemic recovery begins, programs 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 (i.e., H1N1, Ebola, SARS) is needed to guide approaches to surgical service delivery.

To enable evidence-informed reorganization 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 aim was to understand how surgical services were reorganized in response to the first wave of COVID-19 and other public health emergencies; how reorganization impacted patients, healthcare providers, and health systems; and what approaches have been taken to resume surgical service delivery.

METHODS

Study Design

This scoping review followed the Joanna Briggs Institute methodology and Preferred Reporting Items for Systematic reviews and Meta-Analysis extension for Scoping Reviews (PRISMA-ScR) 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 World Health Organization 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. Further, 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 questions: 1) How have surgical services been reorganized in response to public health emergencies? 2)

What are the patient-, healthcare provider-, and system-level consequences of reorganizing surgical services? and 3) What approaches were used for resuming surgical services?

Search Strategy

The search strategy was developed by two investigators (CO, KS) and refined by others with context expertise in surgery and literature review methodology (JNK, AKR). The search strategy included subject headings, keywords, and synonyms identifying public health emergencies in general and specific public health emergencies (Ebola, SARS-CoV1, H1N1, MERS), and surgery; and were tailored for each database (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 May 8, 2020. Anticipating pertinent information may not be published (i.e., 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 (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 standardized data abstraction form (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) reorganization of surgical services, 2) impact of reorganizing 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 (e.g., emergency tracheostomy, caesarean section), settings beyond in-patient acute care (e.g., 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 standardized data abstraction form (Appendix B). Data included: date of publication, country, study design, definition of non-urgent surgery, characteristics of study sample (if applicable), outcomes of interest for the three research questions, detailed below.

Outcomes of Interest

Our primary outcomes were reorganization of surgical services, impact of reorganization 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, conceptualized 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 reorganization of surgical services was organized 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 was 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 summarize quantitative outcomes. We characterized and mapped the available emerging evidence using a narrative approach. We employed inductive thematic analysis, whereby themes were allowed to develop, to aid in characterizing the evidence. Data were synthesized 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.

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 six 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), orthopedics (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.

Reorganization of Surgical Service

A number of themes emerged from the 108 studies describing reorganization of surgical services. Nearly all studies reported partial, with most reporting full cessation of non-urgent surgeries at their centre, albeit with varying definitions of "non-urgent" (e.g., can be safely

postponed for 3 months) and "urgent" (e.g., 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.

1. 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 (e.g., patient characteristics, acuity, imaging) to a larger group representing many surgical specialties to reach consensus on each case.

2. 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 post-operative suture or staple removal were granted in-person visits under strict

conditions including mask wearing, negative symptom check, history or temperature pre-screening. 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 not only follow-up with returning patients but to also 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.

3. 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 (i.e. corridors, 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 Reorganizing 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 summarized below with data for all studies relevant to this question shown in 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 program) reported a 500% increase in latency

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 prioritization.[31] Among studies that changed their surgical triage practices, patients were prioritized for surgery based on procedure acuity or urgency (i.e., 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 Room) ORs, PPE, and testing was necessary to prepare for a large and complicated surgical backlog.

DISCUSSION

This review identified over 3,000 evidence sources, 132 of which were included. Approaches to reorganizing surgical services varied between studies and centers, 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 wellbeing or changes in healthcare utilization 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 centers 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 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 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 pre-public 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 organizing 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 wellbeing 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 World Health Organization and Cochrane's guidance on conducting rapid reviews,[7 8] with the intent of balancing rigor 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 re-running 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- or middle-income countries who may face unique challenges during a pandemic compared to 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 organizations 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 which 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 which 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 (Appendix D).

Author Contributions

CO contributed to the design and conceptualization of the review, analysis and interpretations of the data, and drafting and revising the manuscript; JSN contributed to the design of the review, interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; AKR contributed to the design of the review, interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; JCD contributed to the interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; JW contributed to the interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; JR contributed to the interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; MB contributed to the interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; KMS contributed to the design and conceptualization of the review, analysis and interpretations of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript.

Competing interest statement

All authors declare that they have no competing interests in accordance with the International Committee of Medical Journal Editors uniform declaration of competing interests.

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Data Sharing Statement

All data presented have been previously published. Our data will be made available upon reasonable request to the corresponding author.

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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
Alverez-Gallego	2020	Spain	COVID-19	General			
Ammar	2020	USA	COVID-19	Neurosurgery			
Amparore	2020	Italy	COVID-19	Urology		Changes in clinical and surgical resident involvement	
Ansarin	2020	Italy	COVID-19	Oncology (Head & 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	Orthopedics			
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	2020	USA	COVID-19	Orthopedics		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	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	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		
Chee	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 & Neck)		Number of surgical cancellations
D'Apolito	2020	Italy	COVID-19	Orthopedics		Changes in surgical volume
de Vries	2020	Netherlands	COVID-19	Transplant		Changes in transplantation volumes
Ding	2020	Singapore	COVID-19	Orthopedics		
Dominguez-Gil	2020	Spain	COVID-19	Transplant		Changes in transplantation volumes
Doussot	2020	France	COVID-19	Oncology		Changes in surgical volume
Dowdell	2020	USA	COVID-19	Orthopedics		
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	2020	Italy	COVID-19	Neurosurgery		Changes in surgical volume
Fontanella	2020	Italy	COVID-19	Neurosurgery		
Giorgi	2020	Italy	COVID-19	Spinal		
Givi	2020	USA	COVID-19	Oncology (Head & Neck)		Changes in fellow educational programming
Gomez-Barrena	2020	Spain	COVID-19	Orthopedics		Changes in surgical volume
Gouveia	2020	Portugal	COVID-19	Vascular		
Guerci	2020	Italy	COVID-19	General		
Gupta	2020	India	COVID-19	Oncology (Head & Neck)		
Haines	2003	China	SARS	Obstetrics		
Hemingway	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	Orthopedics		
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	2020	Italy	COVID-19	Transplant		Changes in transplantation volumes	
Lee	2020	China	COVID-19	Oncology (Head & Neck)		Changes in surgical wait times	
Leong Tan	2020	Singapore	COVID-19	Vascular			
Li	2020	China	COVID-19	Transplant			
Liebensteiner	2020	Austria	COVID-19	Orthopedics			
Liu	2003	Singapore	SARS	Anesthesia			
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	—			Prioritization first of patients who would be at increased risk with further delay, followed by those waiting longest
Meneghini	2020	USA	COVID-19	Orthopedics			
Meyer	2020	France	COVID-19	Neurosurgery		Changes in surgical volume	
Morgan	2020	UK	COVID-19	Orthopedics			
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 & Neck)			
Patel	2020	USA	COVID-19	Otolaryngology			
Pelt	2020	USA	COVID-19	Orthopedics		Number of surgical postponements	Surgeries prioritized based on complexity and predicted LOS, scheduling only completed if appropriate PPE and screening available.
Pittet	2020	Switzerland	COVID-19	—		Changes in surgical volume	
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 & Neck)		Changes in surgical volume	
Randelli	2020	Italy	COVID-19	Orthopedics			
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	Orthopedics			
Schull	2007	Canada	SARS	—		Changes in surgical volume	
Schwarzkopf	2020	USA	COVID-19	Orthopedics			
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	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	Anesthesia			
Tan	2020	Singapore	COVID-19	Urology		Changes in surgical and consultation volumes	
Tan	2020	China	COVID-19	Neurosurgery			
Tay	2020	Singapore	COVID-19	Orthopedics		Changes in surgical volumes	
Tay	2020	Singapore	COVID-19	Orthopedics			
Thaler	2020	Austria	COVID-19	Orthopedics			
Tolone	2020	Italy	COVID-19	—			
Too	2020	Singapore	COVID-19	Interventional Radiology			
Topf	2020	USA	COVID-19	Oncology (Head & Neck)			
Tsui	2005	China	SARS	Cardiac			
Tzeng	2020	USA	COVID-19	Oncology			
Unal	2020	Turkey	COVID-19	Vascular			
Vaccaro	2020	USA	COVID-19	Orthopedics		Changes in physician remuneration and staffing	
Valenza	2020	Italy	COVID-19	Oncology		Changes in surgical volumes	
van de Haar	2020	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	2020	Italy	COVID-19	Oncology (Breast)		Changes in surgical volumes	
Vlantis	2004	China	SARS	Otolaryngology		Changes in outpatient and surgical volumes	
Walker	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	Anesthesia	■■■■	
Wu	2020	China	COVID-19	Oncology (Head & Neck)	■■■■■■	
Xiaolei	2020	China	COVID-19	Ophthalmology		
Zangrillo	2020	Italy	COVID-19	—	■■■■■	
Zarzaur	2020	USA	COVID-19	—	■■■	
Zeng	2020	China	COVID-19	Oncology (Head & Neck)	■■■■	
Zizzo	2020	Italy	COVID-19	—	■■	
Zoia	2020	Italy	COVID-19	Neurosurgery	■■■■	

Domains of change to surgical services, represented numerically:
■ Changes to case selection and surgical triage
■ Changes to PPE protocols and practices
■ Changes to the surgical workforce.
■ Changes to inpatient and outpatient care
■ Changes to resident and fellow education
■ Changes to the environment

Abbreviations: — =data not provided, COVID-19=Coronavirus Disease 2019, ED=Emergency department, GI=Gastrointestinal; LOS=Length of stay, PPE=Personal protective equipment, SARS=Severe Acute Respiratory Syndrome

Table 2. Reorganization of surgical services, by domain.

Change Domain	Number of Studies (%)	Examples of Change
Triage or Case Selection	80 (74.7)	1. Prioritization of patients based on pre-defined levels of acuity; 2. Virtual multidisciplinary meetings or tumor 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 (i.e., 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 (e.g., 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 (e.g., 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 maximize 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 (e.g., only admitted to OR during low-risk/non-aerosolizing procedures).
Environment	70 (64.8)	1. Dedication of wards (hallways, 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 (e.g., cubicles, distanced waiting room chairs) implemented.

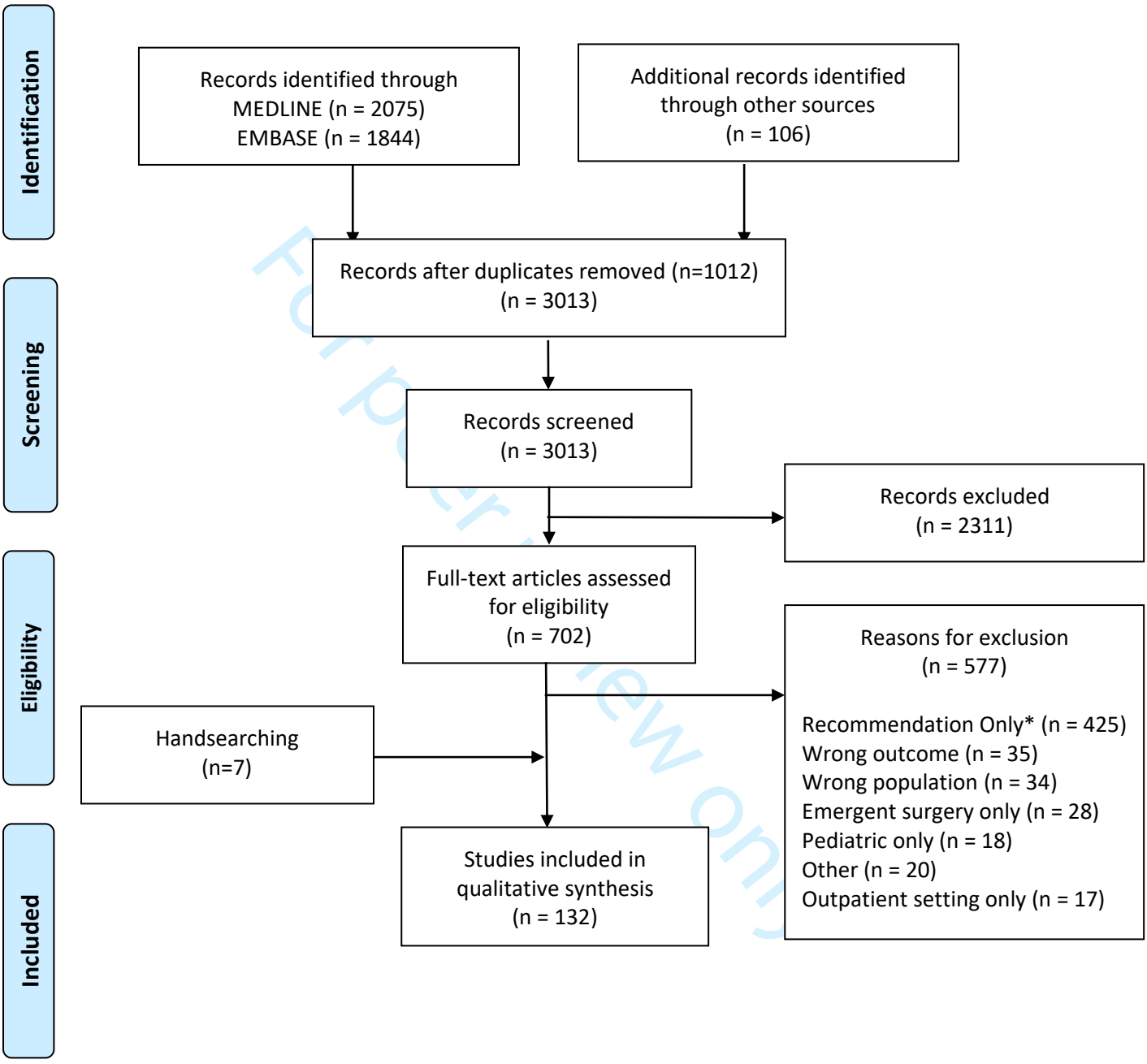
Abbreviations: ICU= Intensive care unit, PPE= Personal protective equipment, PAPR= Powered air purifying respirator, OR= Operating room.

Figure 1. PRISMA Flow diagram.

Figure 2. Summary of study characteristics.

Figure 3. Summary of leading impacts of changes to surgical programming

Figure 1. Flow of studies in the scoping review



*Includes guidelines, recommendation-based reviews, projections or estimations without mention of true changes to surgical programming.

Figure 2. Study characteristics

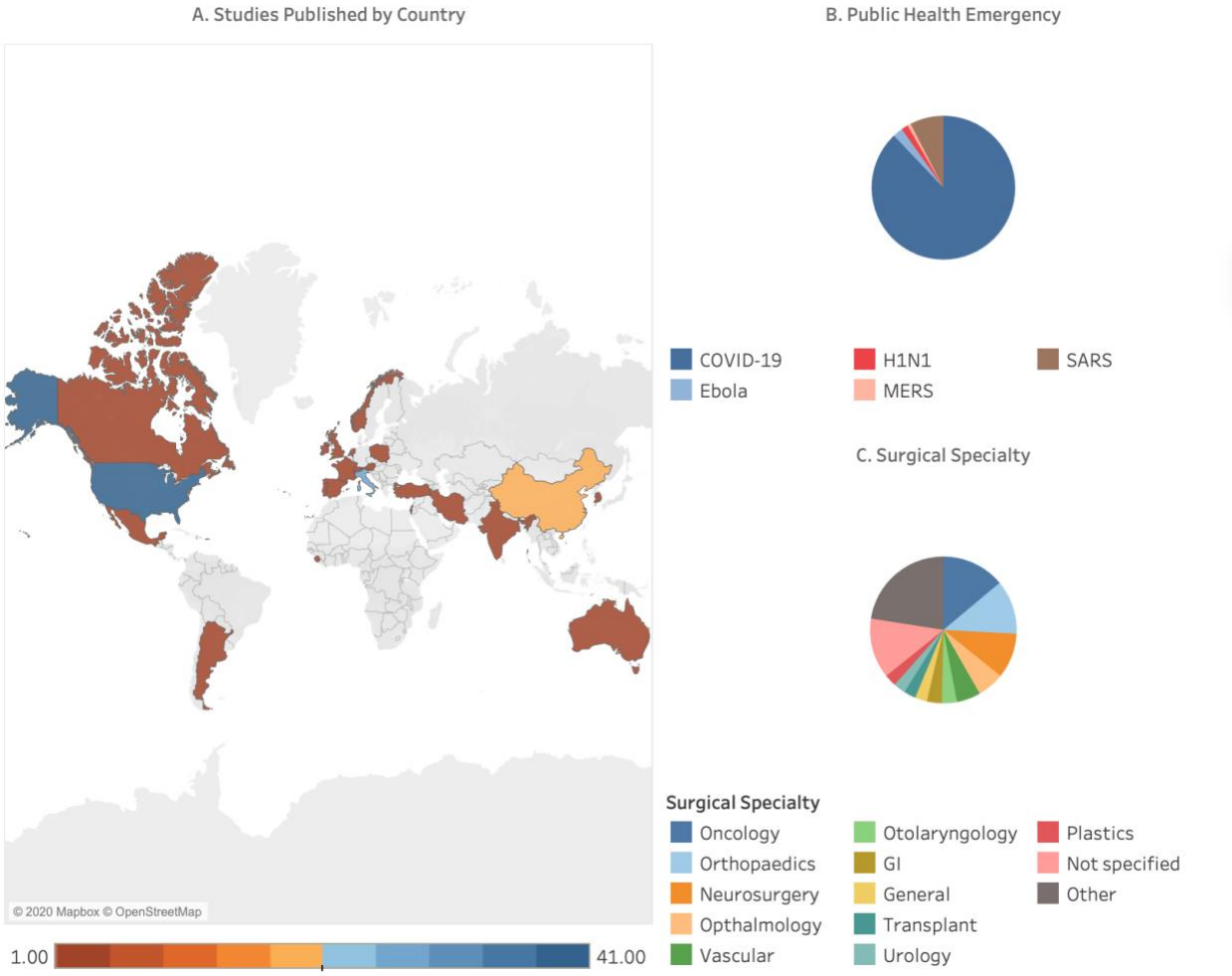


Figure 2. **A.** Country of publication, **B.** Public health emergency discussed, and **C.** Surgical specialty addressed ('Other' includes Cardiac (n=3), Anesthesia (n=3), Electrophysiology (n=3), Obstetrics and Gynecology (n=3), Thoracic (n=2), Interventional Radiology (n=1), and Dermatology (n=1)).

Figure 3. Summary of the impacts of alterations to surgical services

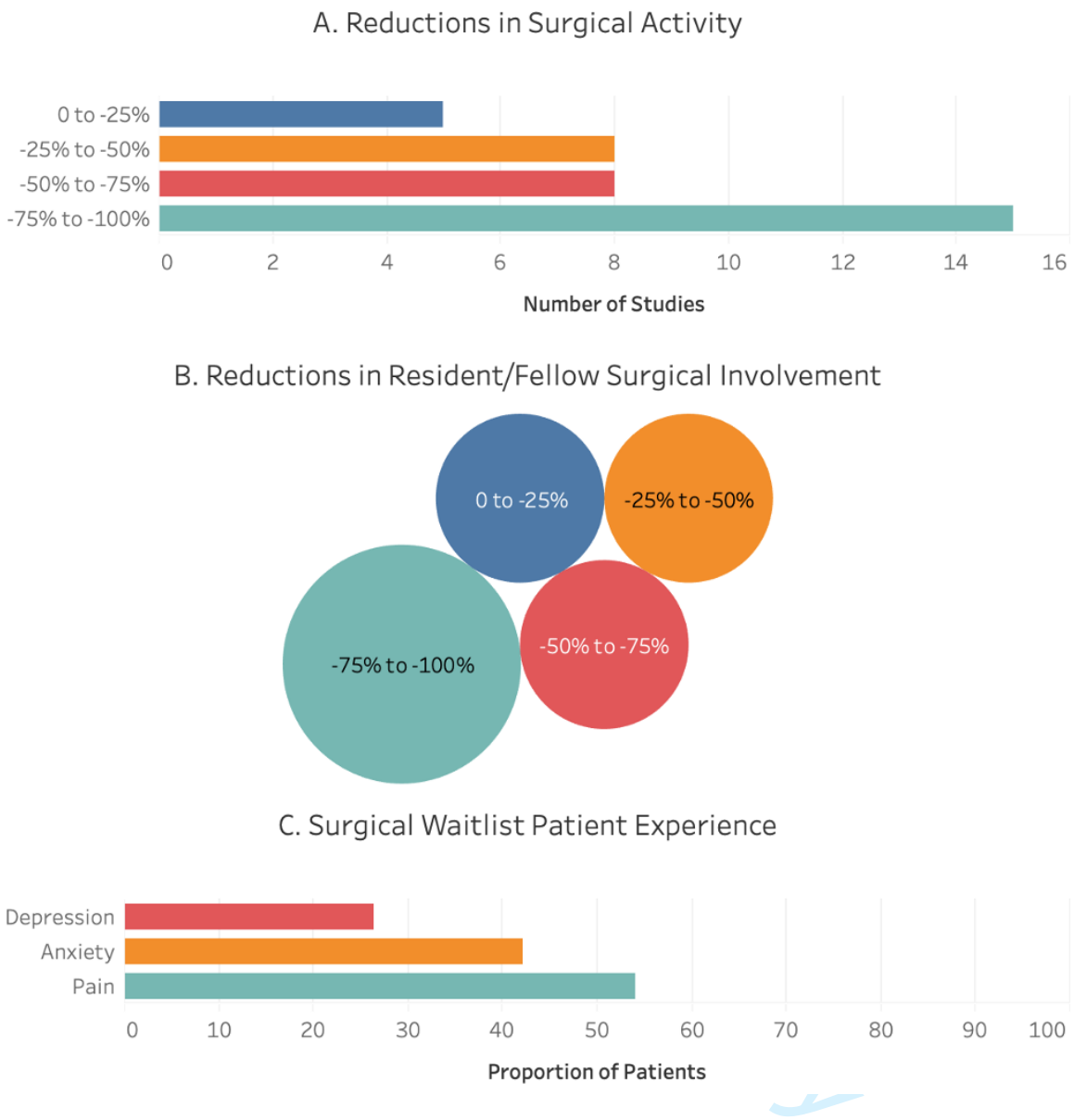


Figure 3. A summary of the impacts of alterations to surgical services during public health emergencies on **A.** Overall surgical activity (n=37 studies), **B.** Resident and fellow involvement in surgery (n=5 studies) where circle size represents the number of studies contributing to that quartile, and **C.** Patient experience (n=2 studies).

