Review

CUTTING EDGE

Immediate and long-term impact of the COVID-19 pandemic on delivery of surgical services

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Background: **The ongoing pandemic is having a collateral health effect on delivery of surgical care to millions of patients. Very little is known about pandemic management and effects on other services, including delivery of surgery.**

Methods: **This was a scoping review of all available literature pertaining to COVID-19 and surgery, using electronic databases, society websites, webinars and preprint repositories.**

Results: **Several perioperative guidelines have been issued within a short time. Many suggestions are contradictory and based on anecdotal data at best. As regions with the highest volume of operations per capita are being hit, an unprecedented number of operations are being cancelled or deferred. No major stakeholder seems to have considered how a pandemic deprives patients with a surgical condition of resources, with patients disproportionally affected owing to the nature of treatment (use of anaesthesia, operating rooms, protective equipment, physical invasion and need for perioperative care). No recommendations exist regarding how to reopen surgical delivery. The postpandemic evaluation and future planning should involve surgical services as an essential part to maintain appropriate surgical care for the population during an outbreak. Surgical delivery, owing to its cross-cutting nature and synergistic effects on health systems at large, needs to be built into the WHO agenda for national health planning.**

Conclusion: **Patients are being deprived of surgical access, with uncertain loss of function and risk of adverse prognosis as a collateral effect of the pandemic. Surgical services need a contingency plan for maintaining surgical care in an ongoing or postpandemic phase.**

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Introduction

The pandemic of COVID-19 caused by the coronavirus SARS-CoV-2[1] is disrupting global health, social welfare and the economy in a proportion unparalleled in modern history. In addition to the effects of the disease itself on public health, a collateral effect from near-universal disruption and cancellation of surgical services has emerged.

Although the seasonal disruption of surgical care and the occasional cancellation of surgery is not new to most healthcare systems[2–4], the current pandemic has unprecedented implications for surgical services and

patients with surgical conditions[5]. Surgical capacity may experience extreme challenges in war zones[6,7], or in the case of mass casualty events from terror or during civilian accidents or natural disasters, with numbers exceeding the surgical capacity (such as operating theatres, number of surgeons and anaesthesia staff). In the current pandemic, rather than mobilizing surgical resources for surgical conditions in need, the current demand for ventilators, hospital space and personnel is depriving surgical capacity to a point where essential surgical delivery is strained in multiple regions, irrespective of their economic classification. This is having an immediate and long-term effect on millions of patients with surgical conditions worldwide. Globally, there have been deficits in surgical service preparation, delivery and recovery from the pandemic; lessons can be learned from countries in each phase of response.

Methods

An international collaborative of co-investigators representative of several surgical disciplines, geographical regions and with experience ranging from administrative leadership roles to frontline practice were involved. A detailed description of the search strategy, inclusion and exclusion criteria, and results are provided in *Tables S1* and *S2*, *Fig. S1* and *Appendix S1* (supporting information). A scoping review approach was used[8–10].

Impact of pandemic on surgical services

Based on the available reports and evolving real-time experience, the pandemic effects on surgery are profound, potentially long-lasting and extensive. Studies[5,11–26] identified in relation to surgery and perioperative care comprised opinions, anecdotal reports and recommendations. Several national surgical societies had launched COVID-19-specific guidelines with dynamic updates, in addition to over 20 subdiscipline-specific surgical and perioperative guidelines (*Table 1*; *Table S3*, supporting information). Of particular note, information related to surgical services in a pandemic was scarce on the WHO website[27].

Several generic themes are similar across regions, and may be used to mitigate the effects of the pandemic on surgical services, both in the short term and in the longer term, and to learn from for preparedness for future possible events.

From a public health perspective, the modelled response and effects are largely dependent on the slope of increase of diseased and critically ill patients, and how the peak of the pandemic curve evolves in order to cope with emerging needs (*Fig. 1*)[28]. The ability of surgical services to maintain a role depends on the peak of the pandemic, the spread of the disease, the duration of societal regulations, and the duration and temporal epidemic repeats by which the disease burden will approach the threshold of maximum capacity of the critical care resources (*Fig. 1*). Even in a situation where the threshold may not be exceeded, one may expect capacity to be close to, or temporarily breached, before the pandemic fades.