Appendix A. Search Strategy

Database: Ovid MEDLINE (R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily <1946 to May 08, 2020>

Search Strategy:

1 exp Disease Outbreaks/ (96117)
2 (pandemic* or epidemic* or outbreak* or out break*).mp. (230774)
3 1 or 2 (231940)
4 exp Coronavirus (13456)
5 coronavirus infections/ or severe acute respiratory syndrome/ (11068)
6 Coronaviridae Infections/ (900)
7 coronaviridae/ or coronavirus/ (3916)
8 Influenza a virus, h1n1 subtype/ or Influenza a virus, h3n2 subtype/ or influenza a virus, h5n1 subtype/ (22141)
9 Hemorrahagic Fever, Ebola/ (5316)
10 SARS Virus/ (3038)
11 Middle East Respiratory Syndrome Coronavirus/ (1034)
12 (pneumonia.mp. or exp pneumonia/) and Wuhan.mp. (661)
13 (coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV or h1n1 or h3n2 or h5n1 or avian influenza or avian flu or swine influenza or swine flu or SARS or ebola* or middle east respiratory syndrome or MERS).mp. (77950)
14 (wuhan) adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV).mp. (190)
15 (coronavir*) adj2 (infection*).mp. (8441)
16 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 (79915)
17 General Surgery/ (38626)
18 Orthopedic Procedures/ (25371)
19 Traumatology/ (3474)
20 Neurosurgery/ (14892)
21 Obstetrics/ (22533)
22 Anesthesia/ (62587)
23 surgical procedures, operative/ or exp elective surgical procedures/ (68085)
24 exp Arthroplasty, Replacement/ (54362)
25 (general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anesthesia or anaesthesia).mp. (748651)
26 (surger* or operation* or procedure*).mp. (3638036)
27 ((elective or non-urgent) adj2 (surg* or procedure*)).mp. (31794)
28 (surg* adj2 (procedure* or planning or triage or operation* or resource* or backlog or re-organiz* or postpone* or cancel* or capacit* or wait time*)).mp. (444474)
29 ((clinic* or hospital) adj2 (process* or procedure* or triage or planning or performance* or capacit*)).mp. (69185)
30 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 (4101483)
31 3 and 16 and 30 (2075)

Database: EMBASE <1974 to 2020 May 08>

Search Strategy:

1	exp epidemic/ (103292)
2	exp pandemic/ (12990)
3	1 or 2 (114458)
4	pandemic influenza/ (4748)
5	exp severe acute respiratory syndrome/ (8505)
6	exp coronaviridae/ or coronaviridae infection/ (14928)
7	coronavirinae/ (2093)
8	Coronavirus infection/ (3397)
9	avian influenza virus/ or "influenza a virus (h1n1)"/ or "influenza a virus (h3n2)"/, "influenza a virus (h5n1)"/ (7466)
10	Ebola hemorrhagic fever/ (5712)
11	exp SARS coronavirus/ (5823)
12	Middle East respiratory syndrome/ (935)
13	(pneumonia.mp. or exp pneumonia/) and Wuhan.mp. (512)
14	(coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV).mp. (92353)
15	(wuhan adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV)).mp. (161)
16	(coronavir* adj2 infection*).mp. (4793)
17	4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 (96712)
18	general surgery/ (15070)
19	orthopedic surgery/ (32672)
20	traumatology/ (10653)
21	neurosurgery/ (59847)
22	obstetrics/ (34886)
23	anesthesiological procedure/ (1785)
24	elective surgery/ (34038)
25	replacement arthroplasty/ or exp arthroplasty/ (73583)
26	(general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anaesthesia or anesthesia).mp. (966732)
27	(surger* or operation* or procedure*).mp. (5402047)
28	((elective or non-urgent adj2 (surg* or procedure*)).mp. (52808)
29	(surg* adj2 (procedure* or planning or triag* or operation* or resource* or backlog or re-organiz* or postpon* or cancel* or capacit* or wait time*)).mp. (187480)
30	((clinic* or hospital) adj2 (process* or procedure* or triag* or planning or performance* or capacit*)).mp. (83715)
31	18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 (5948860)
32	3 and 17 and 31 (1844)

Database	Pandemic terms Pandemic, epidemic	Disease terms COVID-19, SARS, MERS, pandemic flu (h1n1, h3n2, h5n1), ebola	Surgical terms Non-urgent/elective surgery (general, orthopedic, anesthesia, trauma, neurosurgery, obstetrics)
MEDLINE	exp Disease Outbreaks/ OR (pandemic* or epidemic* or outbreak* or out break*).mp.	exp Coronavirus OR coronavirus infections/ or severe acute respiratory syndrome/ OR Coronaviridae Infections/ OR coronaviridae/ or coronavirus/ OR Influenza a virus, h1n1 subtype/ or Influenza a virus, h3n2 subtype/ or influenza a virus, h5n1 subtype/ OR Hemorrahagic Fever, Ebola/ OR SARS Virus/ OR Middle East Respiratory Syndrome Coronavirus/ OR (pneumonia.mp. or exp pneumonia/) and Wuhan.mp. OR (coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV or h1n1 or h3n2 or h5n1 or avian influenza or avian flu or swine influenza or swine flu or SARS or ebola* or middle	General Surgery/ OR Orthopedic Procedures/ OR Traumatology/ OR Neurosurgery/ OR Obstetrics/ OR Anesthesia/ OR surgical procedures, operative/ or exp elective surgical procedures/ OR exp Arthroplasty, Replacement/ OR (general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anesthesia or anaesthesia).mp. OR (surger* or operation* or procedure*).mp. OR ((elective or non-urgent) adj2 (surg* or procedure*)).mp. OR (surg* adj2 (procedure* or planning or triage or operation* or resource* or backlog or re-organiz* or postpone* or cancel* or capacit* or wait time*)).mp.

		east respiratory syndrome or MERS).mp. OR (wuhan) adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV).mp. OR (coronavir*) adj2 (infection*).mp.	OR ((clinic* or hospital) adj2 (process* or procedure* or triage or planning or performance* or capacit*)).mp.
EMBASE	exp epidemic/ OR exp pandemic/	pandemic influenza/ OR exp severe acute respiratory syndrome/ OR exp coronaviridae/ or coronaviridae infection/ OR coronavirinae/ OR Coronavirus infection/ OR avian influenza virus/ or "influenza a virus (h1n1)"/ or "influenza a virus (h3n2)"/, "influenza a virus (h5n1)"/ OR Ebola hemorrhagic fever/ OR exp SARS coronavirus/ OR Middle East respiratory syndrome/ OR (pneumonia.mp. or exp pneumonia/) and Wuhan.mp. OR (coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV).mp. OR	general surgery/ OR orthopedic surgery/ OR traumatology/ OR neurosurgery/ OR obstetrics/ OR anesthesiological procedure/ OR elective surgery/ OR replacement arthroplasty/ or exp arthroplasty/ OR (general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anaesthesia or anesthesia).mp. OR (surger* or operation* or procedure*).mp. OR ((elective or non-urgent adj2 (surg* or procedure*)).mp. OR (surg* adj2 (procedure* or planning or triag* or operation* or resource* or backlog or re-organiz* or postpon* or cancel* or

		(wuhan adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV)).mp. OR (coronavir* adj2 infection*).mp.	capacit* or wait time*)).mp. OR ((clinic* or hospital) adj2 (process* or procedure* or triag* or planning or performance* or capacit*)).mp.

GREY LITERATURE SEARCH PLAN

Developed in reference to Guide from the University of Toronto (Stapleton, Fuller & Lenton)

STEP 1) Targeted Website Browsing. Will be using any combination of standard terms "coronavirus" OR "Covid-19" OR "Surgery" OR "non-urgent surgery" OR "elective surgery" OR "guidelines")

NON-GOVERNMENT GROUPS

World Health Organization (https://www.who.int)
Center for Disease Control and Prevention (https://www.cdc.gov)
European Centre for Disease Prevention and Control (https://www.ecdc.europa.eu/en)

GOVERNMENTS/HEALTH SYSTEMS

Canada (https://www.canada.ca/en.html)

- BC (https://www2.gov.bc.ca/gov/content/home)
- AB (https://www.alberta.ca/index.aspx)
- SK (https://www.saskatchewan.ca)
- MB (https://www.gov.mb.ca)
- ON (https://www.ontario.ca/page/government)
- QC (https://www.quebec.ca/en/)
- NB (https://www2.gnb.ca)
- NS (https://beta.novascotia.ca)
- NL & LB (https://www.gov.nl.ca)
- PEI (https://www.princeedwardisland.ca/en)
- Yukon (https://yukon.ca)
- NWT (https://www.gov.nt.ca)
- Nunavut (https://www.gov.nu.ca)

Australia (https://www.australia.gov.au)
Italy (http://www.governo.it)
Singapore (https://www.gov.sg)
China (https://www.gov.cn/english/)
USA (https://www.usa.gov)

GENERAL SURGICAL GROUPS/COLLEGES

Royal College of Physicians and Surgeons of Canada (http://www.royalcollege.ca)
American College of Surgeons (https://www.facs.org)
European Surgical Association (https://www.europeansurgicalassociation.org)
College of Surgeons, Singapore (https://www.ams.edu.sg/colleges/CSS/home)
French Surgical Association
German Society of Surgery (https://www.dgch.de/index.php?id=118)
Italian Society of Surgery (SIC) and Italian Association of Hospital Surgeons (ACOI)
Philippine College of Surgeons (https://www.pcs.org.ph)
Royal Australasian College of Surgeons (https://www.surgeons.org)
Royal College of Surgeons of England (https://www.rcseng.ac.uk)
Royal College of Surgeons of Ireland (https://www.rcsi.com/dublin/)
Spanish Society of Surgery (Associacion Espanola de Cirujanos) (https://www.aecirujanos.es)
Swedish Surgical Society (http://www.svenskkirurgi.se)
The Association of Surgeons of South Africa (http://www.surgeon.co.za)
The Pan African Association of Surgeons (http://www.africansurgeons.com)

STEP 2) Advanced Google Searching. Targeting above sites will assess 5 pages of Google Search past last click. Will be using standard and consistent terms “coronavirus” OR “Covid-19” OR “Surgery” OR “non-urgent” OR “guidelines”)

STEP 3) General Search Engine (Google) Search with same terms as above, assessing 5 pages past last click for relevance.

STEP 4) Contact with Knowledge Experts.

Source and Site	Search Terms	Potentially Relevant Results
Health Groups		
World Health Organization (https://www.who.int, Advanced Search)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	10
Center for Disease Control and Prevention (https://www.cdc.gov)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	8
European Centre for Disease Prevention and Control (https://www.ecdc.europa.eu/en)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	3
Governments		
Government of Canada (https://www.canada.ca/en.html)	[contains all words] elective surgery covid	4

	[contains all words] non-urgent surgery covid	
Government of BC (https://www2.gov.bc.ca/gov)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	2
Government of AB (https://www.alberta.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	2
Government of SK (https://www.saskatchewan.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	6
Government of MB (https://www.gov.mb.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	4
Government of ON (https://www.ontario.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of QC (https://www.quebec.ca/en/)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of NB (https://www2.gnb.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of NS (https://beta.novascotia.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of NL & LB (https://www.gov.nl.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of PEI (https://www.princeedwardisland.ca)	[contains all words] elective surgery covid	2

	[contains all words] non-urgent surgery covid	
Government of Yukon (https://yukon.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of NWT (https://www.gov.nt.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of Nunavut (https://www.gov.nu.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of Australia (https://www.australia.gov.au)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of Italy (http://www.governo.it)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of Singapore (https://www.gov.sg)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of China ((https://www.gov.cn/english/)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
United States Government (https://www.usa.gov)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Surgical Colleges/Associations		
Royal College of Physicians and Surgeons of Canada (http://www.royalcollege.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0

American College of Surgeons (https://www.facs.org)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	23
European Surgical Association (https://www.europeansurgicalassociation.org)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
College of Surgeons, Singapore (https://www.ams.edu.sg)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	3
German Society of Surgery (https://www.dgch.de/index.php?id=118)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Philippine College of Surgeons (https://www.pcs.org.ph)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	11
Royal Australasian College of Surgeons (https://www.surgeons.org)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	12
Royal College of Surgeons of England (https://www.rcseng.ac.uk)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	7
Royal College of Surgeons of Ireland (https://www.rcsi.com/dublin/)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	8
Spanish Society of Surgery (Associacion Espanola de Cirujanos) (https://www.aecirujanos.es)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Swedish Surgical Society (http://www.svenskkirurgi.se)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0

The Association of Surgeons of South Africa (http://www.surgeon.co.za)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
The Pan African Association of Surgeons (http://www.africansurgeons.com)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
	Total	111

Appendix B. Data Abstraction Form

This form has been developed by adopting and customizing the 'Data collection form- RCTs and NRS' produced by The Cochrane Collaboration. Customization includes the addition of new sections, as well as the omission of sections not relevant to the review.

Notes on using data extraction form:

- Be consistent in the order and style you use to describe the information for each report.
- Record any missing information as unclear or not described, to make it clear that the information was not found in the study report(s), not that you forgot to extract it.
- Include any instructions and decision rules on the data collection form, or in an accompanying document. It is important to practice using the form and give training to any other authors using the form.

1. General Information

1. Date form completed (dd/mm/yyyy)	/ /
2. Name of person extracting data	☐ Connor M. ORielly ☐ Khara M. Sauro
3. Contact details of person extracting data	
4. Title of Article/Abstract (that data are extracted from)	
5. Study ID (plus surname of author and year of study publication)	
6. Study country of origin	
7. Study funding source	
8. Possible conflicts of interest	☐ Reported ☐ Not Reported
9. Notes:	

2. Eligibility

Study Characteristics	Inclusion Criteria	Location in text (page#/fig#/table#)
10. Type of study (design)	☐ Case Study ☐ Case Series ☐ Observational	

11. Population description		
12. Focused diseases/conditions		
13. Types of outcome measures		
14. Decision (with reasons for either inclusion or exclusion)	☐ Include ☐ Exclude If Exclude, explain:	
15. Notes		

IF STUDY IS EXCLUDED FROM REVIEW, DO NOT CONTINUE

2. Population and setting

	Description	Location in text (page#/fig#/table#)
16. Population description		
17. Source/setting of the population (e.g., urban, rural, ethnic group)		
18. Method(s) of recruitment of participants	☐ Random ☐ Non-Random Method:	
19. Notes:		

3. Methods

	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)

20. Aim of study		
21. Design (e.g., cross-sectional, RCT, CCT)	☐ Case Study ☐ Case Series ☐ Observational	
22. Sampling technique (e.g., random or convenience)	☐ Random ☐ Non-Random	
23. Study start date (dd/mm/yyyy)	/ /	
24. Study end date/duration (dd/mm/yyyy)	/ / **OR** Duration:	
25. Notes:		

4. Participants

	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
26. Total number of participants/Sample size		
27. Age		
28. Sex	☐ Both Sexes ☐ Males ☐ Females	
29. Genders Represented		
30. Country		
31. Predominant medical complaint		
32. Co-morbidities (if any)		
33. Definition of 'Frequent use' (if any)		

34. Notes:

5. Outcomes

Keep only the tables for outcomes relevant to this particular study, duplicate tables as necessary.

Outcome 1: Alterations to surgical programming (RQ1)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
35. Outcome definition		
36. Time points measured		
37. Domains of change	☐ Surgical triage ☐ PPE ☐ Workforce ☐ Patient care ☐ Environmental	
38. Unit of measurement	☐ Group ☐ Individual	
39. Notes:		

Outcome 2: Patient-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
40. Specify Outcome		
41. Outcome definition		
42. Time points measured		
43. Unit of Measurement	☐ Group ☐ Individual	
44. Unit of measurement		
45. Notes:		

Outcome 3: System-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
46. Specify Outcome		
47. Outcome definition		
48. Time points measured		
49. Unit of Measurement	☐ Group ☐ Individual	
50. Unit of measurement		
51. Notes:		

Outcome 4: Practitioner-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
52. Specify Outcome		
53. Outcome definition		
54. Time points measured		
55. Unit of Measurement	☐ Group ☐ Individual	
56. Unit of measurement		
57. Notes:		

Outcome 5: Alterations to rebuild capacity (RQ3)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
58. Outcome definition		
59. Time points measured		

60. Domains of change	☐ Surgical triage ☐ PPE ☐ Workforce ☐ Patient care ☐ Environmental	
61. Unit of measurement	☐ Group ☐ Individual	
62. Notes:		

6. Results and findings

Keep only the tables for outcomes relevant to this particular study, duplicate tables as necessary.

Outcome 1: Alterations to surgical programming (RQ1)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
63. Subgroup (if applicable, e.g., age/sex specific reporting)		
64. Results		
65. Response/non-response rate		
66. Unit of analysis (i.e., individual or group)		
67. Notes:		

Outcome 2: Patient-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
68. Subgroup (if applicable, e.g., age/sex specific reporting)		
69. Results		
70. Response/non-response rate		
71. Unit of analysis (i.e., individual or group)		
72. Notes:		

Outcome 3: System-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
73. Subgroup (if applicable, e.g., age/sex specific reporting)		
74. Results		
75. Response/non-response rate		
76. Unit of analysis (i.e., individual or group)		
77. Notes:		

Outcome 4: Practitioner-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
78. Subgroup (if applicable, e.g., age/sex specific reporting)		
79. Results		
80. Response/non-response rate		
81. Unit of analysis (i.e., individual or group)		
82. Notes:		

Outcome 5: Alterations to rebuild capacity (RQ3)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
83. Subgroup (if applicable, e.g., age/sex specific reporting)		
84. Results		
85. Response/non-response rate		
86. Unit of analysis (i.e., individual or group)		
87. Notes:		

Research Questions informed by this study ***(tick only boxes matching the outcome tables kept above)***

☐ Changes to surgical programming in response to public health emergency

☐ Impacts of changes to surgical programming
☐ Actions to rebuild surgical capacity post-public health emergency

7. Strengths, limitations and mitigation strategy

	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
88. Strengths		
89. Limitations		
90. Strategies to overcome limitations		
91. Notes:		

8. Conclusion and other information

	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
92. Key conclusions of study authors		
93. Notes:		

Appendix C. Complete list of references for included studies

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BACKGROUND

The novel coronavirus (COVID-19) has spread across the globe with unrelenting speed. At the time of writing over 4 million cases have been confirmed, among them more than 200,000 fatalities[1]. In addition to protecting those most vulnerable in our societies, efforts to curb further disease escalation (e.g., travel restrictions, physical distancing measures) have had a focal objective: prevent case surges that could overwhelm healthcare institutions or further aggravate existing shortages in personal protective equipment (PPE), ventilators, and hospital capacity.

Medical institutions have themselves also taken steps to maximize the availability of staff, PPE, ventilators and intensive care unit (ICU) capacity in the case that external 'curve flattening' practices are not sufficient. Most notably, surgical programs have suspended non-urgent (or elective) surgical procedures, often defined as procedures for which a delay of three (3) months or longer would not result in any significant adverse effect to the patient[2,3]. These changes span nearly all surgical specialties from oncology to orthopedics and have thrusted patients, providers and programs into previously unexplored territory.

While the governing bodies of surgical practice have recommended alterations to non-urgent surgical service delivery, they have not always provided explicit instructions on how programs should approach the change. As such, different groups have likely taken different approaches to surgical triage and service delivery and it remains unclear who has done what where, and why? Further, the impacts of postponing non-urgent surgeries on the physical, psychological, emotional and professional well-being of patients and practitioners are either anecdotal or unknown[4]. Lastly, as COVID-19 begins to release its grip on the world and a level of post-pandemic normalcy returns, programs will be tasked with rebuilding the surgical capacity necessary to reschedule and resume postponed procedures. Evidence on the experiences of other

groups doing so in the context of COVID-19 and other public health emergencies (i.e., H1N1, Ebola, SARS) will be paramount in guiding subsequent approaches.

To address the aforementioned knowledge gaps, we will conduct a rapid review of the literature to synthesize evidence on how surgical resources were allocated in response to COVID-19 and other public health emergencies, how these reallocations impacted patients, practitioners and broader health systems, and what approaches have been taken to rebuild, reorganize and resume surgical service delivery. This review will not only help explain how international surgical programs responded to this unprecedented emergency and what the consequences were, but will also provide the evidence-base necessary to guide responses to this current and any future pandemic event.

METHODS

Study Design

The planned review will answer three questions: (1) How have surgical resources been allocated in response to COVID-19, (2) What are the patient- and system-level consequences of reorganizing surgical resources, and (3) How have resources been reorganized to resume surgical services? We will focus on surgeries identified as "elective" or "non-urgent'. However, to avoid limiting study eligibility unnecessarily no set definition for this term will be used and we will instead report the definition used by each included study.