Addressing pandemic preparedness phase

In regions where hospital networks already exist, attempts at developing 'COVID-19' and 'non-COVID-19' hospitals may be a reasonable way to preserve surgical services and normal function, while containing the diseased population away from the non-diseased. Suggestions of how to manage this within and between hospitals have been proposed elsewhere[29–31].

Reorganization of surgical services to hospitals and designated pathways

The success of pandemic preparedness and resilience of the system is largely dependent on the scale of the outbreak, the time frame and the pressure on health systems[5,32]. A hub-and-spoke model was used in the Lombardy region of Italy (*Appendix S2*, supporting information). However, this model may be feasible only until community transmission reaches a critical threshold.

At the institutional level, creating within-hospital pathways for 'clean' and 'contaminated' patient flow is essential to maintain open routes for regular diagnosis and treatment. Where resources allow, one should declare dedicated COVID-19 radiology units (CT scanners, etc.), wards, operating theatres and endoscopy suites. Such organization may imply having COVID-19-dedicated teams of healthcare professionals. Using separate pathways at the institutional level can also support rapid outbreaks where system-level 'COVID-19' and 'non-COVID-19' hospitals are not feasible, or when the pandemic reaches a state when hospital designation is no longer sustainable. However, a breakdown of barriers by hospital designation, by separated wards or clinical pathway designation should be prevented or mitigated to avoid uncontrolled spread of disease.

Designation of hospitals, care areas and healthcare professionals for COVID-19 care should be implemented early on to delay and prevent progression of the outbreak via healthcare institutions and professionals. Once the pandemic reaches a critical threshold through community transmission, these models may not be sustainable, and broader reorganization of care becomes necessary.

Table 1 Organizations providing perioperative guidelines for patients with COVID-19

Health systems guidelines	Anaesthesia guidelines	Surgical guidelines	Subspecialty-specific guidelines	
Centers for Disease Control and Prevention	American Society of Anesthesiologists	American College of Surgeons	American Academy of Ophthalmology	British Association of Paediatric Surgeons
European Centre for Disease Prevention and Control	Canadian Anesthesiologists' Society	French Surgical Association	American Academy of Orthopedic Surgeons	European Society of Surgical Oncology
Government of Australia	Faculty of Intensive Care Medicine, Intensive Care Society, Association of Anaesthetists, and Royal College of Anaesthetists	German Society of Surgery	American Academy of Otolaryngology	German Society of General and Visceral Surgery
United States Department of Defense	Italian College of Anaesthesia, Analgesia, Resuscitation, and Intensive Care (SIAARTI)	Italian Society of Surgery (SIC) and Italian Association of Hospital Surgeons (ACOI)	American Association of Oral and Maxillofacial Surgery	Philippine Association of HPB Surgeons
	South African Society of Anaesthesiologists	Philippine College of Surgeons	American Association for the Surgery of Trauma	Royal College of Obstetricians and Gynaecologists
	World Federation of Societies of Anaesthesiologists	Royal Australasian College of Surgeons	American College of Obstetrics and Gynecology, Society for Maternal Fetal Medicine	Sociedade Brasileira de Pneumologia e Tisiologia, Asociación Latinoamericana de Tórax
		Royal College of Surgeons of England	American Dental Association	Sociedad Española de Neumología y Cirugía Torácica
		Royal College of Surgeons of Ireland	American Pediatric Surgical Association	Society of American Gastrointestinal and Endoscopic Surgeons & European Association for Endoscopic Surgery
		Spanish Society of Surgery	American Society of Breast Surgeons	Society of Surgical Oncology
		Swedish Surgical Society	American Society for Gastrointestinal Endoscopy	Society of Thoracic Surgeons
		The Association of Surgeons of South Africa	American Society of Transplant Surgeons	Society for Vascular Surgery
		The Pan African Association of Surgeons	American Urological Association	World Society of Emergency Surgery
			Americas Hepato-Pancreato-Biliary Association	
			Australian Society of Otolaryngology Head and Neck Surgery	

Societies with available COVID-19-specific information or recommendations on 10 April 2020. HPB, hepatopancreatobiliary.

Reorganization of surgical services to critical care capacity

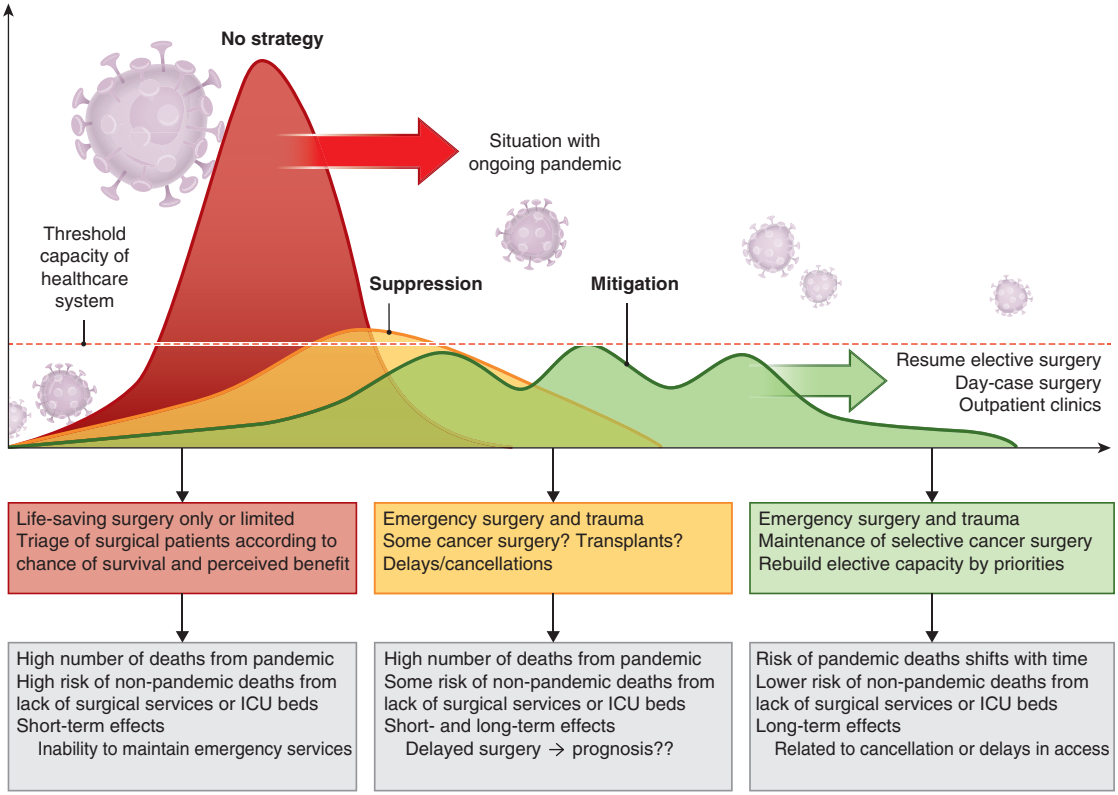
In the extreme case when waves of patients are admitted to hospital, the surge in critically ill patients may deprive surgical services of resources to the point of exclusion. Several regions have experienced this phenomenon and many are planning for this scenario, with cancellation of all non-essential surgery for an initial period[33]. Operating theatres and anaesthesia machines may be converted to temporary respiratory support units. Postoperative recovery rooms and intermediate-care units may be used as care units outside regular intensive care to manage sick patients with COVID-19. In this case, there is a real threat of disruption to all surgical services and difficulty maintaining even critical surgical care.

In order to prepare, all non-essential elective surgery has been recommended to be cancelled in many healthcare systems and by surgical societies, but with variable suggestions and advice across regions and disciplines (*Table 1*; *Table S3*, supporting information). Information and advice are changing as pressure, and needs rise and resources are stretched. New knowledge is emerging rapidly, leading to suggestions sometimes based on anecdotal reports at best. In general, deferral of surgery is especially recommended for non-urgent operations with a potential requirement for postoperative ICU care.