Search Strategy

An electronic search strategy was developed by the investigators (CO, KS) prior to being reviewed and refined by collaborators with context expertise in surgery and literature review

(JNK, AKR). The search strategy includes subject headings, keywords and synonyms identifying the public health emergencies of interest as well as the surgical specialties likely affected by COVID-19 (Appendix A). Headings and keywords were adapted for use in each database. Given the diversity of the research questions related to this review no study design or publication type constraints will be applied to the search. Further, since (by definition) the impacts of a pandemic span many countries, no language restrictions will be applied. However, to deliver on the study objectives in a timely fashion, studies not easily translated by members of the research team will be subsequently excluded from the review.

We will conduct comprehensive searches of Ovid MEDLINE (including Epub Ahead of Print, In-Process & Other Non-Indexed Citations) and EMBASE from database inception onwards. Since much of the information related to the questions of this review is likely unpublished (i.e., joint statements, recommendations and guidelines from surgical colleges) we will also complete a detailed grey literature search. An *a priori* designed plan for this search has been developed (Appendix B) and will follow methodological recommendations by including targeted website searching, advanced and general Google searching and contact with knowledge experts[5]. Further, the reference lists from all included studies will be examined for any additional relevant studies not captured in the formal database and grey literature searches.

Study Selection

In accordance with recommendations from the Cochrane Methods Group and World Health Organization Alliance for Health Policy and Systems Research, the titles and abstracts of all retrieved items will be reviewed by one of two independent researchers (CO, KM) with a third, independent researcher (KS) serving as duplicate reviewer for a random 25% sample of all

references[6,7]. Eligibility criteria varies such that the relevance of studies is determined by the research question to which they pertain. For the first question on how surgical resources have been allocated we will include any study that examines or discusses organization of surgical resources and patients during COVID-19 or other public health emergency (i.e., triage criteria, allocation of hospital resources if they include surgery, PPE for the operating room staff). To address the second question – consequences of reorganizing surgical resources- we will include any studies that examine patient- and/or system-level surgical outcomes during COVID-19 or other public health emergencies (i.e., adverse events, length of stay, ICU admissions). Lastly, to determine how resources have been organized to resume non-urgent surgical services we will include any study that examines resuming surgical services after COVID-19 or another public health emergency.

Full texts of studies not excluded in the title and abstract phase will then be reviewed in duplicate by the same researchers to ensure applicability to any of the research questions. Any articles identified as meeting the pre-specified eligibility criteria at this stage will be included in the final review. Interrater agreement on inclusion for the 25% sample of titles and abstracts reviewed in duplicate as well as the full texts will be measured with a Cohen's kappa (κ) statistic and corresponding 95% confidence interval. At all stages of the review an unbiased third party will be available to resolve any sustained disagreements between reviewers. The full study selection process including reasons for full text exclusions will be reported using a Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram[8].

Outcomes of Interest

Study information will be collected to answer the research questions of steps taken to respond to emergencies and rebuild capacity (see data extraction section below), but these questions are not outcome oriented and as such specific outcomes data for these questions will not be collected. However, the second research question surrounding the consequences of altering non-urgent surgical programming will require the collection of both quantitative and qualitative outcomes in order to provide the desired holistic understanding of impacts. Specifically, we will assess patient-level outcomes including the incidence of adverse events (i.e., negative event leading to patient harm and caused by management (or lack thereof) rather than the underlying condition of the patient), mortality, and quotes discussing emotional and psychological impacts of delays. We will also evaluate impacts on the healthcare system using measures of resource utilization such as number of emergency department visits, number of visits to a healthcare provider, length of hospital or ICU stay, as well as qualitative statements from practitioners and hospital administrators.

Data Extraction

Any relevant study and outcome data will be extracted from included studies by one researcher using a standardized data abstraction form. For all studies this form will guide the collection of information including date of publication, country where study was conducted, study design, definition of elective or non-urgent surgery, and characteristics of study sample (if applicable). The data extraction form is also designed to collect information specific to each of the three research questions such as selected surgical triage criteria, patient and health system-level outcomes, and detailed emergency response plans. A second independent researcher will review all data abstraction forms to verify their completion and accuracy.

Study Quality (Risk of Bias) Assessment

This rapid review will aim to synthesize quantitative outcomes whenever possible but will largely involve scoping the available evidence on surgical service delivery during public heath emergencies. Given this broad aim and the decision to include all study designs, quality appraisal for the included studies is not feasible and will not performed.

Data Synthesis, Analysis and Reporting

Study and sample information will be described in a narrative review and summarized in a data table. We do not anticipate being able to conduct a meta-analysis of quantitative outcomes and will instead synthesize outcomes data qualitatively with support from descriptive statistics whenever possible. Any summary tables for outcomes will be stratified by the three research questions to maximize clarity. Any within-study comparisons (e.g., incidence of adverse events in patients with delayed versus non-delayed surgery) will be considered significant at a two-tailed p-value <0.05.

Ethics and Dissemination

This review will only include secondary data sources and as such there are no applicable ethical considerations. Following completion, this review will become an integral part of evidence-based guidelines to support decisions about allocating resources and organizing surgical care in the era of COVID-19 and during subsequent public health emergencies. The rapid review will also be submitted to peer-reviewed journals to reach the target audiences of patients, policy makers, practitioners and surgical program administrators.

Limitations

The rapidly evolving nature of surgical programming during the COVID-19 situation demands an equally rapid synthesis and dissemination of key evidence. A rapid review therefore supersedes a traditional systematic review, but with this decision come methodological limitations. First, it is possible that much of the identified evidence emerges from non-traditional sources and grey literature and as a result, may be of a lower methodological quality than that from peer-reviewed sources. However, the goal of this review is not to evaluate quantitative outcomes at potential risk of bias but to instead collate the diversity of available information from surgical programs worldwide to inform decision-making. As such the potential negative impacts of lower study quality are of less concern. Secondly, the landscape of evidence specific to COVID-19 changes daily. While the selection of a set date for literature search is important for reporting and review reproducibility, it may lead to the omission of relevant information released beyond this date. We believe, however, that a current date selected for the literature search will span a period of time where some countries are in the process of recovering their surgical services while others remain in the throes of the pandemic. This will maximize the chances that sufficient evidence to answer all research questions is up to date and available.

CONCLUSION

This paper describes the methodology for a planned rapid review that will synthesize evidence on the changes to, impacts of, and recovery of non-urgent surgical service delivery during COVID-19 and other public health emergencies. As post-pandemic normalcy begins to return and non-urgent surgeries resume, the evidence from this review will inform

recommendations for allocating and organizing care while mitigating any potential negative impacts resulting from changes in service delivery.

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Appendices

Appendix A: Ovid MEDLINE Electronic Search Strategy

Database: Ovid MEDLINE (R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily <1946 to May 08, 2020>

Search Strategy:

1 exp Disease Outbreaks/ (96117)
2 (pandemic* or epidemic* or outbreak* or out break*).mp. (230774)
3 1 or 2 (231940)
4 exp Coronavirus (13456)
5 coronavirus infections/ or severe acute respiratory syndrome/ (11068)
6 Coronaviridae Infections/ (900)
7 coronaviridae/ or coronavirus/ (3916)
8 Influenza a virus, h1n1 subtype/ or Influenza a virus, h3n2 subtype/ or influenza a virus, h5n1 subtype/ (22141)
9 Hemorrahagic Fever, Ebola/ (5316)
10 SARS Virus/ (3038)
11 Middle East Respiratory Syndrome Coronavirus/ (1034)
12 (pneumonia.mp. or exp pneumonia/) and Wuhan.mp. (661)
13 (coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV or h1n1 or h3n2 or h5n1 or avian influenza or avian flu or swine influenza or swine flu or SARS or ebola* or middle east respiratory syndrome or MERS).mp. (77950)
14 (wuhan) adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV).mp. (190)
15 (coronavir*) adj2 (infection*).mp. (8441)
16 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 (79915)
17 General Surgery/ (38626)
18 Orthopedic Procedures/ (25371)
19 Traumatology/ (3474)
20 Neurosurgery/ (14892)
21 Obstetrics/ (22533)
22 Anesthesia/ (62587)
23 surgical procedures, operative/ or exp elective surgical procedures/ (68085)
24 exp Arthroplasty, Replacement/ (54362)
25 (general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anesthesia or anaesthesia).mp. (748651)
26 (surger* or operation* or procedure*).mp. (3638036)
27 ((elective or non-urgent) adj2 (surg* or procedure*)).mp. (31794)
28 (surg* adj2 (procedure* or planning or triage or operation* or resource* or backlog or re-organiz* or postpone* or cancel* or capacit* or wait time*)).mp. (444474)
29 ((clinic* or hospital) adj2 (process* or procedure* or triage or planning or performance* or capacit*)).mp. (69185)

30 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 (4101483)
31 3 and 16 and 30 (2075)

Appendix B: Grey Literature Search Plan

GREY LITERATURE SEARCH PLAN

Developed in reference to Guide from the University of Toronto (Stapleton, Fuller & Lenton)

STEP 1) Targeted Website Browsing. Will be using any combination of standard terms "coronavirus" OR "Covid-19" OR "Surgery" OR "non-urgent surgery" OR "elective surgery" OR "guidelines")

NON-GOVERNMENT GROUPS

World Health Organization (https://www.who.int)
Center for Disease Control and Prevention (https://www.cdc.gov)
European Centre for Disease Prevention and Control (https://www.ecdc.europa.eu/en)

GOVERNMENTS/HEALTH SYSTEMS

Canada (https://www.canada.ca/en.html)

- BC (https://www2.gov.bc.ca/gov/content/home)
- AB (https://www.alberta.ca/index.aspx)
- SK (https://www.saskatchewan.ca)
- MB (https://www.gov.mb.ca)
- ON (https://www.ontario.ca/page/government)
- QC (https://www.quebec.ca/en/)
- NB (https://www2.gnb.ca)
- NS (https://beta.novascotia.ca)
- NL & LB (https://www.gov.nl.ca)
- PEI (https://www.princeedwardisland.ca/en)
- Yukon (https://yukon.ca)
- NWT (https://www.gov.nt.ca)
- Nunavut (https://www.gov.nu.ca)

Australia (https://www.australia.gov.au)
Italy (http://www.governo.it)
Singapore (https://www.gov.sg)
China (https://www.gov.cn/english/)
USA (https://www.usa.gov)

GENERAL SURGICAL GROUPS/COLLEGES

Royal College of Physicians and Surgeons of Canada (http://www.royalcollege.ca)
American College of Surgeons (https://www.facs.org)
European Surgical Association (https://www.europeansurgicalassociation.org)

College of Surgeons, Singapore (https://www.ams.edu.sg/colleges/CSS/home)
French Surgical Association
German Society of Surgery (https://www.dgch.de/index.php?id=118)
Italian Society of Surgery (SIC) and Italian Association of Hospital Surgeons (ACOI)
Philippine College of Surgeons (https://www.pcs.org.ph)
Royal Australasian College of Surgeons (https://www.surgeons.org)
Royal College of Surgeons of England (https://www.rcseng.ac.uk)
Royal College of Surgeons of Ireland (https://www.rcsi.com/dublin/)
Spanish Society of Surgery (Associacion Espanola de Cirujanos) (https://www.aecirujanos.es)
Swedish Surgical Society (http://www.svenskkirurgi.se)
The Association of Surgeons of South Africa (http://www.surgeon.co.za)
The Pan African Association of Surgeons (http://www.africansurgeons.com)

STEP 2) Advanced Google Searching. Targeting above sites will assess 5 pages of Google Search past last click. Will be using standard and consistent terms “coronavirus” OR “Covid-19” OR “Surgery” OR “non-urgent” OR “guidelines”)

STEP 3) General Search Engine (Google) Search with same terms as above, assessing 5 pages past last click for relevance.

STEP 4) Contact with Knowledge Experts.

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	Page 1: Title
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	Page 3: Abstract
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	Pages 5,6: Introduction
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	Page 6: Introduction
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	Not registered given rapid nature of review.
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	Page 8: Methods- Study Eligibility
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	Page 6: Methods- Search Strategy
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Appendix A
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	Pages 7.8: Methods- Study Selection
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	Page 9: Methods- Data Extraction
Data items	11	List and define all variables for which data	Page 9: Methods-

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
		were sought and any assumptions and simplifications made.	Outcomes of Interest
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	Page 10: Methods- Study Quality (ROB) Assessment
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	Page 10: Methods- Data Synthesis, Analysis and Reporting
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Pages 10,11: Results- Search Results & Figure 1: PRISMA Flow chart
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Page 11: Results- Description of Studies & Table 1 (Individual) & Figure 2 (Summary)
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Table 1
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	Pages 11-16: Results- Reorganization of Surgical Services & Impact of Reorganizing Surgical Services & Rebuild Surgical Capacity
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	Pages 16 to 18: Discussion
Limitations	20	Discuss the limitations of the scoping review process.	Page 18, 19: Discussion
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	Page 19: Discussion
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	NA

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.
* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).
‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

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

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

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ABSTRACT ***(278/300 words)***

Objectives: To understand how surgical services have been reorganized 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, memos, and press releases from governments and surgical organizations 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. Recommendations and guidelines were excluded.

Primary and secondary outcome measures: Primary outcomes were strategies implemented for the reorganization of surgical services. Secondary were the impacts of reorganization 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 reorganization of surgical services, 55 described the consequences of reorganizing surgical services and six reported actions taken to rebuild surgical capacity in public health emergencies.

Reorganizations of surgical services were grouped under 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. Service reorganizations led to large reductions in non-urgent surgical volumes, increases in surgical wait times, and impacted medical training (i.e., reduced case involvement) and patient outcomes (e.g., 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: Reorganization 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 optimize future health system responses to public health emergencies.

ARTICLE SUMMARY

Strengths and limitations of the 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 1.9M fatalities.[1] To protect the most vulnerable in our societies, efforts to curb further escalation (e.g., travel restrictions, 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 maximize staff, PPE, ventilators, and intensive care unit (ICU) capacity in case public health efforts to 'flatten the curve' are insufficient. Most notably, surgical programs have suspended non-urgent (or 'elective') surgical procedures. Non-urgent surgeries are often defined as procedures for which a delay of three months or longer would not result in significant adverse effects to the patient.[2 3] These changes have thrust patients, providers, and healthcare organizations 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 programs should operationalize the recommendations. As such, approaches to surgical triage and service delivery remain unclear: who has done what where, and why? Further, the impacts of adopting these recommendations on surgical programs, and more importantly, the physical and psychological well-being of patients and healthcare providers have only been hypothesized.[4] Lastly, once COVID-19 begins to release its grip on the world and the post-pandemic recovery begins, programs 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 (i.e., H1N1, Ebola, SARS) is needed to guide approaches to surgical service delivery.

To enable evidence-informed reorganization 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 reorganized 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-Analysis extension for Scoping Reviews (PRISMA-ScR) 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 World Health Organization 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. Further, 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 reorganized in response to public health emergencies, especially the first wave of the COVID-19 pandemic? 2) What are

the patient-, healthcare provider-, and system-level consequences of reorganizing surgical services? and 3) What approaches have been used for resuming surgical services?

Search Strategy

The search strategy was developed by two investigators (CO, KS) and refined by others with context expertise in surgery and literature review methodology (JNK, AKR). The search strategy included subject headings, keywords, and synonyms identifying public health emergencies in general and specific public health emergencies (Ebola, SARS-CoV1, H1N1, MERS), and surgery; and were tailored for each database (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 May 8, 2020. Anticipating pertinent information may not be published (i.e., 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 (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 standardized data abstraction form (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) reorganization of surgical services, 2) impact of reorganizing 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 (e.g., emergency tracheostomy, caesarean section), settings beyond in-patient acute care (e.g., 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 standardized data abstraction form (Appendix B). Data included: date of publication, country, study design, definition of non-urgent surgery, characteristics of study sample (if applicable), outcomes of interest for the three research questions, detailed below.

Outcomes of Interest

Our primary outcomes were reorganization of surgical services, impact of reorganization 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, conceptualized 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 reorganization of surgical services was organized 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 was 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 summarize quantitative outcomes. We characterized and mapped the available emerging evidence using inductive thematic analysis. Specifically, two authors (CO, KS) familiarized themselves with the included studies and, throughout the data extraction process, continuously identified and specified recurrent themes emerging from the data. This was a non-linear process that continued until both authors were satisfied that the selected themes represented all important aspects of the evidence. The penultimate themes are presented. Data were synthesized 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.

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 six 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), orthopedics (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.

Reorganization of Surgical Service

A number of themes emerged from the 108 studies describing reorganization of surgical services. Nearly all studies reported partial, with most reporting full cessation of non-urgent surgeries at their centre, albeit with varying definitions of "non-urgent" (e.g., can be safely postponed for 3 months) and "urgent" (e.g., 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.

1. 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 (e.g., patient characteristics, acuity, imaging) to a larger group representing many surgical specialties to reach consensus on each case.

2. 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 post-operative suture or staple removal were granted in-person visits under strict conditions including mask wearing, negative symptom check, history or temperature pre-screening. 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 not only follow-up with returning patients but to also 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.

3. 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

(i.e. corridors, 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 Reorganizing 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 summarized below with data for all studies relevant to this question shown in 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 program) reported a 500% increase in latency 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 prioritization.[31] Among studies that changed their surgical triage practices, patients were prioritized for surgery based on procedure acuity or urgency (i.e., 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 Room) ORs, PPE, and testing was necessary to prepare for a large and complicated surgical backlog.

DISCUSSION

This review identified over 3,000 evidence sources, 132 of which were included. Approaches to reorganizing surgical services varied between studies and centers, 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 wellbeing or changes in healthcare utilization 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 centers 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 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 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 pre-public 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 organizing 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 wellbeing 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 World Health Organization and Cochrane's guidance on conducting rapid reviews,[7 8] with the intent of balancing rigor 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 re-running 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- or middle-income countries who may face unique challenges during a pandemic compared to 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 organizations 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 which 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 which 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 (Appendix D).

Author Contributions

CO contributed to the design and conceptualization of the review, analysis and interpretations of the data, and drafting and revising the manuscript; JSN contributed to the design of the review, interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; AKR contributed to the design of the review, interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; JCD contributed to the interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; JW contributed to the interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; JR contributed to the interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; MB contributed to the interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; KMS contributed to the design and conceptualization of the review, analysis and interpretations of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript.

Competing interest statement

All authors declare that they have no competing interests in accordance with the International Committee of Medical Journal Editors uniform declaration of competing interests.

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Data Sharing Statement

All data presented have been previously published. Our data will be made available upon reasonable request to the corresponding author.

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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
Alverez-Gallego	2020	Spain	COVID-19	General			
Ammar	2020	USA	COVID-19	Neurosurgery			
Amparore	2020	Italy	COVID-19	Urology		Changes in clinical and surgical resident involvement	
Ansarin	2020	Italy	COVID-19	Oncology (Head & 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	Orthopedics			
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	2020	USA	COVID-19	Orthopedics		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	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	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		
Chee	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 & Neck)		Number of surgical cancellations
D'Apolito	2020	Italy	COVID-19	Orthopedics		Changes in surgical volume
de Vries	2020	Netherlands	COVID-19	Transplant		Changes in transplantation volumes
Ding	2020	Singapore	COVID-19	Orthopedics		
Dominguez-Gil	2020	Spain	COVID-19	Transplant		Changes in transplantation volumes
Doussot	2020	France	COVID-19	Oncology		Changes in surgical volume
Dowdell	2020	USA	COVID-19	Orthopedics		
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	2020	Italy	COVID-19	Neurosurgery		Changes in surgical volume
Fontanella	2020	Italy	COVID-19	Neurosurgery		
Giorgi	2020	Italy	COVID-19	Spinal		
Givi	2020	USA	COVID-19	Oncology (Head & Neck)		Changes in fellow educational programming
Gomez-Barrena	2020	Spain	COVID-19	Orthopedics		Changes in surgical volume
Gouveia	2020	Portugal	COVID-19	Vascular		
Guerci	2020	Italy	COVID-19	General		
Gupta	2020	India	COVID-19	Oncology (Head & Neck)		
Haines	2003	China	SARS	Obstetrics		
Hemingway	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	Orthopedics		
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	2020	Italy	COVID-19	Transplant		Changes in transplantation volumes	
Lee	2020	China	COVID-19	Oncology (Head & Neck)		Changes in surgical wait times	
Leong Tan	2020	Singapore	COVID-19	Vascular			
Li	2020	China	COVID-19	Transplant			
Liebensteiner	2020	Austria	COVID-19	Orthopedics			
Liu	2003	Singapore	SARS	Anesthesia			
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	—			Prioritization first of patients who would be at increased risk with further delay, followed by those waiting longest
Meneghini	2020	USA	COVID-19	Orthopedics			
Meyer	2020	France	COVID-19	Neurosurgery		Changes in surgical volume	
Morgan	2020	UK	COVID-19	Orthopedics			
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 & Neck)			
Patel	2020	USA	COVID-19	Otolaryngology			
Pelt	2020	USA	COVID-19	Orthopedics		Number of surgical postponements	Surgeries prioritized based on complexity and predicted LOS, scheduling only completed if appropriate PPE and screening available.
Pittet	2020	Switzerland	COVID-19	—		Changes in surgical volume	
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 & Neck)		Changes in surgical volume	
Randelli	2020	Italy	COVID-19	Orthopedics			
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	Orthopedics			
Schull	2007	Canada	SARS	—		Changes in surgical volume	
Schwarzkopf	2020	USA	COVID-19	Orthopedics			
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	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	Anesthesia			
Tan	2020	Singapore	COVID-19	Urology		Changes in surgical and consultation volumes	
Tan	2020	China	COVID-19	Neurosurgery			
Tay	2020	Singapore	COVID-19	Orthopedics		Changes in surgical volumes	
Tay	2020	Singapore	COVID-19	Orthopedics			
Thaler	2020	Austria	COVID-19	Orthopedics			
Tolone	2020	Italy	COVID-19	—			
Too	2020	Singapore	COVID-19	Interventional Radiology			
Topf	2020	USA	COVID-19	Oncology (Head & Neck)			
Tsui	2005	China	SARS	Cardiac			
Tzeng	2020	USA	COVID-19	Oncology			
Unal	2020	Turkey	COVID-19	Vascular			
Vaccaro	2020	USA	COVID-19	Orthopedics		Changes in physician remuneration and staffing	
Valenza	2020	Italy	COVID-19	Oncology		Changes in surgical volumes	
van de Haar	2020	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	2020	Italy	COVID-19	Oncology (Breast)		Changes in surgical volumes	
Vlantis	2004	China	SARS	Otolaryngology		Changes in outpatient and surgical volumes	
Walker	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	Anesthesia	■■■■	
Wu	2020	China	COVID-19	Oncology (Head & Neck)	■■■■■■	
Xiaolei	2020	China	COVID-19	Ophthalmology		
Zangrillo	2020	Italy	COVID-19	—	■■■■■	
Zarzaur	2020	USA	COVID-19	—	■■■	
Zeng	2020	China	COVID-19	Oncology (Head & Neck)	■■■■	
Zizzo	2020	Italy	COVID-19	—	■■	
Zoia	2020	Italy	COVID-19	Neurosurgery	■■■■	

Domains of change to surgical services, represented numerically:
■ Changes to case selection and surgical triage
■ Changes to PPE protocols and practices
■ Changes to the surgical workforce.
■ Changes to inpatient and outpatient care
■ Changes to resident and fellow education
■ Changes to the environment

Abbreviations: — =data not provided, COVID-19=Coronavirus Disease 2019, ED=Emergency department, GI=Gastrointestinal; LOS=Length of stay, PPE=Personal protective equipment, SARS=Severe Acute Respiratory Syndrome

Table 2. Reorganization of surgical services, by domain.