Reorganization of surgical workforce

In countries where intensive care medicine is part of, or integrated into, surgical care, there is an opportunity to relocate surgical providers to COVID-19 management to enhance the intensive care capacity of personnel familiar with, or experienced in, use of ventilators. Intensive care training is highly variable in surgical training across training systems, and actual practice and experience vary from country to country. In the USA and Canada, surgeons trained in critical care may be a resource for management

Fig. 1 Pandemic burden and impact on surgical services



The threshold for a given healthcare system may be broken by a surge in infected patients. Capacity to maintain even life-saving surgery may not be sustained (during major or minor peaks of outbreak), leading to a potential additional loss of lives unrelated to the pandemic disease itself, but as collateral damage. Mitigation or suppression strategies may be long-lasting (tail effect) and have effects on elective and semiurgent capacity, with the risk of worsening disease or function, or have a detrimental impact on prognosis. Models to show implications of the pandemic on various capacity scenarios are needed, as the toll on patients and public health is potentially enormous.

of patients in need of respiratory support on a ventilator. In other regions, such as the Nordic countries, all intensive care is within the domain of anaesthetists trained in critical care. Thus, surgeons do not represent an immediate resource for allocation to such services. In addition, as anaesthetists will be involved in the critical care rota, their availability for surgical anaesthesia and perioperative care will be affected. Other forms of redirection of services are possible and needed in this setting.

Some surgeon subspecialists who do not usually cover emergency surgery (such as hepatobiliary surgeons and surgical oncologists) may be called on to cover emergency general surgery and trauma. As personnel may become diseased or quarantined, it may be necessary to rotate staff according to need and competence, and also to allow staff to have breaks from periods of extreme work pressure and intense workload.

Viral risks and effects on available workforce

With large numbers of staff being quarantined (owing to travel, contact or cluster exposure; for example, at risk, but not tested) or in imposed self-quarantine (sore throat, cough or cold; not tested) or who have actually contracted the disease (SARS-CoV-2-positive), there is also a need to relocate personnel across surgical services to cover staff shortages.

Appropriate personal protective equipment (PPE) is an absolute necessity, but has proven to be a global issue, with variable and unpredictable supply chains and delivery networks across the globe[15]. For the surgical workforce working on wards with non-infected patients, a high suspicion should be maintained and social distancing principles

applied by patients and staff (such as working in smaller groups; splitting teams with alternating half-and-half working at home and on site; reducing participants in meetings; virtual participation at multidisciplinary team meetings through telecommunication)[24,34,35].

Ambulatory surgery should stop, even if low risk, as this uses equipment and protective gear as well as having the risk of bilateral disease spread (patient to provider and vice versa). Reports of adverse effects and fatal outcomes from contracting COVID-19 after ambulatory and elective surgery are of concern[14,15,25,36]. Outpatient clinics should be reduced to a minimum, and maintained through alternative sources, such as video consultations. These have long been used in remote areas to avoid long travel distances[34,37–39], but can be implemented rapidly even in large metropolitan regions to maintain social distancing during a pandemic[35].

There are currently no data to assess the impact on the surgical (and related healthcare personnel) workforce. In Italy (*Appendix S2*, supporting information), several healthcare providers have developed severe COVID-19 and died. In Hong Kong (*Appendix S3*, supporting information) none of the healthcare workers have been infected by COVID-19 in the hospital setting. It is too early to predict the total impact on the healthcare workforce. A grave global concern is the universal lack of PPE, which is likely to have a huge impact on the morbidity and mortality of healthcare personnel from contracting COVID-19 owing to a lack of appropriate protection.

Reconsidering or redirection of choice of management

In a scenario in which the goal is to reduce unwanted admissions to hospital, to avoid surgery (if at all possible), or delay or defer interventions until resources or risk can be better controlled, there is a need to reconsider treatment options or management strategies for several disease groups. Surgeons are used to decision-making processes, albeit usually based on a broad array of clinical, personal and institutional variables[40]. A pandemic scenario changes the reasoning and premise by which decisions will be made. In general, a risk-averse strategy should be implemented. Notably, this may result in changes in management and outcomes for surgical conditions.

A template prescription of which patients should be preferred for a specific management option is not possible. Each patient should be evaluated individually. However, in a situation where resources are scarce, one should not treat or prioritize on a first-come, first-served principle[41]. Each healthcare system may have different principles by which decisions are guided. Ideally, decisions should not be based on local hospital directions. Where healthcare is delivered jurisdictionally, there should be governing principles organized regionally. Individually, healthcare workers should consult colleagues in teams to reach decisions in settings of priorities, end-of-life-decisions or when there is a need to rationalize resources[41], in order to avoid fatigue, burn out, guilt and unbearable psychological pressures.

Surgical services during pandemic phase

Surgical care that is not essential or time-critical can be delayed and deferred to a later date when the pandemic subsides[16]. However, even in the midst of a pandemic certain procedure types must be performed, including appropriate cancer treatment, emergency surgery and urgent transplantation, as these are considered life-saving procedures with curative potential. A complete neglect of certain surgical services would be considered unwanted collateral damage, and inadvertently increase the number of deaths and life-years lost owing to the COVID-19 pandemic. This can create ethical dilemmas at a time of scarce resources and high pressure on critical care staff[23,41,42], especially when surgical theatres are shut down or reduced to a minimum of activity, and triage for the indicated and urgent operations is required. Several surgical societies and organizations (*Table 1*; *Table S3*, supporting information) have launched lists of proposed procedures and ways of prioritizing these during times of high disease pressure.

Patients with conditions in need of high-priority elective or urgent surgery

There is no consensus on what types of non-elective, non-emergency procedures should proceed, and under what circumstances. The definition of elective surgery varies widely, but general recommendations have been issued by several surgical societies and organizations (*Table 1*) to advise on priorities and support cancellations or deferred procedures. A definition of major surgery is also lacking, and varies between surgeons, regions and even subdisciplines. A recent Delphi study[43] agreed that 'significant co-morbidities' were the only preoperative factor retained to define major surgery. Notably, several of the risk factors in patients that predict risk of complications and need for intensive care after surgery are also the factors associated with higher risk of poor outcomes in COVID-19, including increasing age, diabetes, hypertension and cardiac disease[44,45].

A conceptual framework might stratify medically necessary, time-sensitive surgery[46] by variables that include

the nature of the disease, the nature of the procedure and the nature of the patient. As regards procedures, variables to consider include the duration of operation, potential for ICU care, length of hospital stay, surgical site and risk of aerosolized droplets. Disease-specific considerations include the risk of delay on outcome (2, 4 or 8 weeks or longer) and alternative non-surgical options for therapy. Patient-specific considerations, in addition to COVID-19 or influenza-like illness status, might include age, pre-existing cardiopulmonary disease, immunocompetence and diabetes.

With some early reports of a high risk of postoperative morbidity and death in patients exposed to COVID-19 at the time of surgery[14,36], a set of minimum screening initiatives should take place until better data are available. For patients with urgent and non-emergency surgical conditions requiring operation, before admission (or on admission in a pathway evaluation if admitted semiurgently) there should be an interview with attention to sick contacts and extent of social isolation performed. A single swab with PCR or chest CT on the day before surgery to screen for COVID-19 is recommended by some[47,48]. The applicability of these measures may change as knowledge, testing capability and sensitivity evolve, and with prevalence of COVID-19 (and evolving immunity) among the public.

Considering risk of surgery during COVID-19 pandemic

Patients with COVID-19 present with the classical symptoms of fever, dry cough and difficulty breathing[44,49–51], but it is increasingly being recognized that a large number of patients have minimal or no symptoms in the early course of the disease. Digestive symptoms may have been overlooked in early reports, as increasing numbers of patients are being reported to have abdominal symptoms[52–55]. An increasing number of reports are suggesting that other symptoms may be associated with COVID-19, such as anosmia[56,57]. A thorough history of risk and exposure as well as testing should be done for all patients admitted for elective surgery.

The SARS-CoV-2 virus is particularly contagious through transmission via droplets. Airborne transmission via aerosols remains uncertain, debated and of concern. Hence, the premise for delivering essential diagnostic and therapeutic interventions for surgical conditions has already changed. Evaluation of mitigation strategies and risk is needed in order to unlock current changes to practice. The implications of transmission risk uncertainty may last months, if not years, for the practice of surgery.

Outcomes after surgery in COVID-19 have not yet been investigated systematically, but anecdotal experience reports unfavourable outcomes even after some routine surgical operations (such as cholecystectomy, hernia repair and hysterectomy)[14,36]. The effects of COVID-19 on surgery (and vice versa) are not known. Pathological changes in blood coagulation[58], inflammatory response[59], and co-morbidities added to single or multiple organ failures[60] may be considered as mechanisms for added risk for surgery.