Change Domain	Number of Studies (%)	Examples of Change
Triage or Case Selection	80 (74.7)	1. Prioritization of patients based on pre-defined levels of acuity; 2. Virtual multidisciplinary meetings or tumor 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 (i.e., 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 (e.g., 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 (e.g., 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 maximize 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 (e.g., only admitted to OR during low-risk/non-aerosolizing procedures).
Environment	70 (64.8)	1. Dedication of wards (hallways, 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 (e.g., cubicles, distanced waiting room chairs) implemented.

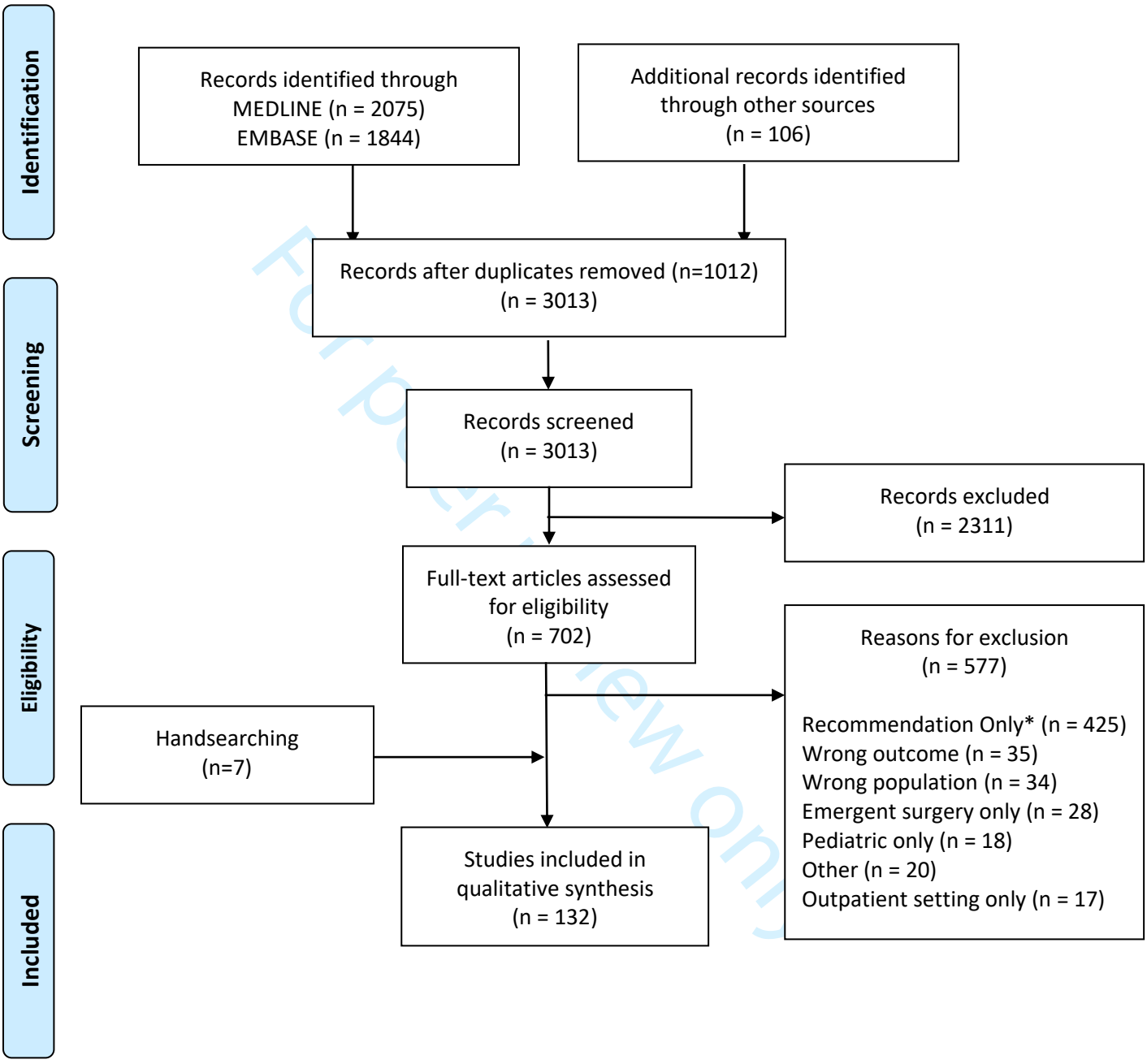
Abbreviations: ICU= Intensive care unit, PPE= Personal protective equipment, PAPR= Powered air purifying respirator, OR= Operating room.

Figure 1. PRISMA Flow diagram.

Figure 2. Summary of study characteristics.

Figure 3. Summary of leading impacts of changes to surgical programming

Figure 1. Flow of studies in the scoping review



*Includes guidelines, recommendation-based reviews, projections or estimations without mention of true changes to surgical programming.

Figure 2. Study characteristics

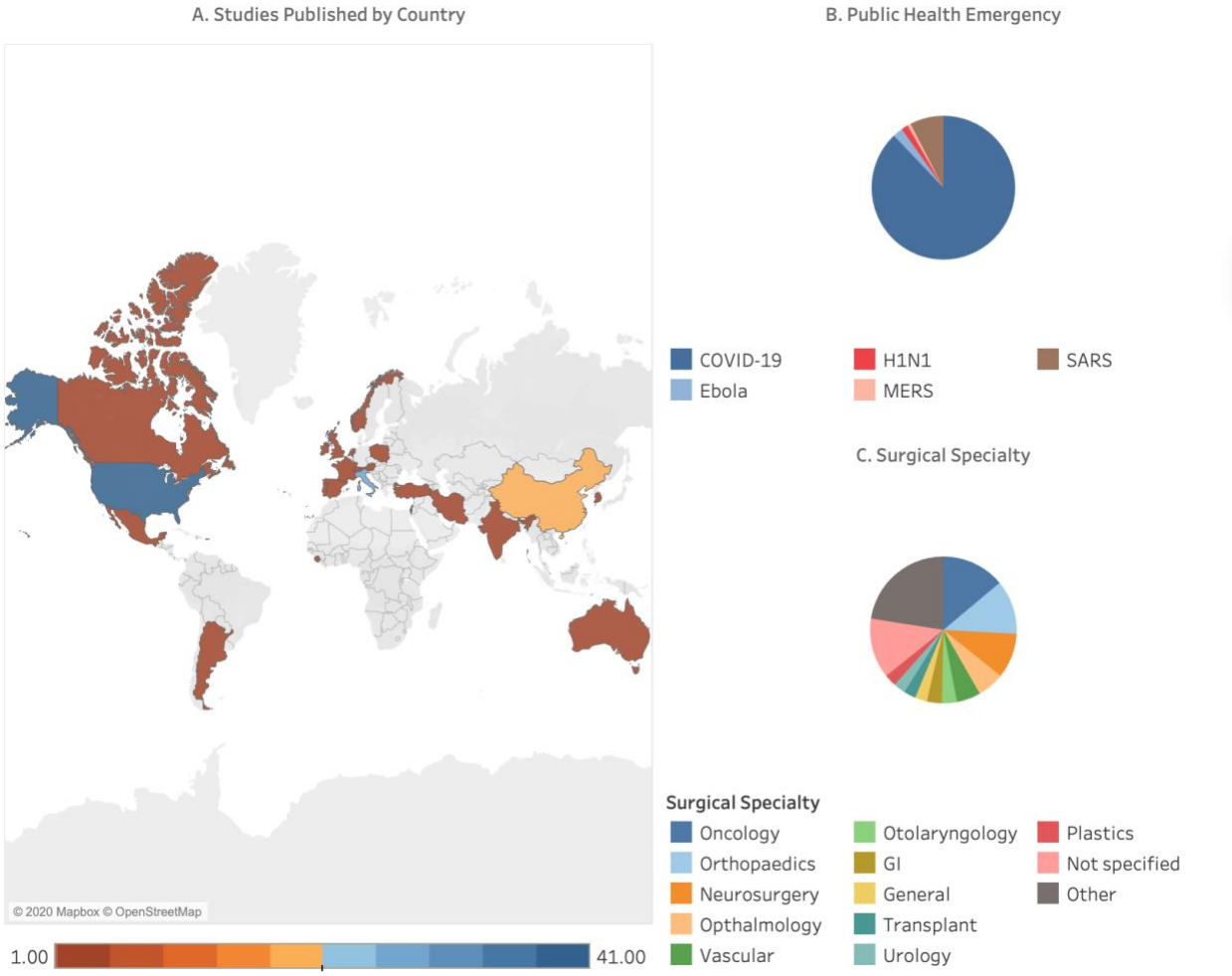


Figure 2. **A.** Country of publication, **B.** Public health emergency discussed, and **C.** Surgical specialty addressed ('Other' includes Cardiac (n=3), Anesthesia (n=3), Electrophysiology (n=3), Obstetrics and Gynecology (n=3), Thoracic (n=2), Interventional Radiology (n=1), and Dermatology (n=1)).

Figure 3. Summary of the impacts of alterations to surgical services

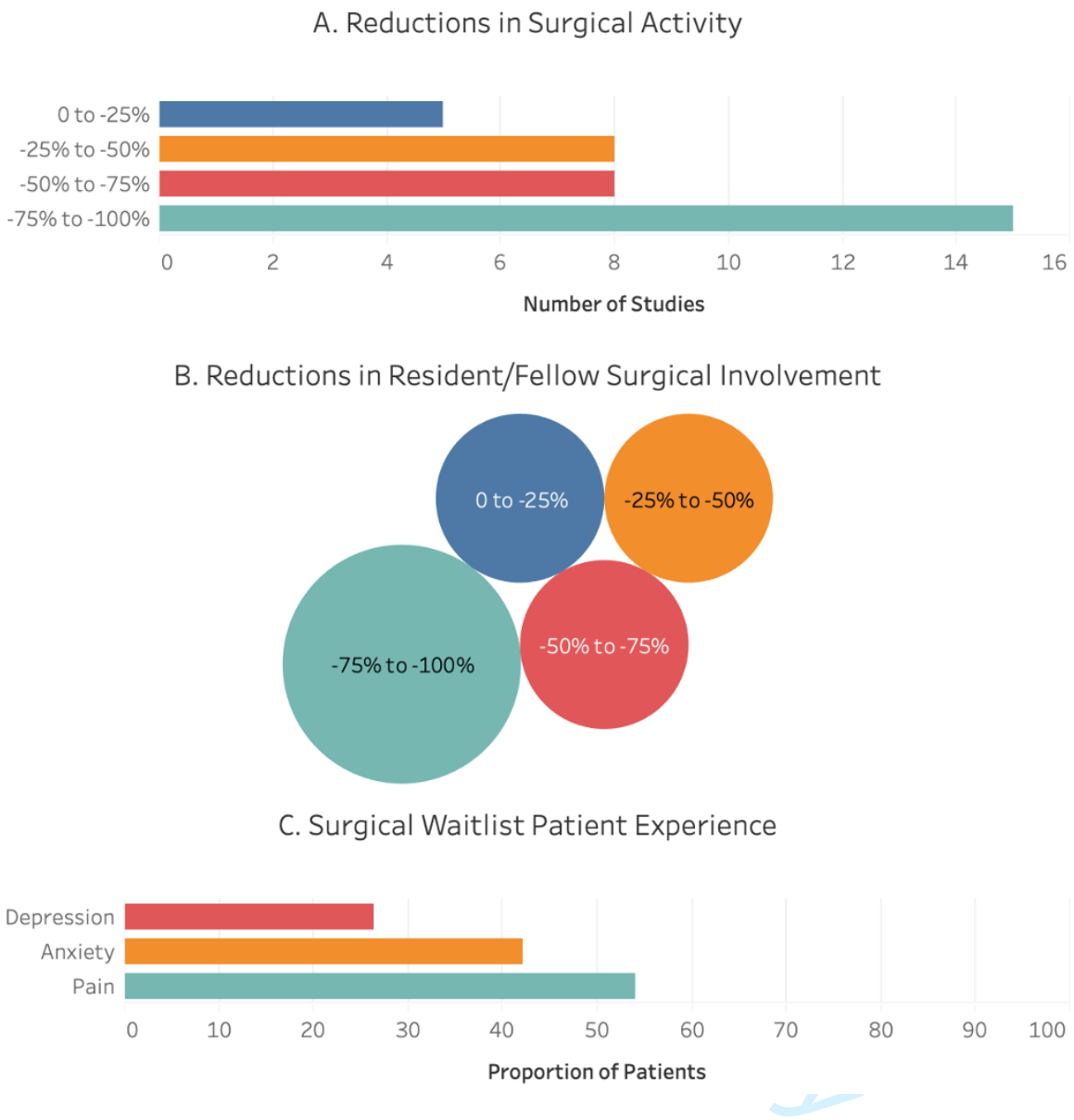


Figure 3. A summary of the impacts of alterations to surgical services during public health emergencies on **A.** Overall surgical activity (n=37 studies), **B.** Resident and fellow involvement in surgery (n=5 studies) where circle size represents the number of studies contributing to that quartile, and **C.** Patient experience (n=2 studies).

Appendix A. Search Strategy

Database: Ovid MEDLINE (R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily <1946 to May 08, 2020>

Search Strategy:

1 exp Disease Outbreaks/ (96117)
2 (pandemic* or epidemic* or outbreak* or out break*).mp. (230774)
3 1 or 2 (231940)
4 exp Coronavirus (13456)
5 coronavirus infections/ or severe acute respiratory syndrome/ (11068)
6 Coronaviridae Infections/ (900)
7 coronaviridae/ or coronavirus/ (3916)
8 Influenza a virus, h1n1 subtype/ or Influenza a virus, h3n2 subtype/ or influenza a virus, h5n1 subtype/ (22141)
9 Hemorrahagic Fever, Ebola/ (5316)
10 SARS Virus/ (3038)
11 Middle East Respiratory Syndrome Coronavirus/ (1034)
12 (pneumonia.mp. or exp pneumonia/) and Wuhan.mp. (661)
13 (coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV or h1n1 or h3n2 or h5n1 or avian influenza or avian flu or swine influenza or swine flu or SARS or ebola* or middle east respiratory syndrome or MERS).mp. (77950)
14 (wuhan) adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV).mp. (190)
15 (coronavir*) adj2 (infection*).mp. (8441)
16 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 (79915)
17 General Surgery/ (38626)
18 Orthopedic Procedures/ (25371)
19 Traumatology/ (3474)
20 Neurosurgery/ (14892)
21 Obstetrics/ (22533)
22 Anesthesia/ (62587)
23 surgical procedures, operative/ or exp elective surgical procedures/ (68085)
24 exp Arthroplasty, Replacement/ (54362)
25 (general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anesthesia or anaesthesia).mp. (748651)
26 (surger* or operation* or procedure*).mp. (3638036)
27 ((elective or non-urgent) adj2 (surg* or procedure*)).mp. (31794)
28 (surg* adj2 (procedure* or planning or triage or operation* or resource* or backlog or re-organiz* or postpone* or cancel* or capacit* or wait time*)).mp. (444474)
29 ((clinic* or hospital) adj2 (process* or procedure* or triage or planning or performance* or capacit*)).mp. (69185)
30 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 (4101483)
31 3 and 16 and 30 (2075)

Database: EMBASE <1974 to 2020 May 08>

Search Strategy:

1	exp epidemic/ (103292)
2	exp pandemic/ (12990)
3	1 or 2 (114458)
4	pandemic influenza/ (4748)
5	exp severe acute respiratory syndrome/ (8505)
6	exp coronaviridae/ or coronaviridae infection/ (14928)
7	coronavirinae/ (2093)
8	Coronavirus infection/ (3397)
9	avian influenza virus/ or "influenza a virus (h1n1)"/ or "influenza a virus (h3n2)"/, "influenza a virus (h5n1)"/ (7466)
10	Ebola hemorrhagic fever/ (5712)
11	exp SARS coronavirus/ (5823)
12	Middle East respiratory syndrome/ (935)
13	(pneumonia.mp. or exp pneumonia/) and Wuhan.mp. (512)
14	(coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV).mp. (92353)
15	(wuhan adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV)).mp. (161)
16	(coronavir* adj2 infection*).mp. (4793)
17	4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 (96712)
18	general surgery/ (15070)
19	orthopedic surgery/ (32672)
20	traumatology/ (10653)
21	neurosurgery/ (59847)
22	obstetrics/ (34886)
23	anesthesiological procedure/ (1785)
24	elective surgery/ (34038)
25	replacement arthroplasty/ or exp arthroplasty/ (73583)
26	(general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anaesthesia or anesthesia).mp. (966732)
27	(surger* or operation* or procedure*).mp. (5402047)
28	((elective or non-urgent adj2 (surg* or procedure*)).mp. (52808)
29	(surg* adj2 (procedure* or planning or triag* or operation* or resource* or backlog or re-organiz* or postpon* or cancel* or capacit* or wait time*)).mp. (187480)
30	((clinic* or hospital) adj2 (process* or procedure* or triag* or planning or performance* or capacit*)).mp. (83715)
31	18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 (5948860)
32	3 and 17 and 31 (1844)

Database	Pandemic terms Pandemic, epidemic	Disease terms COVID-19, SARS, MERS, pandemic flu (h1n1, h3n2, h5n1), ebola	Surgical terms Non-urgent/elective surgery (general, orthopedic, anesthesia, trauma, neurosurgery, obstetrics)
MEDLINE	exp Disease Outbreaks/ OR (pandemic* or epidemic* or outbreak* or out break*).mp.	exp Coronavirus OR coronavirus infections/ or severe acute respiratory syndrome/ OR Coronaviridae Infections/ OR coronaviridae/ or coronavirus/ OR Influenza a virus, h1n1 subtype/ or Influenza a virus, h3n2 subtype/ or influenza a virus, h5n1 subtype/ OR Hemorrahagic Fever, Ebola/ OR SARS Virus/ OR Middle East Respiratory Syndrome Coronavirus/ OR (pneumonia.mp. or exp pneumonia/) and Wuhan.mp. OR (coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV or h1n1 or h3n2 or h5n1 or avian influenza or avian flu or swine influenza or swine flu or SARS or ebola* or middle	General Surgery/ OR Orthopedic Procedures/ OR Traumatology/ OR Neurosurgery/ OR Obstetrics/ OR Anesthesia/ OR surgical procedures, operative/ or exp elective surgical procedures/ OR exp Arthroplasty, Replacement/ OR (general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anesthesia or anaesthesia).mp. OR (surger* or operation* or procedure*).mp. OR ((elective or non-urgent) adj2 (surg* or procedure*)).mp. OR (surg* adj2 (procedure* or planning or triage or operation* or resource* or backlog or re-organiz* or postpone* or cancel* or capacit* or wait time*)).mp.

		east respiratory syndrome or MERS).mp. OR (wuhan) adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV).mp. OR (coronavir*) adj2 (infection*).mp.	OR ((clinic* or hospital) adj2 (process* or procedure* or triage or planning or performance* or capacit*)).mp.
EMBASE	exp epidemic/ OR exp pandemic/	pandemic influenza/ OR exp severe acute respiratory syndrome/ OR exp coronaviridae/ or coronaviridae infection/ OR coronavirinae/ OR Coronavirus infection/ OR avian influenza virus/ or "influenza a virus (h1n1)"/ or "influenza a virus (h3n2)"/, "influenza a virus (h5n1)"/ OR Ebola hemorrhagic fever/ OR exp SARS coronavirus/ OR Middle East respiratory syndrome/ OR (pneumonia.mp. or exp pneumonia/) and Wuhan.mp. OR (coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV).mp. OR	general surgery/ OR orthopedic surgery/ OR traumatology/ OR neurosurgery/ OR obstetrics/ OR anesthesiological procedure/ OR elective surgery/ OR replacement arthroplasty/ or exp arthroplasty/ OR (general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anaesthesia or anesthesia).mp. OR (surger* or operation* or procedure*).mp. OR ((elective or non-urgent adj2 (surg* or procedure*)).mp. OR (surg* adj2 (procedure* or planning or triag* or operation* or resource* or backlog or re-organiz* or postpon* or cancel* or

		(wuhan adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV)).mp. OR (coronavir* adj2 infection*).mp.	capacit* or wait time*)).mp. OR ((clinic* or hospital) adj2 (process* or procedure* or triag* or planning or performance* or capacit*)).mp.

GREY LITERATURE SEARCH PLAN

Developed in reference to Guide from the University of Toronto (Stapleton, Fuller & Lenton)

STEP 1) Targeted Website Browsing. Will be using any combination of standard terms "coronavirus" OR "Covid-19" OR "Surgery" OR "non-urgent surgery" OR "elective surgery" OR "guidelines")

NON-GOVERNMENT GROUPS

World Health Organization (https://www.who.int)
Center for Disease Control and Prevention (https://www.cdc.gov)
European Centre for Disease Prevention and Control (https://www.ecdc.europa.eu/en)

GOVERNMENTS/HEALTH SYSTEMS

Canada (https://www.canada.ca/en.html)

- BC (https://www2.gov.bc.ca/gov/content/home)
- AB (https://www.alberta.ca/index.aspx)
- SK (https://www.saskatchewan.ca)
- MB (https://www.gov.mb.ca)
- ON (https://www.ontario.ca/page/government)
- QC (https://www.quebec.ca/en/)
- NB (https://www2.gnb.ca)
- NS (https://beta.novascotia.ca)
- NL & LB (https://www.gov.nl.ca)
- PEI (https://www.princeedwardisland.ca/en)
- Yukon (https://yukon.ca)
- NWT (https://www.gov.nt.ca)
- Nunavut (https://www.gov.nu.ca)

Australia (https://www.australia.gov.au)
Italy (http://www.governo.it)
Singapore (https://www.gov.sg)
China (https://www.gov.cn/english/)
USA (https://www.usa.gov)

GENERAL SURGICAL GROUPS/COLLEGES

Royal College of Physicians and Surgeons of Canada (http://www.royalcollege.ca)
American College of Surgeons (https://www.facs.org)
European Surgical Association (https://www.europeansurgicalassociation.org)
College of Surgeons, Singapore (https://www.ams.edu.sg/colleges/CSS/home)
French Surgical Association
German Society of Surgery (https://www.dgch.de/index.php?id=118)
Italian Society of Surgery (SIC) and Italian Association of Hospital Surgeons (ACOI)
Philippine College of Surgeons (https://www.pcs.org.ph)
Royal Australasian College of Surgeons (https://www.surgeons.org)
Royal College of Surgeons of England (https://www.rcseng.ac.uk)
Royal College of Surgeons of Ireland (https://www.rcsi.com/dublin/)
Spanish Society of Surgery (Associacion Espanola de Cirujanos) (https://www.aecirujanos.es)
Swedish Surgical Society (http://www.svenskkirurgi.se)
The Association of Surgeons of South Africa (http://www.surgeon.co.za)
The Pan African Association of Surgeons (http://www.africansurgeons.com)

STEP 2) Advanced Google Searching. Targeting above sites will assess 5 pages of Google Search past last click. Will be using standard and consistent terms “coronavirus” OR “Covid-19” OR “Surgery” OR “non-urgent” OR “guidelines”)

STEP 3) General Search Engine (Google) Search with same terms as above, assessing 5 pages past last click for relevance.

STEP 4) Contact with Knowledge Experts.

Source and Site	Search Terms	Potentially Relevant Results
Health Groups		
World Health Organization (https://www.who.int, Advanced Search)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	10
Center for Disease Control and Prevention (https://www.cdc.gov)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	8
European Centre for Disease Prevention and Control (https://www.ecdc.europa.eu/en)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	3
Governments		
Government of Canada (https://www.canada.ca/en.html)	[contains all words] elective surgery covid	4

	[contains all words] non-urgent surgery covid	
Government of BC (https://www2.gov.bc.ca/gov)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	2
Government of AB (https://www.alberta.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	2
Government of SK (https://www.saskatchewan.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	6
Government of MB (https://www.gov.mb.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	4
Government of ON (https://www.ontario.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of QC (https://www.quebec.ca/en/)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of NB (https://www2.gnb.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of NS (https://beta.novascotia.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of NL & LB (https://www.gov.nl.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of PEI (https://www.princeedwardisland.ca)	[contains all words] elective surgery covid	2

	[contains all words] non-urgent surgery covid	
Government of Yukon (https://yukon.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of NWT (https://www.gov.nt.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of Nunavut (https://www.gov.nu.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of Australia (https://www.australia.gov.au)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of Italy (http://www.governo.it)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of Singapore (https://www.gov.sg)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of China ((https://www.gov.cn/english/)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
United States Government (https://www.usa.gov)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Surgical Colleges/Associations		
Royal College of Physicians and Surgeons of Canada (http://www.royalcollege.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0

American College of Surgeons (https://www.facs.org)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	23
European Surgical Association (https://www.europeansurgicalassociation.org)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
College of Surgeons, Singapore (https://www.ams.edu.sg)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	3
German Society of Surgery (https://www.dgch.de/index.php?id=118)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Philippine College of Surgeons (https://www.pcs.org.ph)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	11
Royal Australasian College of Surgeons (https://www.surgeons.org)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	12
Royal College of Surgeons of England (https://www.rcseng.ac.uk)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	7
Royal College of Surgeons of Ireland (https://www.rcsi.com/dublin/)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	8
Spanish Society of Surgery (Associacion Espanola de Cirujanos) (https://www.aecirujanos.es)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Swedish Surgical Society (http://www.svenskkirurgi.se)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0

The Association of Surgeons of South Africa (http://www.surgeon.co.za)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
The Pan African Association of Surgeons (http://www.africansurgeons.com)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
	Total	111

Appendix B. Data Abstraction Form

This form has been developed by adopting and customizing the 'Data collection form- RCTs and NRS' produced by The Cochrane Collaboration. Customization includes the addition of new sections, as well as the omission of sections not relevant to the review.

Notes on using data extraction form:

- Be consistent in the order and style you use to describe the information for each report.
- Record any missing information as unclear or not described, to make it clear that the information was not found in the study report(s), not that you forgot to extract it.
- Include any instructions and decision rules on the data collection form, or in an accompanying document. It is important to practice using the form and give training to any other authors using the form.

1. General Information

1. Date form completed (dd/mm/yyyy)	/ /
2. Name of person extracting data	☐ Connor M. ORielly ☐ Khara M. Sauro
3. Contact details of person extracting data	
4. Title of Article/Abstract (that data are extracted from)	
5. Study ID (plus surname of author and year of study publication)	
6. Study country of origin	
7. Study funding source	
8. Possible conflicts of interest	☐ Reported ☐ Not Reported
9. Notes:	

2. Eligibility

Study Characteristics	Inclusion Criteria	Location in text (page#/fig#/table#)
10. Type of study (design)	☐ Case Study ☐ Case Series ☐ Observational	

11. Population description		
12. Focused diseases/conditions		
13. Types of outcome measures		
14. Decision (with reasons for either inclusion or exclusion)	☐ Include ☐ Exclude If Exclude, explain:	
15. Notes		

IF STUDY IS EXCLUDED FROM REVIEW, DO NOT CONTINUE

2. Population and setting

	Description	Location in text (page#/fig#/table#)
16. Population description		
17. Source/setting of the population (e.g., urban, rural, ethnic group)		
18. Method(s) of recruitment of participants	☐ Random ☐ Non-Random Method:	
19. Notes:		

3. Methods

	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)

20. Aim of study		
21. Design (e.g., cross-sectional, RCT, CCT)	☐ Case Study ☐ Case Series ☐ Observational	
22. Sampling technique (e.g., random or convenience)	☐ Random ☐ Non-Random	
23. Study start date (dd/mm/yyyy)	/ /	
24. Study end date/duration (dd/mm/yyyy)	/ / **OR** Duration:	
25. Notes:		

4. Participants

	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
26. Total number of participants/Sample size		
27. Age		
28. Sex	☐ Both Sexes ☐ Males ☐ Females	
29. Genders Represented		
30. Country		
31. Predominant medical complaint		
32. Co-morbidities (if any)		
33. Definition of 'Frequent use' (if any)		

34. Notes:

5. Outcomes

Keep only the tables for outcomes relevant to this particular study, duplicate tables as necessary.

Outcome 1: Alterations to surgical programming (RQ1)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
35. Outcome definition		
36. Time points measured		
37. Domains of change	☐ Surgical triage ☐ PPE ☐ Workforce ☐ Patient care ☐ Environmental	
38. Unit of measurement	☐ Group ☐ Individual	
39. Notes:		

Outcome 2: Patient-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
40. Specify Outcome		
41. Outcome definition		
42. Time points measured		
43. Unit of Measurement	☐ Group ☐ Individual	
44. Unit of measurement		
45. Notes:		

Outcome 3: System-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
46. Specify Outcome		
47. Outcome definition		
48. Time points measured		
49. Unit of Measurement	☐ Group ☐ Individual	
50. Unit of measurement		
51. Notes:		

Outcome 4: Practitioner-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
52. Specify Outcome		
53. Outcome definition		
54. Time points measured		
55. Unit of Measurement	☐ Group ☐ Individual	
56. Unit of measurement		
57. Notes:		

Outcome 5: Alterations to rebuild capacity (RQ3)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
58. Outcome definition		
59. Time points measured		

60. Domains of change	☐ Surgical triage ☐ PPE ☐ Workforce ☐ Patient care ☐ Environmental	
61. Unit of measurement	☐ Group ☐ Individual	
62. Notes:		

6. Results and findings

Keep only the tables for outcomes relevant to this particular study, duplicate tables as necessary.

Outcome 1: Alterations to surgical programming (RQ1)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
63. Subgroup (if applicable, e.g., age/sex specific reporting)		
64. Results		
65. Response/non-response rate		
66. Unit of analysis (i.e., individual or group)		
67. Notes:		

Outcome 2: Patient-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
68. Subgroup (if applicable, e.g., age/sex specific reporting)		
69. Results		
70. Response/non-response rate		
71. Unit of analysis (i.e., individual or group)		
72. Notes:		

Outcome 3: System-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
73. Subgroup (if applicable, e.g., age/sex specific reporting)		
74. Results		
75. Response/non-response rate		
76. Unit of analysis (i.e., individual or group)		
77. Notes:		

Outcome 4: Practitioner-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
78. Subgroup (if applicable, e.g., age/sex specific reporting)		
79. Results		
80. Response/non-response rate		
81. Unit of analysis (i.e., individual or group)		
82. Notes:		

Outcome 5: Alterations to rebuild capacity (RQ3)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
83. Subgroup (if applicable, e.g., age/sex specific reporting)		
84. Results		
85. Response/non-response rate		
86. Unit of analysis (i.e., individual or group)		
87. Notes:		

Research Questions informed by this study ***(tick only boxes matching the outcome tables kept above)***

☐ Changes to surgical programming in response to public health emergency

☐ Impacts of changes to surgical programming
☐ Actions to rebuild surgical capacity post-public health emergency

7. Strengths, limitations and mitigation strategy

	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
88. Strengths		
89. Limitations		
90. Strategies to overcome limitations		
91. Notes:		

8. Conclusion and other information

	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
92. Key conclusions of study authors		
93. Notes:		

Appendix C. Complete list of references for included studies

1. Alvarez Gallego M, Gortazar de Las Casas S, Pascual Miguelanez I, et al. SARS-CoV-2 pandemic on the activity and professionals of a General Surgery and Digestive Surgery Service in a tertiary hospital. *Cir Esp* 2020 doi: 10.1016/j.ciresp.2020.04.001 [published Online First: 2020/04/28]
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BACKGROUND

The novel coronavirus (COVID-19) has spread across the globe with unrelenting speed. At the time of writing over 4 million cases have been confirmed, among them more than 200,000 fatalities[1]. In addition to protecting those most vulnerable in our societies, efforts to curb further disease escalation (e.g., travel restrictions, physical distancing measures) have had a focal objective: prevent case surges that could overwhelm healthcare institutions or further aggravate existing shortages in personal protective equipment (PPE), ventilators, and hospital capacity.

Medical institutions have themselves also taken steps to maximize the availability of staff, PPE, ventilators and intensive care unit (ICU) capacity in the case that external 'curve flattening' practices are not sufficient. Most notably, surgical programs have suspended non-urgent (or elective) surgical procedures, often defined as procedures for which a delay of three (3) months or longer would not result in any significant adverse effect to the patient[2,3]. These changes span nearly all surgical specialties from oncology to orthopedics and have thrusted patients, providers and programs into previously unexplored territory.

While the governing bodies of surgical practice have recommended alterations to non-urgent surgical service delivery, they have not always provided explicit instructions on how programs should approach the change. As such, different groups have likely taken different approaches to surgical triage and service delivery and it remains unclear who has done what where, and why? Further, the impacts of postponing non-urgent surgeries on the physical, psychological, emotional and professional well-being of patients and practitioners are either anecdotal or unknown[4]. Lastly, as COVID-19 begins to release its grip on the world and a level of post-pandemic normalcy returns, programs will be tasked with rebuilding the surgical capacity necessary to reschedule and resume postponed procedures. Evidence on the experiences of other

groups doing so in the context of COVID-19 and other public health emergencies (i.e., H1N1, Ebola, SARS) will be paramount in guiding subsequent approaches.

To address the aforementioned knowledge gaps, we will conduct a rapid review of the literature to synthesize evidence on how surgical resources were allocated in response to COVID-19 and other public health emergencies, how these reallocations impacted patients, practitioners and broader health systems, and what approaches have been taken to rebuild, reorganize and resume surgical service delivery. This review will not only help explain how international surgical programs responded to this unprecedented emergency and what the consequences were, but will also provide the evidence-base necessary to guide responses to this current and any future pandemic event.

METHODS

Study Design

The planned review will answer three questions: (1) How have surgical resources been allocated in response to COVID-19, (2) What are the patient- and system-level consequences of reorganizing surgical resources, and (3) How have resources been reorganized to resume surgical services? We will focus on surgeries identified as "elective" or "non-urgent'. However, to avoid limiting study eligibility unnecessarily no set definition for this term will be used and we will instead report the definition used by each included study.

Search Strategy

An electronic search strategy was developed by the investigators (CO, KS) prior to being reviewed and refined by collaborators with context expertise in surgery and literature review

(JNK, AKR). The search strategy includes subject headings, keywords and synonyms identifying the public health emergencies of interest as well as the surgical specialties likely affected by COVID-19 (Appendix A). Headings and keywords were adapted for use in each database. Given the diversity of the research questions related to this review no study design or publication type constraints will be applied to the search. Further, since (by definition) the impacts of a pandemic span many countries, no language restrictions will be applied. However, to deliver on the study objectives in a timely fashion, studies not easily translated by members of the research team will be subsequently excluded from the review.

We will conduct comprehensive searches of Ovid MEDLINE (including Epub Ahead of Print, In-Process & Other Non-Indexed Citations) and EMBASE from database inception onwards. Since much of the information related to the questions of this review is likely unpublished (i.e., joint statements, recommendations and guidelines from surgical colleges) we will also complete a detailed grey literature search. An *a priori* designed plan for this search has been developed (Appendix B) and will follow methodological recommendations by including targeted website searching, advanced and general Google searching and contact with knowledge experts[5]. Further, the reference lists from all included studies will be examined for any additional relevant studies not captured in the formal database and grey literature searches.

Study Selection

In accordance with recommendations from the Cochrane Methods Group and World Health Organization Alliance for Health Policy and Systems Research, the titles and abstracts of all retrieved items will be reviewed by one of two independent researchers (CO, KM) with a third, independent researcher (KS) serving as duplicate reviewer for a random 25% sample of all

references[6,7]. Eligibility criteria varies such that the relevance of studies is determined by the research question to which they pertain. For the first question on how surgical resources have been allocated we will include any study that examines or discusses organization of surgical resources and patients during COVID-19 or other public health emergency (i.e., triage criteria, allocation of hospital resources if they include surgery, PPE for the operating room staff). To address the second question – consequences of reorganizing surgical resources- we will include any studies that examine patient- and/or system-level surgical outcomes during COVID-19 or other public health emergencies (i.e., adverse events, length of stay, ICU admissions). Lastly, to determine how resources have been organized to resume non-urgent surgical services we will include any study that examines resuming surgical services after COVID-19 or another public health emergency.

Full texts of studies not excluded in the title and abstract phase will then be reviewed in duplicate by the same researchers to ensure applicability to any of the research questions. Any articles identified as meeting the pre-specified eligibility criteria at this stage will be included in the final review. Interrater agreement on inclusion for the 25% sample of titles and abstracts reviewed in duplicate as well as the full texts will be measured with a Cohen's kappa (κ) statistic and corresponding 95% confidence interval. At all stages of the review an unbiased third party will be available to resolve any sustained disagreements between reviewers. The full study selection process including reasons for full text exclusions will be reported using a Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram[8].

Outcomes of Interest

Study information will be collected to answer the research questions of steps taken to respond to emergencies and rebuild capacity (see data extraction section below), but these questions are not outcome oriented and as such specific outcomes data for these questions will not be collected. However, the second research question surrounding the consequences of altering non-urgent surgical programming will require the collection of both quantitative and qualitative outcomes in order to provide the desired holistic understanding of impacts. Specifically, we will assess patient-level outcomes including the incidence of adverse events (i.e., negative event leading to patient harm and caused by management (or lack thereof) rather than the underlying condition of the patient), mortality, and quotes discussing emotional and psychological impacts of delays. We will also evaluate impacts on the healthcare system using measures of resource utilization such as number of emergency department visits, number of visits to a healthcare provider, length of hospital or ICU stay, as well as qualitative statements from practitioners and hospital administrators.

Data Extraction

Any relevant study and outcome data will be extracted from included studies by one researcher using a standardized data abstraction form. For all studies this form will guide the collection of information including date of publication, country where study was conducted, study design, definition of elective or non-urgent surgery, and characteristics of study sample (if applicable). The data extraction form is also designed to collect information specific to each of the three research questions such as selected surgical triage criteria, patient and health system-level outcomes, and detailed emergency response plans. A second independent researcher will review all data abstraction forms to verify their completion and accuracy.

Study Quality (Risk of Bias) Assessment

This rapid review will aim to synthesize quantitative outcomes whenever possible but will largely involve scoping the available evidence on surgical service delivery during public heath emergencies. Given this broad aim and the decision to include all study designs, quality appraisal for the included studies is not feasible and will not performed.

Data Synthesis, Analysis and Reporting

Study and sample information will be described in a narrative review and summarized in a data table. We do not anticipate being able to conduct a meta-analysis of quantitative outcomes and will instead synthesize outcomes data qualitatively with support from descriptive statistics whenever possible. Any summary tables for outcomes will be stratified by the three research questions to maximize clarity. Any within-study comparisons (e.g., incidence of adverse events in patients with delayed versus non-delayed surgery) will be considered significant at a two-tailed p-value <0.05.

Ethics and Dissemination

This review will only include secondary data sources and as such there are no applicable ethical considerations. Following completion, this review will become an integral part of evidence-based guidelines to support decisions about allocating resources and organizing surgical care in the era of COVID-19 and during subsequent public health emergencies. The rapid review will also be submitted to peer-reviewed journals to reach the target audiences of patients, policy makers, practitioners and surgical program administrators.

Limitations

The rapidly evolving nature of surgical programming during the COVID-19 situation demands an equally rapid synthesis and dissemination of key evidence. A rapid review therefore supersedes a traditional systematic review, but with this decision come methodological limitations. First, it is possible that much of the identified evidence emerges from non-traditional sources and grey literature and as a result, may be of a lower methodological quality than that from peer-reviewed sources. However, the goal of this review is not to evaluate quantitative outcomes at potential risk of bias but to instead collate the diversity of available information from surgical programs worldwide to inform decision-making. As such the potential negative impacts of lower study quality are of less concern. Secondly, the landscape of evidence specific to COVID-19 changes daily. While the selection of a set date for literature search is important for reporting and review reproducibility, it may lead to the omission of relevant information released beyond this date. We believe, however, that a current date selected for the literature search will span a period of time where some countries are in the process of recovering their surgical services while others remain in the throes of the pandemic. This will maximize the chances that sufficient evidence to answer all research questions is up to date and available.

CONCLUSION

This paper describes the methodology for a planned rapid review that will synthesize evidence on the changes to, impacts of, and recovery of non-urgent surgical service delivery during COVID-19 and other public health emergencies. As post-pandemic normalcy begins to return and non-urgent surgeries resume, the evidence from this review will inform

recommendations for allocating and organizing care while mitigating any potential negative impacts resulting from changes in service delivery.