As a general recommendation, surgery on patients who are SARS-CoV-2-positive or have symptomatic COVID-19 should be undertaken only in true emergency circumstances. For patients in the ICU who develop a surgical condition, surgery should be considered when discussed as a likely life-saving intervention with benefit to the patient. Non-surgical or minimally invasive alternatives should be entertained, if possible, such as draining a severely infected gallbladder rather than operating.

Surgery for patients with COVID-19 should be performed in designated theatres, preferably located in the periphery of other theatres, and with negative-pressure room ventilation[11,13,17,18]. Procedure for transport of patients with COVID-19 should be followed strictly – either from ward or from ICU to theatres[61]. If the patient is not already intubated, precautions for intubation should be adhered to, as this is considered to be a procedure with high aerosol risk[12,17,62]. Perioperative guidelines (*Table 1*) must be consulted, as these are evolving based on new knowledge[11–13].

Emergency general surgery admissions

Patients who are admitted for an acute abdomen (and in need of surgery) may be co-infected with COVID-19, and hence represent a risk for contamination of healthcare personnel and other patients, even when not feeling ill or experiencing severe symptoms suggestive of COVID-19.

With an increasing number of infected yet asymptomatic subjects in the population, a high clinical suspicion for non-typical symptoms is also warranted. Notably, several hospitals have started to include CT of the thorax as a routine part of diagnostic evaluation (and COVID-19 screening) if cross-sectional imaging of the abdomen is part of the planned work-up, as there have been several anecdotal reports of diagnosis of typical lung findings in patients without respiratory symptoms or other signs suggestive of COVID-19. Typically, ground-glass findings may be present in the early phase of the disease course[63]. Only after finding the CT signs, and testing the patients using regular swabs, was the disease actually confirmed as SARS-CoV-2. This poses a particular challenge to the healthcare system to avoid potentially admitting and treating patients with otherwise no suspect symptoms.

Trauma admissions still occur during a pandemic, although there are unconfirmed reports of a reduction in acute and trauma admissions as an effect of the social distancing and overall reduced activity in society. Although trauma admissions may drop, so may recruitment of the regular pool of blood donors, potentially leading to a shortage of blood products in some systems. In addition, coagulation may be affected in patients who are COVID-19-positive, potentially adding to issues with bleeding injuries[58]. As reported in Seattle, Washington, in the early phase of the outbreak[64], the overall use of blood products decreased significantly among inpatients and remained stable in the outpatient clinic at the starting point. However, owing to the confinement situation taking place in some countries, blood reserves could be affected as donations decrease. Although coronavirus predominantly infects the respiratory tract, the potential risk of transmission by transfusion needs to be addressed. One of the main concerns is the ability asymptomatic patients may have to infect during the incubation period[65]. Appropriate testing of donors who give blood during the pandemic should be put in place.

Transplant activity

Organ transplantation is a life-saving procedure. Limiting access to transplantation is associated with a significant loss of prognosis for most patients on the transplant list. How the pandemic affects organ transplantation is related to impact on the donor pool, risk of transmission of infection, risk to living donors and overall access to scarce resources[66,67]. Donors must be tested and confirmed as COVID-19-negative. The risk of bloodborne transmission during transplantation appears to be low, as only about 1–15 per cent of subjects appear to have circulating virus RNA[50]. Lung transplantation poses a particular problem.

In planning the reorganization of transplant programmes during the pandemic, a phased approach scaled to the current severity of the pandemic has been suggested. Accordingly, most centres have initially stopped elective living donor programmes while maintaining other transplant services[66–68]. The scenario of submitting a healthy donor to a major surgical procedure concomitant with the risk of being infected with COVID-19 must be considered and calls for caution, even if cases of successful recovery exist[69]. Furthermore, the competition for scarce resources related to hospital and ICU beds and blood transfusions mandates strict prioritization. As the overall strain of the pandemic intensifies, this might dynamically change organ allocation and prioritization policies[66–68].

In times of crisis and shortage of resources, several ethical challenges may present[23,24,42]. The competing risks and need to allocate resources may require a change in patient priorities in several surgical disciplines, notably transplantation, cancer surgery and other high-risk procedures. As a result, some patients may unfortunately not be offered the treatment they would otherwise have received.

Preparing surgical services for postpandemic phase

The cancellation of all elective operations creates a huge backlog of patients who have been, or would be, seen for planned surgery (*Fig. 2*). With a long-lasting lockdown and social distancing in effect, there will be millions of operations cancelled, deferred or simply not done at all over the coming months. Surgery is already recognized as a scarce resource in much of the world[70–72], with a global challenge to provide safe surgery and anaesthesia as a recognized area of priority[73].

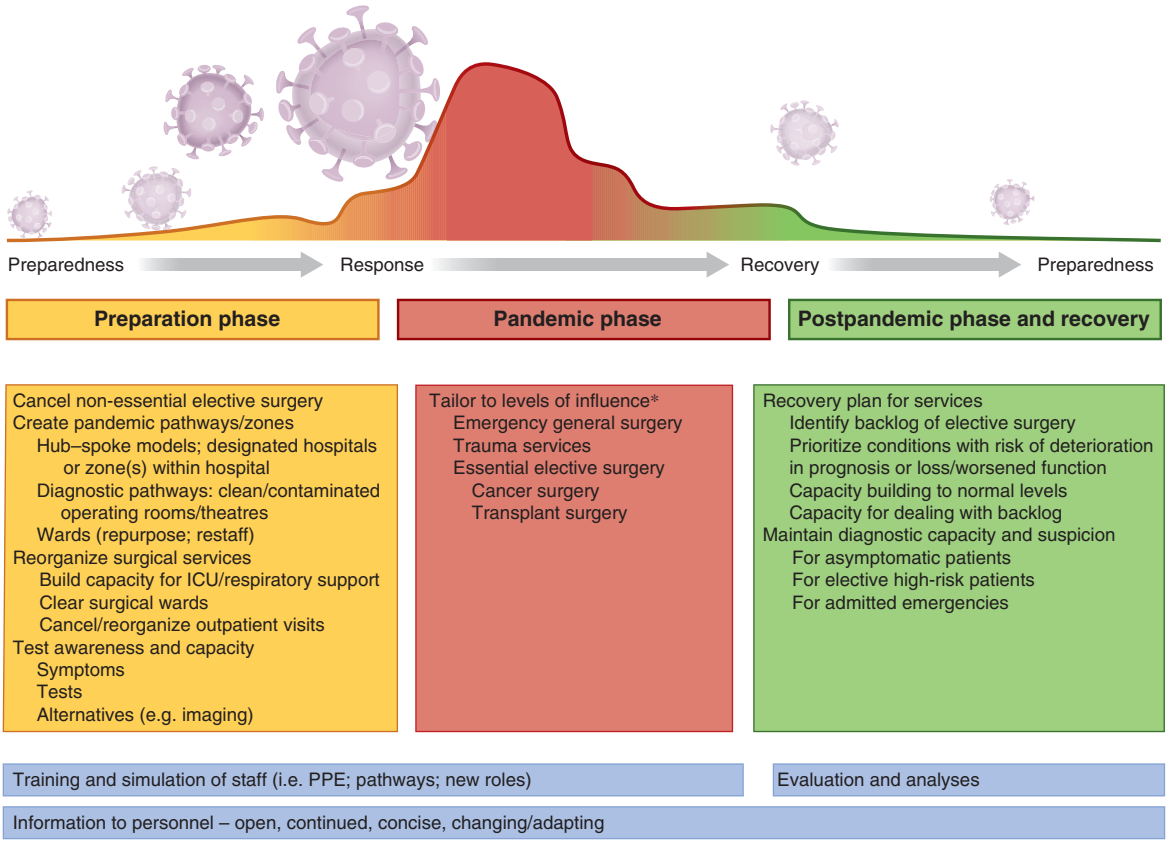
Although the majority of infected people experience a mild disease, there are currently only anecdotal reports on potential adverse outcomes even after relatively minor, elective surgical procedures[14,36]. Until better data are at hand, the uncertainty will affect management during the surge of the pandemic and also have implications in the long term during the 'tail' of the pandemic (*Fig. 1*), as COVID-19 may be present in the general population for months ahead (until vaccine is universally available), until proper systems for high-accuracy testing and availability allow proper protection of patients and healthcare providers alike.