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Appendices

Appendix A: Ovid MEDLINE Electronic Search Strategy

Database: Ovid MEDLINE (R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily <1946 to May 08, 2020>

Search Strategy:

1 exp Disease Outbreaks/ (96117)
2 (pandemic* or epidemic* or outbreak* or out break*).mp. (230774)
3 1 or 2 (231940)
4 exp Coronavirus (13456)
5 coronavirus infections/ or severe acute respiratory syndrome/ (11068)
6 Coronaviridae Infections/ (900)
7 coronaviridae/ or coronavirus/ (3916)
8 Influenza a virus, h1n1 subtype/ or Influenza a virus, h3n2 subtype/ or influenza a virus, h5n1 subtype/ (22141)
9 Hemorrahagic Fever, Ebola/ (5316)
10 SARS Virus/ (3038)
11 Middle East Respiratory Syndrome Coronavirus/ (1034)
12 (pneumonia.mp. or exp pneumonia/) and Wuhan.mp. (661)
13 (coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV or h1n1 or h3n2 or h5n1 or avian influenza or avian flu or swine influenza or swine flu or SARS or ebola* or middle east respiratory syndrome or MERS).mp. (77950)
14 (wuhan) adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV).mp. (190)
15 (coronavir*) adj2 (infection*).mp. (8441)
16 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 (79915)
17 General Surgery/ (38626)
18 Orthopedic Procedures/ (25371)
19 Traumatology/ (3474)
20 Neurosurgery/ (14892)
21 Obstetrics/ (22533)
22 Anesthesia/ (62587)
23 surgical procedures, operative/ or exp elective surgical procedures/ (68085)
24 exp Arthroplasty, Replacement/ (54362)
25 (general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anesthesia or anaesthesia).mp. (748651)
26 (surger* or operation* or procedure*).mp. (3638036)
27 ((elective or non-urgent) adj2 (surg* or procedure*)).mp. (31794)
28 (surg* adj2 (procedure* or planning or triage or operation* or resource* or backlog or re-organiz* or postpone* or cancel* or capacit* or wait time*)).mp. (444474)
29 ((clinic* or hospital) adj2 (process* or procedure* or triage or planning or performance* or capacit*)).mp. (69185)

30 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 (4101483)
31 3 and 16 and 30 (2075)

Appendix B: Grey Literature Search Plan

GREY LITERATURE SEARCH PLAN

Developed in reference to Guide from the University of Toronto (Stapleton, Fuller & Lenton)

STEP 1) Targeted Website Browsing. Will be using any combination of standard terms "coronavirus" OR "Covid-19" OR "Surgery" OR "non-urgent surgery" OR "elective surgery" OR "guidelines")

NON-GOVERNMENT GROUPS

World Health Organization (https://www.who.int)
Center for Disease Control and Prevention (https://www.cdc.gov)
European Centre for Disease Prevention and Control (https://www.ecdc.europa.eu/en)

GOVERNMENTS/HEALTH SYSTEMS

Canada (https://www.canada.ca/en.html)

- BC (https://www2.gov.bc.ca/gov/content/home)
- AB (https://www.alberta.ca/index.aspx)
- SK (https://www.saskatchewan.ca)
- MB (https://www.gov.mb.ca)
- ON (https://www.ontario.ca/page/government)
- QC (https://www.quebec.ca/en/)
- NB (https://www2.gnb.ca)
- NS (https://beta.novascotia.ca)
- NL & LB (https://www.gov.nl.ca)
- PEI (https://www.princeedwardisland.ca/en)
- Yukon (https://yukon.ca)
- NWT (https://www.gov.nt.ca)
- Nunavut (https://www.gov.nu.ca)

Australia (https://www.australia.gov.au)
Italy (http://www.governo.it)
Singapore (https://www.gov.sg)
China (https://www.gov.cn/english/)
USA (https://www.usa.gov)

GENERAL SURGICAL GROUPS/COLLEGES

Royal College of Physicians and Surgeons of Canada (http://www.royalcollege.ca)
American College of Surgeons (https://www.facs.org)
European Surgical Association (https://www.europeansurgicalassociation.org)

College of Surgeons, Singapore (https://www.ams.edu.sg/colleges/CSS/home)
French Surgical Association
German Society of Surgery (https://www.dgch.de/index.php?id=118)
Italian Society of Surgery (SIC) and Italian Association of Hospital Surgeons (ACOI)
Philippine College of Surgeons (https://www.pcs.org.ph)
Royal Australasian College of Surgeons (https://www.surgeons.org)
Royal College of Surgeons of England (https://www.rcseng.ac.uk)
Royal College of Surgeons of Ireland (https://www.rcsi.com/dublin/)
Spanish Society of Surgery (Associacion Espanola de Cirujanos) (https://www.aecirujanos.es)
Swedish Surgical Society (http://www.svenskkirurgi.se)
The Association of Surgeons of South Africa (http://www.surgeon.co.za)
The Pan African Association of Surgeons (http://www.africansurgeons.com)

STEP 2) Advanced Google Searching. Targeting above sites will assess 5 pages of Google Search past last click. Will be using standard and consistent terms “coronavirus” OR “Covid-19” OR “Surgery” OR “non-urgent” OR “guidelines”)

STEP 3) General Search Engine (Google) Search with same terms as above, assessing 5 pages past last click for relevance.

STEP 4) Contact with Knowledge Experts.

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	Page 1: Title
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	Page 3: Abstract
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	Pages 5,6: Introduction
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	Page 6: Introduction
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	Not registered given rapid nature of review.
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	Page 8: Methods- Study Eligibility
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	Page 6: Methods- Search Strategy
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Appendix A
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	Pages 7.8: Methods- Study Selection
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	Page 9: Methods- Data Extraction
Data items	11	List and define all variables for which data	Page 9: Methods-

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
		were sought and any assumptions and simplifications made.	Outcomes of Interest
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	Page 10: Methods- Study Quality (ROB) Assessment
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	Page 10: Methods- Data Synthesis, Analysis and Reporting
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Pages 10,11: Results- Search Results & Figure 1: PRISMA Flow chart
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Page 11: Results- Description of Studies & Table 1 (Individual) & Figure 2 (Summary)
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Table 1
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	Pages 11-16: Results- Reorganization of Surgical Services & Impact of Reorganizing Surgical Services & Rebuild Surgical Capacity
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	Pages 16 to 18: Discussion
Limitations	20	Discuss the limitations of the scoping review process.	Page 18, 19: Discussion
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	Page 19: Discussion
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	NA

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.
* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).
‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

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

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ABSTRACT ***(278/300 words)***

Objectives: To understand how surgical services have been reorganized 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 organizations 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 reorganization of surgical services. Secondary were the impacts of reorganization 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 reorganization of surgical services, 55 described the consequences of reorganizing surgical services and six reported actions taken to rebuild surgical capacity in public health emergencies.

Reorganizations of surgical services were grouped under 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. Service reorganizations led to large reductions in non-urgent surgical volumes, increases in surgical wait times, and impacted medical training (i.e., reduced case involvement) and patient outcomes (e.g., 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: Reorganization 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 optimize future health system responses to public health emergencies.

ARTICLE SUMMARY

Strengths and limitations of the 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 1.9M fatalities.[1] To protect the most vulnerable in our societies, efforts to curb further escalation (e.g., travel restrictions, 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 maximize staff, PPE, ventilators, and intensive care unit (ICU) capacity in case public health efforts to 'flatten the curve' are insufficient. Most notably, surgical programs have suspended non-urgent (or 'elective') surgical procedures. Non-urgent surgeries are often defined as procedures for which a delay of three months or longer would not result in significant adverse effects to the patient.[2 3] These changes have thrust patients, providers, and healthcare organizations 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 programs should operationalize the recommendations. As such, approaches to surgical triage and service delivery remain unclear: who has done what where, and why? Further, the impacts of adopting these recommendations on surgical programs, and more importantly, the physical and psychological well-being of patients and healthcare providers have only been hypothesized.[4] Lastly, once COVID-19 begins to release its grip on the world and the post-pandemic recovery begins, programs 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 (i.e., H1N1, Ebola, SARS) is needed to guide approaches to surgical service delivery.

To enable evidence-informed reorganization 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 reorganized 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-Analysis extension for Scoping Reviews (PRISMA-ScR) 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 World Health Organization 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. Further, 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 reorganized in response to public health emergencies, especially the first wave of the COVID-19 pandemic? 2) What are

the patient-, healthcare provider-, and system-level consequences of reorganizing surgical services? and 3) What approaches have been used for resuming surgical services?

Search Strategy

The search strategy was developed by two investigators (CO, KS) and refined by others with context expertise in surgery and literature review methodology (JNK, AKR). The search strategy included subject headings, keywords, and synonyms identifying public health emergencies in general and specific public health emergencies (Ebola, SARS-CoV1, H1N1, MERS), and surgery; and were tailored for each database (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 May 8, 2020. Anticipating pertinent information may not be published (i.e., 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 (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 standardized data abstraction form (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) reorganization of surgical services, 2) impact of reorganizing 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 (e.g., emergency tracheostomy, caesarean section), settings beyond in-patient acute care (e.g., 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 standardized data abstraction form (Appendix B). Data included: date of publication, country, study design, definition of non-urgent surgery, characteristics of study sample (if applicable), outcomes of interest for the three research questions, detailed below.

Outcomes of Interest

Our primary outcomes were reorganization of surgical services, impact of reorganization 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, conceptualized 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 reorganization of surgical services was organized 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 was 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 summarize quantitative outcomes. We characterized and mapped the available emerging evidence using an inductive qualitative approach. Specifically, two authors (CO, KS) familiarized 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 penultimate categories are presented. Data were synthesized 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 six 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), orthopedics (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.

Reorganization of Surgical Service

A number of categories emerged from the 108 studies describing reorganization of surgical services. Nearly all studies reported partial, with most reporting full cessation of non-urgent surgeries at their centre, albeit with varying definitions of "non-urgent" (e.g., can be safely postponed for 3 months) and "urgent" (e.g., 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.

1. 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 (e.g., patient characteristics, acuity, imaging) to a larger group representing many surgical specialties to reach consensus on each case.

2. 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 post-operative suture or staple removal were granted in-person visits under strict conditions including mask wearing, negative symptom check, history or temperature pre-screening. 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 not only follow-up with returning patients but to also 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.

3. 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 (i.e. corridors, 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 Reorganizing 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 summarized below with data for all studies relevant to this question shown in 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 program) reported a 500% increase in latency 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 prioritization.[31] Among studies that changed their surgical triage practices, patients were prioritized for surgery based on procedure acuity or urgency (i.e., 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 Room) ORs, PPE, and testing was necessary to prepare for a large and complicated surgical backlog.

DISCUSSION

This review identified over 3,000 evidence sources, 132 of which were included. Approaches to reorganizing surgical services varied between studies and centers, 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 wellbeing or changes in healthcare utilization 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 centers 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 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 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 pre-public 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 organizing 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 wellbeing 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 World Health Organization and Cochrane's guidance on conducting rapid reviews,[7 8] with the intent of balancing rigor 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 re-running 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- or middle-income countries who may face unique challenges during a pandemic compared to 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 organizations 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 which 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 which 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 (Appendix D).

Author Contributions

CO contributed to the design and conceptualization of the review, analysis and interpretations of the data, and drafting and revising the manuscript; JSN contributed to the design of the review, interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; AKR contributed to the design of the review, interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; JCD contributed to the interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; JW contributed to the interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; JR contributed to the interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; MB contributed to the interpretation of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript; KMS contributed to the design and conceptualization of the review,

analysis and interpretations of the data, providing feedback on the manuscript, and gave approval of the final version of the manuscript.

Competing interest statement

All authors declare that they have no competing interests in accordance with the International Committee of Medical Journal Editors uniform declaration of competing interests.

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Data Sharing Statement

All data presented have been previously published. Our data will be made available upon reasonable request to the corresponding author.

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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
Alverez-Gallego	2020	Spain	COVID-19	General			
Ammar	2020	USA	COVID-19	Neurosurgery			
Amparore	2020	Italy	COVID-19	Urology		Changes in clinical and surgical resident involvement	
Ansarin	2020	Italy	COVID-19	Oncology (Head & 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	Orthopedics			
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	2020	USA	COVID-19	Orthopedics		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	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	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		
Chee	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 & Neck)		Number of surgical cancellations
D'Apolito	2020	Italy	COVID-19	Orthopedics		Changes in surgical volume
de Vries	2020	Netherlands	COVID-19	Transplant		Changes in transplantation volumes
Ding	2020	Singapore	COVID-19	Orthopedics		
Dominguez-Gil	2020	Spain	COVID-19	Transplant		Changes in transplantation volumes
Doussot	2020	France	COVID-19	Oncology		Changes in surgical volume
Dowdell	2020	USA	COVID-19	Orthopedics		
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	2020	Italy	COVID-19	Neurosurgery		Changes in surgical volume
Fontanella	2020	Italy	COVID-19	Neurosurgery		
Giorgi	2020	Italy	COVID-19	Spinal		
Givi	2020	USA	COVID-19	Oncology (Head & Neck)		Changes in fellow educational programming
Gomez-Barrena	2020	Spain	COVID-19	Orthopedics		Changes in surgical volume
Gouveia	2020	Portugal	COVID-19	Vascular		
Guerci	2020	Italy	COVID-19	General		
Gupta	2020	India	COVID-19	Oncology (Head & Neck)		
Haines	2003	China	SARS	Obstetrics		
Hemingway	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	Orthopedics		
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	2020	Italy	COVID-19	Transplant		Changes in transplantation volumes	
Lee	2020	China	COVID-19	Oncology (Head & Neck)		Changes in surgical wait times	
Leong Tan	2020	Singapore	COVID-19	Vascular			
Li	2020	China	COVID-19	Transplant			
Liebensteiner	2020	Austria	COVID-19	Orthopedics			
Liu	2003	Singapore	SARS	Anesthesia			
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	—			Prioritization first of patients who would be at increased risk with further delay, followed by those waiting longest
Meneghini	2020	USA	COVID-19	Orthopedics			
Meyer	2020	France	COVID-19	Neurosurgery		Changes in surgical volume	
Morgan	2020	UK	COVID-19	Orthopedics			
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 & Neck)			
Patel	2020	USA	COVID-19	Otolaryngology			
Pelt	2020	USA	COVID-19	Orthopedics		Number of surgical postponements	Surgeries prioritized based on complexity and predicted LOS, scheduling only completed if appropriate PPE and screening available.
Pittet	2020	Switzerland	COVID-19	—		Changes in surgical volume	
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 & Neck)		Changes in surgical volume	
Randelli	2020	Italy	COVID-19	Orthopedics			
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	Orthopedics			
Schull	2007	Canada	SARS	—		Changes in surgical volume	
Schwarzkopf	2020	USA	COVID-19	Orthopedics			
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	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	Anesthesia			
Tan	2020	Singapore	COVID-19	Urology		Changes in surgical and consultation volumes	
Tan	2020	China	COVID-19	Neurosurgery			
Tay	2020	Singapore	COVID-19	Orthopedics		Changes in surgical volumes	
Tay	2020	Singapore	COVID-19	Orthopedics			
Thaler	2020	Austria	COVID-19	Orthopedics			
Tolone	2020	Italy	COVID-19	—			
Too	2020	Singapore	COVID-19	Interventional Radiology			
Topf	2020	USA	COVID-19	Oncology (Head & Neck)			
Tsui	2005	China	SARS	Cardiac			
Tzeng	2020	USA	COVID-19	Oncology			
Unal	2020	Turkey	COVID-19	Vascular			
Vaccaro	2020	USA	COVID-19	Orthopedics		Changes in physician remuneration and staffing	
Valenza	2020	Italy	COVID-19	Oncology		Changes in surgical volumes	
van de Haar	2020	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	2020	Italy	COVID-19	Oncology (Breast)		Changes in surgical volumes	
Vlantis	2004	China	SARS	Otolaryngology		Changes in outpatient and surgical volumes	
Walker	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	Anesthesia	■■■■	
Wu	2020	China	COVID-19	Oncology (Head & Neck)	■■■■■■	
Xiaolei	2020	China	COVID-19	Ophthalmology		
Zangrillo	2020	Italy	COVID-19	—	■■■■■	
Zarzaur	2020	USA	COVID-19	—	■■■	
Zeng	2020	China	COVID-19	Oncology (Head & Neck)	■■■■	
Zizzo	2020	Italy	COVID-19	—	■■	
Zoia	2020	Italy	COVID-19	Neurosurgery	■■■■	

Domains of change to surgical services, represented numerically:
■ Changes to case selection and surgical triage
■ Changes to PPE protocols and practices
■ Changes to the surgical workforce.
■ Changes to inpatient and outpatient care
■ Changes to resident and fellow education
■ Changes to the environment

Abbreviations: — =data not provided, COVID-19=Coronavirus Disease 2019, ED=Emergency department, GI=Gastrointestinal; LOS=Length of stay, PPE=Personal protective equipment, SARS=Severe Acute Respiratory Syndrome

Table 2. Reorganization of surgical services, by domain.

Change Domain	Number of Studies (%)	Examples of Change
Triage or Case Selection	80 (74.7)	1. Prioritization of patients based on pre-defined levels of acuity; 2. Virtual multidisciplinary meetings or tumor 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 (i.e., 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 (e.g., 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 (e.g., 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 maximize 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 (e.g., only admitted to OR during low-risk/non-aerosolizing procedures).
Environment	70 (64.8)	1. Dedication of wards (hallways, 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 (e.g., cubicles, distanced waiting room chairs) implemented.

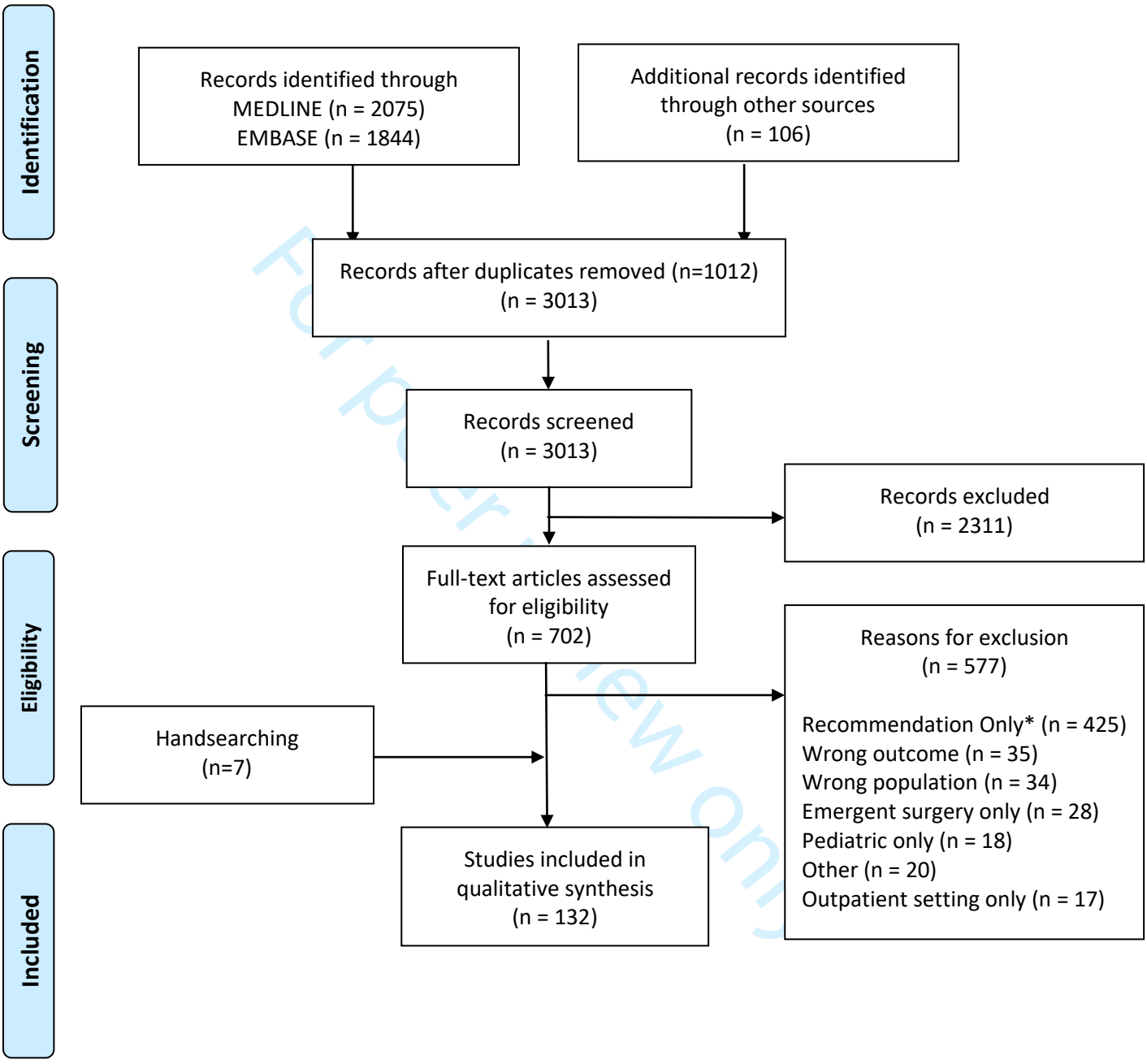
Abbreviations: ICU= Intensive care unit, PPE= Personal protective equipment, PAPR= Powered air purifying respirator, OR= Operating room.

Figure 1. PRISMA Flow diagram.

Figure 2. Summary of study characteristics.

Figure 3. Summary of leading impacts of changes to surgical programming

Figure 1. Flow of studies in the scoping review



*Includes guidelines, recommendation-based reviews, projections or estimations without mention of true changes to surgical programming.