There is a lack of data on the actual risk of several procedures that are potentially aerosol-generating, including thoracoscopic interventions, laparoscopic abdominal surgery, endoscopic procedures, and open surgery performed with traditional equipment (including electrocautery and tissue-sealing devices)[14,26,74]. Safety hazards need to be addressed and investigated by proper methods to arrive at guidelines that protect surgical teams appropriately[15,16]. Changing clinical practice to a point that jeopardizes surgical care or even leads to substandard management in fear of COVID-19 should be avoided.

Rebuilding surgical capacity after pandemic

There is no existing knowledge as to what impact this loss of surgical capacity will have on patients' surgical condition and associated health, or in terms of well-being, functional capacity, risk of loss of function or adverse effects on prognosis. It is known from cancellations under normal circumstances that patients can experience feelings of sadness, disappointment, anger, frustration and stress[75]. This

Fig. 2 Proposed framework for surgical planning through pandemic phases



The framework is a basic overview of steps for surgical services to incorporate, and is not exhaustive. Currently, no universal framework for planning of surgical services and maintenance of capacity exists in the governing organizations. Surgery may be affected disproportionally by the loss of space and personnel, and the uncertainty of associated risks to patients and with exposure to procedures, compared with other disciplines. Training and simulation for personnel (donning and doffing; getting used to specific personal protective equipment (PPE); logistics and transport) is important in every phase. Clear and continued communication of information and knowledge is of the essence in all phases. *Depending on burden to hospital/region.

comes in addition to the potential economic consequence (loss of work, sick leave or inability to maintain occupancy) and impact on family life.

There are currently no robust data available to model the number of operations being put on hold and how this backlog will be addressed in the aftermath of the pandemic. However, rough estimates suggest that approximately 330 million operations are done worldwide annually[76], the vast majority in high-income regions now exercising a strong policy of cancellation of all non-essential surgery (North America and European countries). With a global average of about six million procedures per week, the aggregated numbers of patients who will be affected over the coming months are growing at a concerning pace. Little is known about the timeline or duration of these cancellations, or what criteria should be used to reopen these services.

In the current pandemic, patients may prefer to have non-essential elective surgery deferred owing to fear of contracting the disease while in hospital. However, this fear may also lead patients not to seek timely care for conditions that would otherwise have been correctable or curable by presenting at an earlier stage; loss of function and reduced life expectancy may be the result of delayed presentation and an untimely diagnosis. This burden will only increase with the duration and severity of the pandemic.

Future research and need for better knowledge

The current situation is unparalleled in modern history, and so no readily available information exists to compare or project the effect of disruption of surgical services on public health during the pandemic. Medical resources and

response systems must be evaluated after this pandemic in order to prepare for the next[2].

Data on the effects of surgical cancellation on patient well-being, including emotional and physical health, are much needed. In addition, the effect of the backlog of operations and the aftermath of the pandemic will need to be analysed. As elective surgery has been cancelled on a scale never before seen in modern history, the collateral damage to health and well-being, maintenance of function, and risk of shortened lifespan is present for patients in countries of all income designations. However, the implicit assumption is that the poor and marginalized will be affected most severely. For this reason, an equity-based approach to critical analysis will provide answers that could guide future health system strengthening that works toward a socially just construction of surgical systems.

Finally, we call for a structured framework for evaluation of this COVID-19 pandemic *vis à vis* surgical care delivery. It is imperative to understand how and why different countries were prepared (or not), how the effects of the pandemic on surgical services were mitigated, and how some countries managed the delivery of surgical care in their healthcare services better than others. A strong advocacy agenda is needed that includes investigation, planning, research and communication for surgical and anaesthesia services for future pandemics. Surgical delivery before, during and after a pandemic, owing to its cross-cutting nature and synergistic effects on health systems at large, needs to be built into the WHO agenda for national health planning. We must ask the questions that will lead to appropriate change in how countries should construct surgical systems in terms of infrastructure, workforce, care delivery, information management, financing and governance to prepare for future events on this scale.

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Supporting information

Additional supporting information can be found online in the Supporting Information section at the end of the article.