Figure 2. Study characteristics

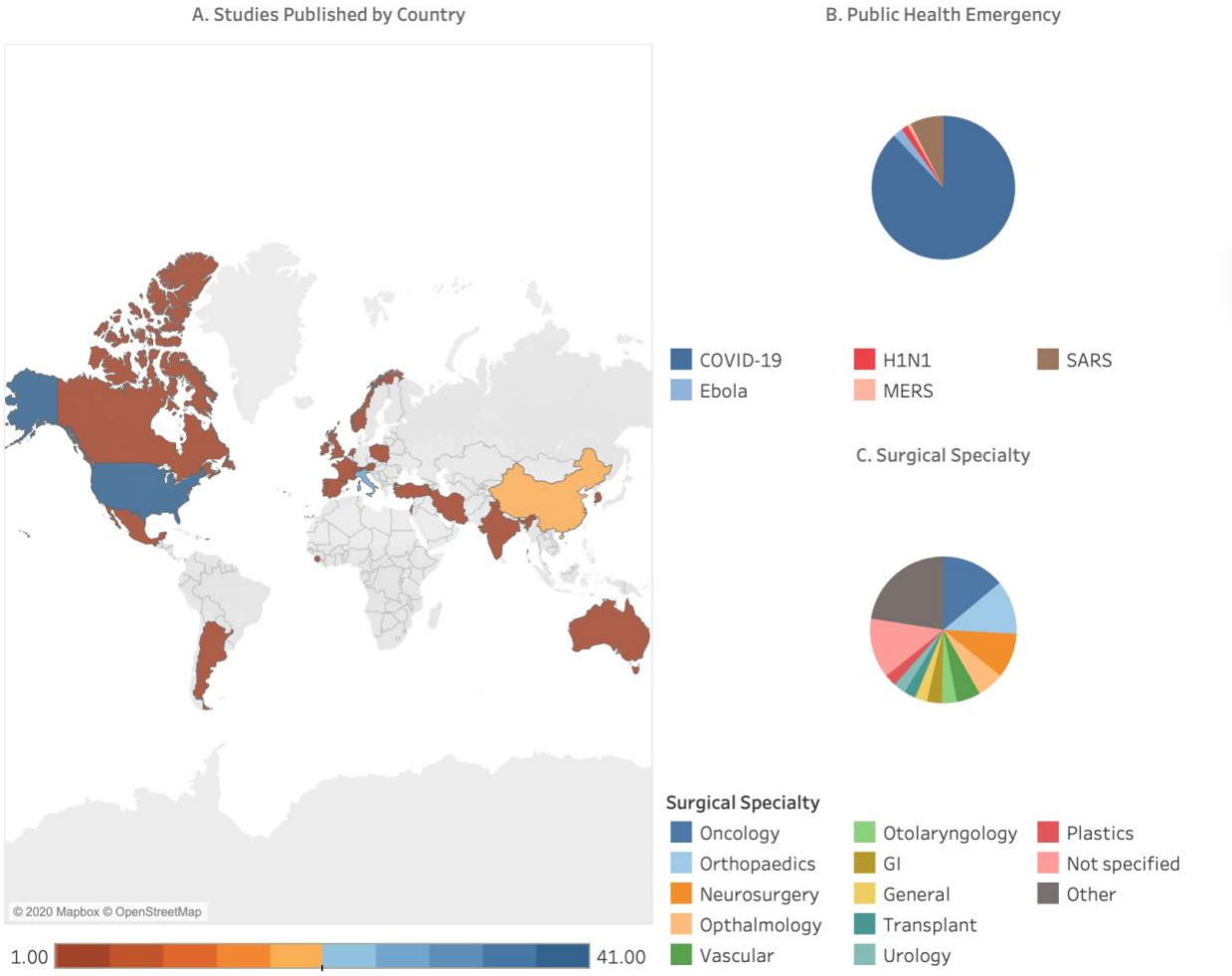


Figure 2. **A.** Country of publication, **B.** Public health emergency discussed, and **C.** Surgical specialty addressed ('Other' includes Cardiac (n=3), Anesthesia (n=3), Electrophysiology (n=3), Obstetrics and Gynecology (n=3), Thoracic (n=2), Interventional Radiology (n=1), and Dermatology (n=1)).

Figure 3. Summary of the impacts of alterations to surgical services

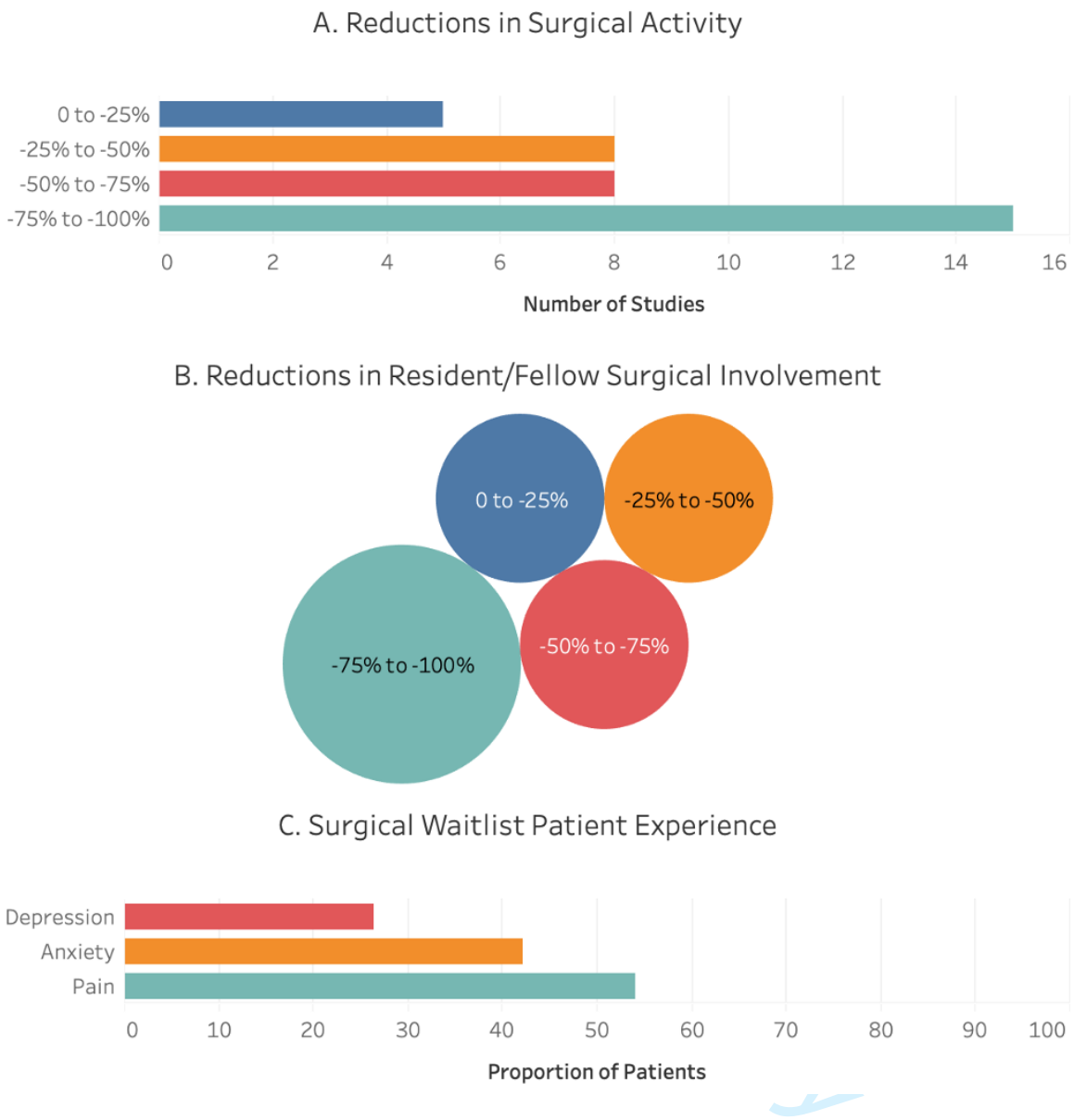


Figure 3. A summary of the impacts of alterations to surgical services during public health emergencies on **A.** Overall surgical activity (n=37 studies), **B.** Resident and fellow involvement in surgery (n=5 studies) where circle size represents the number of studies contributing to that quartile, and **C.** Patient experience (n=2 studies).

Appendix A. Search Strategy

Database: Ovid MEDLINE (R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily <1946 to May 08, 2020>

Search Strategy:

1 exp Disease Outbreaks/ (96117)
2 (pandemic* or epidemic* or outbreak* or out break*).mp. (230774)
3 1 or 2 (231940)
4 exp Coronavirus (13456)
5 coronavirus infections/ or severe acute respiratory syndrome/ (11068)
6 Coronaviridae Infections/ (900)
7 coronaviridae/ or coronavirus/ (3916)
8 Influenza a virus, h1n1 subtype/ or Influenza a virus, h3n2 subtype/ or influenza a virus, h5n1 subtype/ (22141)
9 Hemorrahagic Fever, Ebola/ (5316)
10 SARS Virus/ (3038)
11 Middle East Respiratory Syndrome Coronavirus/ (1034)
12 (pneumonia.mp. or exp pneumonia/) and Wuhan.mp. (661)
13 (coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV or h1n1 or h3n2 or h5n1 or avian influenza or avian flu or swine influenza or swine flu or SARS or ebola* or middle east respiratory syndrome or MERS).mp. (77950)
14 (wuhan) adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV).mp. (190)
15 (coronavir*) adj2 (infection*).mp. (8441)
16 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 (79915)
17 General Surgery/ (38626)
18 Orthopedic Procedures/ (25371)
19 Traumatology/ (3474)
20 Neurosurgery/ (14892)
21 Obstetrics/ (22533)
22 Anesthesia/ (62587)
23 surgical procedures, operative/ or exp elective surgical procedures/ (68085)
24 exp Arthroplasty, Replacement/ (54362)
25 (general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anesthesia or anaesthesia).mp. (748651)
26 (surger* or operation* or procedure*).mp. (3638036)
27 ((elective or non-urgent) adj2 (surg* or procedure*)).mp. (31794)
28 (surg* adj2 (procedure* or planning or triage or operation* or resource* or backlog or re-organiz* or postpone* or cancel* or capacit* or wait time*)).mp. (444474)
29 ((clinic* or hospital) adj2 (process* or procedure* or triage or planning or performance* or capacit*)).mp. (69185)
30 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 (4101483)
31 3 and 16 and 30 (2075)

Database: EMBASE <1974 to 2020 May 08>

Search Strategy:

1	exp epidemic/ (103292)
2	exp pandemic/ (12990)
3	1 or 2 (114458)
4	pandemic influenza/ (4748)
5	exp severe acute respiratory syndrome/ (8505)
6	exp coronaviridae/ or coronaviridae infection/ (14928)
7	coronavirinae/ (2093)
8	Coronavirus infection/ (3397)
9	avian influenza virus/ or "influenza a virus (h1n1)"/ or "influenza a virus (h3n2)"/, "influenza a virus (h5n1)"/ (7466)
10	Ebola hemorrhagic fever/ (5712)
11	exp SARS coronavirus/ (5823)
12	Middle East respiratory syndrome/ (935)
13	(pneumonia.mp. or exp pneumonia/) and Wuhan.mp. (512)
14	(coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV).mp. (92353)
15	(wuhan adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV)).mp. (161)
16	(coronavir* adj2 infection*).mp. (4793)
17	4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 (96712)
18	general surgery/ (15070)
19	orthopedic surgery/ (32672)
20	traumatology/ (10653)
21	neurosurgery/ (59847)
22	obstetrics/ (34886)
23	anesthesiological procedure/ (1785)
24	elective surgery/ (34038)
25	replacement arthroplasty/ or exp arthroplasty/ (73583)
26	(general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anaesthesia or anesthesia).mp. (966732)
27	(surger* or operation* or procedure*).mp. (5402047)
28	((elective or non-urgent adj2 (surg* or procedure*)).mp. (52808)
29	(surg* adj2 (procedure* or planning or triag* or operation* or resource* or backlog or re-organiz* or postpon* or cancel* or capacit* or wait time*)).mp. (187480)
30	((clinic* or hospital) adj2 (process* or procedure* or triag* or planning or performance* or capacit*)).mp. (83715)
31	18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 (5948860)
32	3 and 17 and 31 (1844)

Database	Pandemic terms Pandemic, epidemic	Disease terms COVID-19, SARS, MERS, pandemic flu (h1n1, h3n2, h5n1), ebola	Surgical terms Non-urgent/elective surgery (general, orthopedic, anesthesia, trauma, neurosurgery, obstetrics)
MEDLINE	exp Disease Outbreaks/ OR (pandemic* or epidemic* or outbreak* or out break*).mp.	exp Coronavirus OR coronavirus infections/ or severe acute respiratory syndrome/ OR Coronaviridae Infections/ OR coronaviridae/ or coronavirus/ OR Influenza a virus, h1n1 subtype/ or Influenza a virus, h3n2 subtype/ or influenza a virus, h5n1 subtype/ OR Hemorrahagic Fever, Ebola/ OR SARS Virus/ OR Middle East Respiratory Syndrome Coronavirus/ OR (pneumonia.mp. or exp pneumonia/) and Wuhan.mp. OR (coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV or h1n1 or h3n2 or h5n1 or avian influenza or avian flu or swine influenza or swine flu or SARS or ebola* or middle	General Surgery/ OR Orthopedic Procedures/ OR Traumatology/ OR Neurosurgery/ OR Obstetrics/ OR Anesthesia/ OR surgical procedures, operative/ or exp elective surgical procedures/ OR exp Arthroplasty, Replacement/ OR (general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anesthesia or anaesthesia).mp. OR (surger* or operation* or procedure*).mp. OR ((elective or non-urgent) adj2 (surg* or procedure*)).mp. OR (surg* adj2 (procedure* or planning or triage or operation* or resource* or backlog or re-organiz* or postpone* or cancel* or capacit* or wait time*)).mp.

		east respiratory syndrome or MERS).mp. OR (wuhan) adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV).mp. OR (coronavir*) adj2 (infection*).mp.	OR ((clinic* or hospital) adj2 (process* or procedure* or triage or planning or performance* or capacit*)).mp.
EMBASE	exp epidemic/ OR exp pandemic/	pandemic influenza/ OR exp severe acute respiratory syndrome/ OR exp coronaviridae/ or coronaviridae infection/ OR coronavirinae/ OR Coronavirus infection/ OR avian influenza virus/ or "influenza a virus (h1n1)"/ or "influenza a virus (h3n2)"/, "influenza a virus (h5n1)"/ OR Ebola hemorrhagic fever/ OR exp SARS coronavirus/ OR Middle East respiratory syndrome/ OR (pneumonia.mp. or exp pneumonia/) and Wuhan.mp. OR (coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV).mp. OR	general surgery/ OR orthopedic surgery/ OR traumatology/ OR neurosurgery/ OR obstetrics/ OR anesthesiological procedure/ OR elective surgery/ OR replacement arthroplasty/ or exp arthroplasty/ OR (general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anaesthesia or anesthesia).mp. OR (surger* or operation* or procedure*).mp. OR ((elective or non-urgent adj2 (surg* or procedure*)).mp. OR (surg* adj2 (procedure* or planning or triag* or operation* or resource* or backlog or re-organiz* or postpon* or cancel* or

		(wuhan adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV)).mp. OR (coronavir* adj2 infection*).mp.	capacit* or wait time*)).mp. OR ((clinic* or hospital) adj2 (process* or procedure* or triag* or planning or performance* or capacit*)).mp.

GREY LITERATURE SEARCH PLAN

Developed in reference to Guide from the University of Toronto (Stapleton, Fuller & Lenton)

STEP 1) Targeted Website Browsing. Will be using any combination of standard terms "coronavirus" OR "Covid-19" OR "Surgery" OR "non-urgent surgery" OR "elective surgery" OR "guidelines")

NON-GOVERNMENT GROUPS

World Health Organization (https://www.who.int)
Center for Disease Control and Prevention (https://www.cdc.gov)
European Centre for Disease Prevention and Control (https://www.ecdc.europa.eu/en)

GOVERNMENTS/HEALTH SYSTEMS

Canada (https://www.canada.ca/en.html)

- BC (https://www2.gov.bc.ca/gov/content/home)
- AB (https://www.alberta.ca/index.aspx)
- SK (https://www.saskatchewan.ca)
- MB (https://www.gov.mb.ca)
- ON (https://www.ontario.ca/page/government)
- QC (https://www.quebec.ca/en/)
- NB (https://www2.gnb.ca)
- NS (https://beta.novascotia.ca)
- NL & LB (https://www.gov.nl.ca)
- PEI (https://www.princeedwardisland.ca/en)
- Yukon (https://yukon.ca)
- NWT (https://www.gov.nt.ca)
- Nunavut (https://www.gov.nu.ca)

Australia (https://www.australia.gov.au)
Italy (http://www.governo.it)
Singapore (https://www.gov.sg)
China (https://www.gov.cn/english/)
USA (https://www.usa.gov)

GENERAL SURGICAL GROUPS/COLLEGES

Royal College of Physicians and Surgeons of Canada (http://www.royalcollege.ca)
American College of Surgeons (https://www.facs.org)
European Surgical Association (https://www.europeansurgicalassociation.org)
College of Surgeons, Singapore (https://www.ams.edu.sg/colleges/CSS/home)
French Surgical Association
German Society of Surgery (https://www.dgch.de/index.php?id=118)
Italian Society of Surgery (SIC) and Italian Association of Hospital Surgeons (ACOI)
Philippine College of Surgeons (https://www.pcs.org.ph)
Royal Australasian College of Surgeons (https://www.surgeons.org)
Royal College of Surgeons of England (https://www.rcseng.ac.uk)
Royal College of Surgeons of Ireland (https://www.rcsi.com/dublin/)
Spanish Society of Surgery (Associacion Espanola de Cirujanos) (https://www.aecirujanos.es)
Swedish Surgical Society (http://www.svenskkirurgi.se)
The Association of Surgeons of South Africa (http://www.surgeon.co.za)
The Pan African Association of Surgeons (http://www.africansurgeons.com)

STEP 2) Advanced Google Searching. Targeting above sites will assess 5 pages of Google Search past last click. Will be using standard and consistent terms “coronavirus” OR “Covid-19” OR “Surgery” OR “non-urgent” OR “guidelines”)

STEP 3) General Search Engine (Google) Search with same terms as above, assessing 5 pages past last click for relevance.

STEP 4) Contact with Knowledge Experts.

Source and Site	Search Terms	Potentially Relevant Results
Health Groups		
World Health Organization (https://www.who.int, Advanced Search)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	10
Center for Disease Control and Prevention (https://www.cdc.gov)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	8
European Centre for Disease Prevention and Control (https://www.ecdc.europa.eu/en)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	3
Governments		
Government of Canada (https://www.canada.ca/en.html)	[contains all words] elective surgery covid	4

	[contains all words] non-urgent surgery covid	
Government of BC (https://www2.gov.bc.ca/gov)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	2
Government of AB (https://www.alberta.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	2
Government of SK (https://www.saskatchewan.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	6
Government of MB (https://www.gov.mb.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	4
Government of ON (https://www.ontario.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of QC (https://www.quebec.ca/en/)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of NB (https://www2.gnb.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of NS (https://beta.novascotia.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of NL & LB (https://www.gov.nl.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of PEI (https://www.princeedwardisland.ca)	[contains all words] elective surgery covid	2

	[contains all words] non-urgent surgery covid	
Government of Yukon (https://yukon.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Government of NWT (https://www.gov.nt.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of Nunavut (https://www.gov.nu.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of Australia (https://www.australia.gov.au)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of Italy (http://www.governo.it)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of Singapore (https://www.gov.sg)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Government of China ((https://www.gov.cn/english/)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
United States Government (https://www.usa.gov)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Surgical Colleges/Associations		
Royal College of Physicians and Surgeons of Canada (http://www.royalcollege.ca)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0

American College of Surgeons (https://www.facs.org)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	23
European Surgical Association (https://www.europeansurgicalassociation.org)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
College of Surgeons, Singapore (https://www.ams.edu.sg)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	3
German Society of Surgery (https://www.dgch.de/index.php?id=118)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
Philippine College of Surgeons (https://www.pcs.org.ph)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	11
Royal Australasian College of Surgeons (https://www.surgeons.org)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	12
Royal College of Surgeons of England (https://www.rcseng.ac.uk)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	7
Royal College of Surgeons of Ireland (https://www.rcsi.com/dublin/)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	8
Spanish Society of Surgery (Associacion Espanola de Cirujanos) (https://www.aecirujanos.es)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	1
Swedish Surgical Society (http://www.svenskkirurgi.se)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0

The Association of Surgeons of South Africa (http://www.surgeon.co.za)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
The Pan African Association of Surgeons (http://www.africansurgeons.com)	[contains all words] elective surgery covid [contains all words] non-urgent surgery covid	0
	Total	111

Appendix B. Data Abstraction Form

This form has been developed by adopting and customizing the 'Data collection form- RCTs and NRS' produced by The Cochrane Collaboration. Customization includes the addition of new sections, as well as the omission of sections not relevant to the review.

Notes on using data extraction form:

- Be consistent in the order and style you use to describe the information for each report.
- Record any missing information as unclear or not described, to make it clear that the information was not found in the study report(s), not that you forgot to extract it.
- Include any instructions and decision rules on the data collection form, or in an accompanying document. It is important to practice using the form and give training to any other authors using the form.

1. General Information

1. Date form completed (dd/mm/yyyy)	/ /
2. Name of person extracting data	☐ Connor M. ORielly ☐ Khara M. Sauro
3. Contact details of person extracting data	
4. Title of Article/Abstract (that data are extracted from)	
5. Study ID (plus surname of author and year of study publication)	
6. Study country of origin	
7. Study funding source	
8. Possible conflicts of interest	☐ Reported ☐ Not Reported
9. Notes:	

2. Eligibility

Study Characteristics	Inclusion Criteria	Location in text (page#/fig#/table#)
10. Type of study (design)	☐ Case Study ☐ Case Series ☐ Observational	

11. Population description		
12. Focused diseases/conditions		
13. Types of outcome measures		
14. Decision (with reasons for either inclusion or exclusion)	☐ Include ☐ Exclude If Exclude, explain:	
15. Notes		

IF STUDY IS EXCLUDED FROM REVIEW, DO NOT CONTINUE

2. Population and setting

	Description	Location in text (page#/fig#/table#)
16. Population description		
17. Source/setting of the population (e.g., urban, rural, ethnic group)		
18. Method(s) of recruitment of participants	☐ Random ☐ Non-Random Method:	
19. Notes:		

3. Methods

	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)

20. Aim of study		
21. Design (e.g., cross-sectional, RCT, CCT)	☐ Case Study ☐ Case Series ☐ Observational	
22. Sampling technique (e.g., random or convenience)	☐ Random ☐ Non-Random	
23. Study start date (dd/mm/yyyy)	/ /	
24. Study end date/duration (dd/mm/yyyy)	/ / **OR** Duration:	
25. Notes:		

4. Participants

	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
26. Total number of participants/Sample size		
27. Age		
28. Sex	☐ Both Sexes ☐ Males ☐ Females	
29. Genders Represented		
30. Country		
31. Predominant medical complaint		
32. Co-morbidities (if any)		
33. Definition of 'Frequent use' (if any)		

34. Notes:

5. Outcomes

Keep only the tables for outcomes relevant to this particular study, duplicate tables as necessary.

Outcome 1: Alterations to surgical programming (RQ1)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
35. Outcome definition		
36. Time points measured		
37. Domains of change	☐ Surgical triage ☐ PPE ☐ Workforce ☐ Patient care ☐ Environmental	
38. Unit of measurement	☐ Group ☐ Individual	
39. Notes:		

Outcome 2: Patient-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
40. Specify Outcome		
41. Outcome definition		
42. Time points measured		
43. Unit of Measurement	☐ Group ☐ Individual	
44. Unit of measurement		
45. Notes:		

Outcome 3: System-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
46. Specify Outcome		
47. Outcome definition		
48. Time points measured		
49. Unit of Measurement	☐ Group ☐ Individual	
50. Unit of measurement		
51. Notes:		

Outcome 4: Practitioner-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
52. Specify Outcome		
53. Outcome definition		
54. Time points measured		
55. Unit of Measurement	☐ Group ☐ Individual	
56. Unit of measurement		
57. Notes:		

Outcome 5: Alterations to rebuild capacity (RQ3)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
58. Outcome definition		
59. Time points measured		

60. Domains of change	☐ Surgical triage ☐ PPE ☐ Workforce ☐ Patient care ☐ Environmental	
61. Unit of measurement	☐ Group ☐ Individual	
62. Notes:		

6. Results and findings

Keep only the tables for outcomes relevant to this particular study, duplicate tables as necessary.

Outcome 1: Alterations to surgical programming (RQ1)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
63. Subgroup (if applicable, e.g., age/sex specific reporting)		
64. Results		
65. Response/non-response rate		
66. Unit of analysis (i.e., individual or group)		
67. Notes:		

Outcome 2: Patient-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
68. Subgroup (if applicable, e.g., age/sex specific reporting)		
69. Results		
70. Response/non-response rate		
71. Unit of analysis (i.e., individual or group)		
72. Notes:		

Outcome 3: System-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
73. Subgroup (if applicable, e.g., age/sex specific reporting)		
74. Results		
75. Response/non-response rate		
76. Unit of analysis (i.e., individual or group)		
77. Notes:		

Outcome 4: Practitioner-level outcomes (RQ2)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
78. Subgroup (if applicable, e.g., age/sex specific reporting)		
79. Results		
80. Response/non-response rate		
81. Unit of analysis (i.e., individual or group)		
82. Notes:		

Outcome 5: Alterations to rebuild capacity (RQ3)	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
83. Subgroup (if applicable, e.g., age/sex specific reporting)		
84. Results		
85. Response/non-response rate		
86. Unit of analysis (i.e., individual or group)		
87. Notes:		

Research Questions informed by this study ***(tick only boxes matching the outcome tables kept above)***

☐ Changes to surgical programming in response to public health emergency

☐ Impacts of changes to surgical programming
☐ Actions to rebuild surgical capacity post-public health emergency

7. Strengths, limitations and mitigation strategy

	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
88. Strengths		
89. Limitations		
90. Strategies to overcome limitations		
91. Notes:		

8. Conclusion and other information

	Descriptions as stated in the article/abstract	Location in text (page#/fig#/table#)
92. Key conclusions of study authors		
93. Notes:		

Appendix C. Complete list of references for included studies

1. Alvarez Gallego M, Gortazar de Las Casas S, Pascual Miguelanez I, et al. SARS-CoV-2 pandemic on the activity and professionals of a General Surgery and Digestive Surgery Service in a tertiary hospital. *Cir Esp* 2020 doi: 10.1016/j.ciresp.2020.04.001 [published Online First: 2020/04/28]
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7. Bernucci C, Brembilla C, Veiceschi P. Effects of the COVID-19 Outbreak in Northern Italy: Perspectives from the Bergamo Neurosurgery Department. *World Neurosurg* 2020;137:465-68 e1. doi: 10.1016/j.wneu.2020.03.179 [published Online First: 2020/04/06]
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13. Brethauer SA, Poulose BK, Needleman BJ, et al. Redesigning a Department of Surgery during the COVID-19 Pandemic. *J Gastrointest Surg* 2020 doi: 10.1007/s11605-020-04608-4 [published Online First: 2020/04/30]
14. Brown TS, Bedard NA, Rojas EO, et al. The Effect of the COVID-19 Pandemic on Electively Scheduled Hip and Knee Arthroplasty Patients in the United States. *J Arthroplasty* 2020 doi: 10.1016/j.arth.2020.04.052 [published Online First: 2020/05/08]

15. Buckstein M, Skubish S, Smith K, et al. Experiencing the Surge: Report from a Large New York Radiation Oncology Department During the COVID-19 Pandemic. *Adv Radiat Oncol* 2020 doi: 10.1016/j.adro.2020.04.014 [published Online First: 2020/05/08]
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BACKGROUND

The novel coronavirus (COVID-19) has spread across the globe with unrelenting speed. At the time of writing over 4 million cases have been confirmed, among them more than 200,000 fatalities[1]. In addition to protecting those most vulnerable in our societies, efforts to curb further disease escalation (e.g., travel restrictions, physical distancing measures) have had a focal objective: prevent case surges that could overwhelm healthcare institutions or further aggravate existing shortages in personal protective equipment (PPE), ventilators, and hospital capacity.

Medical institutions have themselves also taken steps to maximize the availability of staff, PPE, ventilators and intensive care unit (ICU) capacity in the case that external 'curve flattening' practices are not sufficient. Most notably, surgical programs have suspended non-urgent (or elective) surgical procedures, often defined as procedures for which a delay of three (3) months or longer would not result in any significant adverse effect to the patient[2,3]. These changes span nearly all surgical specialties from oncology to orthopedics and have thrusted patients, providers and programs into previously unexplored territory.

While the governing bodies of surgical practice have recommended alterations to non-urgent surgical service delivery, they have not always provided explicit instructions on how programs should approach the change. As such, different groups have likely taken different approaches to surgical triage and service delivery and it remains unclear who has done what where, and why? Further, the impacts of postponing non-urgent surgeries on the physical, psychological, emotional and professional well-being of patients and practitioners are either anecdotal or unknown[4]. Lastly, as COVID-19 begins to release its grip on the world and a level of post-pandemic normalcy returns, programs will be tasked with rebuilding the surgical capacity necessary to reschedule and resume postponed procedures. Evidence on the experiences of other

groups doing so in the context of COVID-19 and other public health emergencies (i.e., H1N1, Ebola, SARS) will be paramount in guiding subsequent approaches.

To address the aforementioned knowledge gaps, we will conduct a rapid review of the literature to synthesize evidence on how surgical resources were allocated in response to COVID-19 and other public health emergencies, how these reallocations impacted patients, practitioners and broader health systems, and what approaches have been taken to rebuild, reorganize and resume surgical service delivery. This review will not only help explain how international surgical programs responded to this unprecedented emergency and what the consequences were, but will also provide the evidence-base necessary to guide responses to this current and any future pandemic event.

METHODS

Study Design

The planned review will answer three questions: (1) How have surgical resources been allocated in response to COVID-19, (2) What are the patient- and system-level consequences of reorganizing surgical resources, and (3) How have resources been reorganized to resume surgical services? We will focus on surgeries identified as “elective” or “non-urgent’. However, to avoid limiting study eligibility unnecessarily no set definition for this term will be used and we will instead report the definition used by each included study.

Search Strategy

An electronic search strategy was developed by the investigators (CO, KS) prior to being reviewed and refined by collaborators with context expertise in surgery and literature review

(JNK, AKR). The search strategy includes subject headings, keywords and synonyms identifying the public health emergencies of interest as well as the surgical specialties likely affected by COVID-19 (Appendix A). Headings and keywords were adapted for use in each database. Given the diversity of the research questions related to this review no study design or publication type constraints will be applied to the search. Further, since (by definition) the impacts of a pandemic span many countries, no language restrictions will be applied. However, to deliver on the study objectives in a timely fashion, studies not easily translated by members of the research team will be subsequently excluded from the review.

We will conduct comprehensive searches of Ovid MEDLINE (including Epub Ahead of Print, In-Process & Other Non-Indexed Citations) and EMBASE from database inception onwards. Since much of the information related to the questions of this review is likely unpublished (i.e., joint statements, recommendations and guidelines from surgical colleges) we will also complete a detailed grey literature search. An *a priori* designed plan for this search has been developed (Appendix B) and will follow methodological recommendations by including targeted website searching, advanced and general Google searching and contact with knowledge experts[5]. Further, the reference lists from all included studies will be examined for any additional relevant studies not captured in the formal database and grey literature searches.

Study Selection

In accordance with recommendations from the Cochrane Methods Group and World Health Organization Alliance for Health Policy and Systems Research, the titles and abstracts of all retrieved items will be reviewed by one of two independent researchers (CO, KM) with a third, independent researcher (KS) serving as duplicate reviewer for a random 25% sample of all

references[6,7]. Eligibility criteria varies such that the relevance of studies is determined by the research question to which they pertain. For the first question on how surgical resources have been allocated we will include any study that examines or discusses organization of surgical resources and patients during COVID-19 or other public health emergency (i.e., triage criteria, allocation of hospital resources if they include surgery, PPE for the operating room staff). To address the second question – consequences of reorganizing surgical resources- we will include any studies that examine patient- and/or system-level surgical outcomes during COVID-19 or other public health emergencies (i.e., adverse events, length of stay, ICU admissions). Lastly, to determine how resources have been organized to resume non-urgent surgical services we will include any study that examines resuming surgical services after COVID-19 or another public health emergency.

Full texts of studies not excluded in the title and abstract phase will then be reviewed in duplicate by the same researchers to ensure applicability to any of the research questions. Any articles identified as meeting the pre-specified eligibility criteria at this stage will be included in the final review. Interrater agreement on inclusion for the 25% sample of titles and abstracts reviewed in duplicate as well as the full texts will be measured with a Cohen's kappa (κ) statistic and corresponding 95% confidence interval. At all stages of the review an unbiased third party will be available to resolve any sustained disagreements between reviewers. The full study selection process including reasons for full text exclusions will be reported using a Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram[8].

Outcomes of Interest

Study information will be collected to answer the research questions of steps taken to respond to emergencies and rebuild capacity (see data extraction section below), but these questions are not outcome oriented and as such specific outcomes data for these questions will not be collected. However, the second research question surrounding the consequences of altering non-urgent surgical programming will require the collection of both quantitative and qualitative outcomes in order to provide the desired holistic understanding of impacts. Specifically, we will assess patient-level outcomes including the incidence of adverse events (i.e., negative event leading to patient harm and caused by management (or lack thereof) rather than the underlying condition of the patient), mortality, and quotes discussing emotional and psychological impacts of delays. We will also evaluate impacts on the healthcare system using measures of resource utilization such as number of emergency department visits, number of visits to a healthcare provider, length of hospital or ICU stay, as well as qualitative statements from practitioners and hospital administrators.

Data Extraction

Any relevant study and outcome data will be extracted from included studies by one researcher using a standardized data abstraction form. For all studies this form will guide the collection of information including date of publication, country where study was conducted, study design, definition of elective or non-urgent surgery, and characteristics of study sample (if applicable). The data extraction form is also designed to collect information specific to each of the three research questions such as selected surgical triage criteria, patient and health system-level outcomes, and detailed emergency response plans. A second independent researcher will review all data abstraction forms to verify their completion and accuracy.

Study Quality (Risk of Bias) Assessment

This rapid review will aim to synthesize quantitative outcomes whenever possible but will largely involve scoping the available evidence on surgical service delivery during public heath emergencies. Given this broad aim and the decision to include all study designs, quality appraisal for the included studies is not feasible and will not performed.

Data Synthesis, Analysis and Reporting

Study and sample information will be described in a narrative review and summarized in a data table. We do not anticipate being able to conduct a meta-analysis of quantitative outcomes and will instead synthesize outcomes data qualitatively with support from descriptive statistics whenever possible. Any summary tables for outcomes will be stratified by the three research questions to maximize clarity. Any within-study comparisons (e.g., incidence of adverse events in patients with delayed versus non-delayed surgery) will be considered significant at a two-tailed p-value <0.05.

Ethics and Dissemination

This review will only include secondary data sources and as such there are no applicable ethical considerations. Following completion, this review will become an integral part of evidence-based guidelines to support decisions about allocating resources and organizing surgical care in the era of COVID-19 and during subsequent public health emergencies. The rapid review will also be submitted to peer-reviewed journals to reach the target audiences of patients, policy makers, practitioners and surgical program administrators.

Limitations

The rapidly evolving nature of surgical programming during the COVID-19 situation demands an equally rapid synthesis and dissemination of key evidence. A rapid review therefore supersedes a traditional systematic review, but with this decision come methodological limitations. First, it is possible that much of the identified evidence emerges from non-traditional sources and grey literature and as a result, may be of a lower methodological quality than that from peer-reviewed sources. However, the goal of this review is not to evaluate quantitative outcomes at potential risk of bias but to instead collate the diversity of available information from surgical programs worldwide to inform decision-making. As such the potential negative impacts of lower study quality are of less concern. Secondly, the landscape of evidence specific to COVID-19 changes daily. While the selection of a set date for literature search is important for reporting and review reproducibility, it may lead to the omission of relevant information released beyond this date. We believe, however, that a current date selected for the literature search will span a period of time where some countries are in the process of recovering their surgical services while others remain in the throes of the pandemic. This will maximize the chances that sufficient evidence to answer all research questions is up to date and available.

CONCLUSION

This paper describes the methodology for a planned rapid review that will synthesize evidence on the changes to, impacts of, and recovery of non-urgent surgical service delivery during COVID-19 and other public health emergencies. As post-pandemic normalcy begins to return and non-urgent surgeries resume, the evidence from this review will inform

recommendations for allocating and organizing care while mitigating any potential negative impacts resulting from changes in service delivery.

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Appendices

Appendix A: Ovid MEDLINE Electronic Search Strategy

Database: Ovid MEDLINE (R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily <1946 to May 08, 2020>

Search Strategy:

1	exp Disease Outbreaks/ (96117)
2	(pandemic* or epidemic* or outbreak* or out break*).mp. (230774)
3	1 or 2 (231940)
4	exp Coronavirus (13456)
5	coronavirus infections/ or severe acute respiratory syndrome/ (11068)
6	Coronaviridae Infections/ (900)
7	coronaviridae/ or coronavirus/ (3916)
8	Influenza a virus, h1n1 subtype/ or Influenza a virus, h3n2 subtype/ or influenza a virus, h5n1 subtype/ (22141)
9	Hemorrahagic Fever, Ebola/ (5316)
10	SARS Virus/ (3038)
11	Middle East Respiratory Syndrome Coronavirus/ (1034)
12	(pneumonia.mp. or exp pneumonia/) and Wuhan.mp. (661)
13	(coronavir* or COVID-19 or SARS-related coronavirus or SARS-CoV-2 or 2019 novel coronavirus or 2019-nCoV or nCoV or h1n1 or h3n2 or h5n1 or avian influenza or avian flu or swine influenza or swine flu or SARS or ebola* or middle east respiratory syndrome or MERS).mp. (77950)
14	(wuhan) adj2 (coronavir* or flu or pneumonia* or COVID-19 or 2019-nCoV).mp. (190)
15	(coronavir*) adj2 (infection*).mp. (8441)
16	4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 (79915)
17	General Surgery/ (38626)
18	Orthopedic Procedures/ (25371)
19	Traumatology/ (3474)
20	Neurosurgery/ (14892)
21	Obstetrics/ (22533)
22	Anesthesia/ (62587)
23	surgical procedures, operative/ or exp elective surgical procedures/ (68085)
24	exp Arthroplasty, Replacement/ (54362)
25	(general surgery or orthopaedic or orthopedic or trauma or neurosurgery or obstetrics or anesthesia or anaesthesia).mp. (748651)
26	(surger* or operation* or procedure*).mp. (3638036)
27	((elective or non-urgent) adj2 (surg* or procedure*)).mp. (31794)
28	(surg* adj2 (procedure* or planning or triage or operation* or resource* or backlog or re-organiz* or postpone* or cancel* or capacit* or wait time*)).mp. (444474)
29	((clinic* or hospital) adj2 (process* or procedure* or triage or planning or performance* or capacit*)).mp. (69185)

30 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 (4101483)
31 3 and 16 and 30 (2075)

Appendix B: Grey Literature Search Plan

GREY LITERATURE SEARCH PLAN

Developed in reference to Guide from the University of Toronto (Stapleton, Fuller & Lenton)

STEP 1) Targeted Website Browsing. Will be using any combination of standard terms "coronavirus" OR "Covid-19" OR "Surgery" OR "non-urgent surgery" OR "elective surgery" OR "guidelines")

NON-GOVERNMENT GROUPS

World Health Organization (https://www.who.int)
Center for Disease Control and Prevention (https://www.cdc.gov)
European Centre for Disease Prevention and Control (https://www.ecdc.europa.eu/en)

GOVERNMENTS/HEALTH SYSTEMS

Canada (https://www.canada.ca/en.html)

- BC (https://www2.gov.bc.ca/gov/content/home)
- AB (https://www.alberta.ca/index.aspx)
- SK (https://www.saskatchewan.ca)
- MB (https://www.gov.mb.ca)
- ON (https://www.ontario.ca/page/government)
- QC (https://www.quebec.ca/en/)
- NB (https://www2.gnb.ca)
- NS (https://beta.novascotia.ca)
- NL & LB (https://www.gov.nl.ca)
- PEI (https://www.princeedwardisland.ca/en)
- Yukon (https://yukon.ca)
- NWT (https://www.gov.nt.ca)
- Nunavut (https://www.gov.nu.ca)

Australia (https://www.australia.gov.au)
Italy (http://www.governo.it)
Singapore (https://www.gov.sg)
China (https://www.gov.cn/english/)
USA (https://www.usa.gov)

GENERAL SURGICAL GROUPS/COLLEGES

Royal College of Physicians and Surgeons of Canada (http://www.royalcollege.ca)
American College of Surgeons (https://www.facs.org)
European Surgical Association (https://www.europeansurgicalassociation.org)

College of Surgeons, Singapore (https://www.ams.edu.sg/colleges/CSS/home)
French Surgical Association
German Society of Surgery (https://www.dgch.de/index.php?id=118)
Italian Society of Surgery (SIC) and Italian Association of Hospital Surgeons (ACOI)
Philippine College of Surgeons (https://www.pcs.org.ph)
Royal Australasian College of Surgeons (https://www.surgeons.org)
Royal College of Surgeons of England (https://www.rcseng.ac.uk)
Royal College of Surgeons of Ireland (https://www.rcsi.com/dublin/)
Spanish Society of Surgery (Associacion Espanola de Cirujanos) (https://www.aecirujanos.es)
Swedish Surgical Society (http://www.svenskkirurgi.se)
The Association of Surgeons of South Africa (http://www.surgeon.co.za)
The Pan African Association of Surgeons (http://www.africansurgeons.com)

STEP 2) Advanced Google Searching. Targeting above sites will assess 5 pages of Google Search past last click. Will be using standard and consistent terms “coronavirus” OR “Covid-19” OR “Surgery” OR “non-urgent” OR “guidelines”)

STEP 3) General Search Engine (Google) Search with same terms as above, assessing 5 pages past last click for relevance.

STEP 4) Contact with Knowledge Experts.

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	Page 1: Title
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	Page 3: Abstract
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	Pages 5,6: Introduction
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	Page 6: Introduction
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	Not registered given rapid nature of review.
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	Page 8: Methods- Study Eligibility
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	Page 6: Methods- Search Strategy
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Appendix A
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	Pages 7.8: Methods- Study Selection
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	Page 9: Methods- Data Extraction
Data items	11	List and define all variables for which data	Page 9: Methods-

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
		were sought and any assumptions and simplifications made.	Outcomes of Interest
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	Page 10: Methods- Study Quality (ROB) Assessment
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	Page 10: Methods- Data Synthesis, Analysis and Reporting
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Pages 10,11: Results- Search Results & Figure 1: PRISMA Flow chart
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Page 11: Results- Description of Studies & Table 1 (Individual) & Figure 2 (Summary)
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Table 1
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	Pages 11-16: Results- Reorganization of Surgical Services & Impact of Reorganizing Surgical Services & Rebuild Surgical Capacity
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	Pages 16 to 18: Discussion
Limitations	20	Discuss the limitations of the scoping review process.	Page 18, 19: Discussion
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	Page 19: Discussion
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	NA

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.
* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).
‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.