OXFORD

*BJS*, 2021, **108,** 1162–1180
DOI: 10.1093/bjs/znab307
Advance Access Publication Date: 8 October 2021
**Review Article**

# BJS commission on surgery and perioperative care post-COVID-19

BJS Commission Team

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## Abstract

**Background:** Coronavirus disease 2019 (COVID-19) was declared a pandemic by the WHO on 11 March 2020 and global surgical practice was compromised. This Commission aimed to document and reflect on the changes seen in the surgical environment during the pandemic, by reviewing colleagues' experiences and published evidence.

**Methods:** In late 2020, *BJS* contacted colleagues across the global surgical community and asked them to describe how severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) had affected their practice. In addition to this, the Commission undertook a literature review on the impact of COVID-19 on surgery and perioperative care. A thematic analysis was performed to identify the issues most frequently encountered by the correspondents, as well as the solutions and ideas suggested to address them.

**Results:** *BJS* received communications for this Commission from leading clinicians and academics across a variety of surgical specialties in every inhabited continent. The responses from all over the world provided insights into multiple facets of surgical practice from a governmental level to individual clinical practice and training.

**Conclusion:** The COVID-19 pandemic has uncovered a variety of problems in healthcare systems, including negative impacts on surgical practice. Global surgical multidisciplinary teams are working collaboratively to address research questions about the future of surgery in the post-COVID-19 era. The COVID-19 pandemic is severely damaging surgical training. The establishment of a multidisciplinary ethics committee should be encouraged at all surgical oncology centres. Innovative leadership and collaboration is vital in the post-COVID-19 era.

Members of the BJS Commission Team are co-authors of this study and are listed under the heading Collaborators.

## Introduction

Coronavirus disease 2019 (COVID-19) has emerged as a highly contagious, rapidly spreading respiratory infection[1] and was declared a pandemic by the WHO on 11 March 2020. Although about 80 per cent of patients with COVID-19 have mild or no symptoms, the remaining 15–20 per cent may develop severe disease that necessitates admission to a critical care unit, with a possible need for mechanical ventilation[2]. As the situation evolved, surgical practice across the world started to be compromised considerably by the COVID-19 pandemic. The impact of the current crisis on outpatient surgical services, elective surgery, and emergency procedures has been well observed and reported by several investigators in a variety of studies[3]. Global guidance for surgical care during the pandemic has been published, and has emphasized the importance of implementation of detailed context-specific pandemic preparedness plans, with regular updates of specific guidance to reflect. emerging evidence during the pandemic[4]. Key data on the impact of COVID-19 on surgery are summarized in *Table 1*.

## BJS Commission

In late 2020, *BJS* asked colleagues across the global surgical community to describe how the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) had affected their practice. *BJS* received communications for this Commission from a number of leading clinicians and academics across a variety of surgical specialties in every inhabited continent (*Fig. 1*). The responses from

**Table 1 Key facts and figures**

| |
|---|
| During the initial 12 weeks of COVID-19, 28.4 million operations were cancelled or postponed, 10 per cent of which were cancer-related |
| Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infections had a perioperative morbidity rate exceeding 50 per cent and 30-day mortality rate of 24 per cent |
| Risk factors for mortality following SARS-CoV-2 infection after surgery included<br>Male sex<br>Age over 70 years<br>ASA ≥ III<br>Major/cancer surgery<br>Emergency surgery |
| Swab testing of patients deemed at high risk of SARS-CoV-2 before surgery yielded detection rates of 1 in 18 |
| Delaying surgery for more than 7 weeks after a positive swab is associated with better perioperative outcomes |

**Received:** July 26, 2021. **Accepted:** July 26, 2021
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**Fig. 1 Distribution of the Young BJS and BJS Commission correspondents across the world.**

all over the world provided insights into multiple facets of surgical practice from a governmental level to individual clinical practice(s) and training. The Commission aimed to document and reflect on the changes seen in the surgical environment due to the pandemic, based on colleagues' experiences and published evidence. There have been both positive and negative changes. These accounts are based on communications with surgeons and academics, surveys conducted during the pandemic by surgical teams (including Young BJS), and the insights of the writing team and Young BJS.

## Young BJS

Young BJS represents early-career surgeons (from medical students through to junior faculty) to foster their interest in academia. The group is supported by the BJS Society and affiliated journals (*BJS* and *BJS Open*), allowing members to have a voice, gain insights into international collaborative projects, and will act as a forum for surgeons-in-training. It already has representation in over 100 countries, with over 1200 members (*Fig. 2*).

In late 2020, as part of the BJS Commission on the global impact of COVID-19, the Young BJS group was surveyed to establish views and insights regarding the real-world knock-on effect of the pandemic. Overall, 468 people, across six continents, responded: 68 per cent were men, and 84 per cent were aged between 25 and 55 years (*Table 2*). The most common specialty to respond identified as being a general surgeon (37 per cent of respondents); 22 per cent of respondents were still in a training position. Interestingly, the single biggest impact of COVID-19 on surgery was the lack of access to perform surgical procedures (42 per cent of respondents); 30 per cent cited a delay in screening/diagnostics as a major concern, and 11 per cent concerns about the lack of surgical training of future consultant surgeons (*Table 3*). Furthermore, 15 per cent were concerned about late presentations of advanced disease due to the pandemic. When asked about the biggest challenge to future surgical care or changes to surgical practice, the delivery of surgical care in a safe environment, with reduced risks of nosocomial SARS-CoV-2 infection, were major concerns (*Table 4*). In addition, the challenge of making up lost ground in terms of oncological and non-oncological workload poses a considerable infrastructural, financial, and/or medicolegal proposition. *Tables 2–4* depict voices from the Young BJS survey.

More recently, the role of surgeons has changed dramatically worldwide, with disruption of standard clinical pathways owing to competing demands for ICU care. In most cases, surgical activity has been reduced progressively, or sometimes even completely stopped[5,6], and almost all surgical departments have been reorganized to facilitate the creation of COVID units. This Commission shares the highs and lows from these reports, and present the themes that emerge as a global narrative.

## Economic, operational, and political impact

The economic impact has affected people in high- and low/middle-income countries in varying ways according to the model of healthcare. Some of the problems encountered are detailed here.

### Centrally imposed limits on provision of diagnostic tests and operations

In the early months of the pandemic, at least 28 million operations were cancelled[5], partly reflecting concerns about the impact of nosocomial SARS-CoV-2 infection in patients after surgery[4,7]. A survey of 359 hospitals in 71 countries around the world estimated that in late March 2020 about 14 million procedures (including gastrointestinal/pancreatobiliary, urological, head and neck, gynaecological/obstetric, plastic, and orthopaedic) had been cancelled or postponed. Cancellation rates were 30 per cent for approximately 100 000 cancer and 84 per cent for about 13 million non-cancer operations. The pandemic led to many countries deferring elective procedures and restricting surgical practice to acute and emergency procedures only. The Intercollegiate

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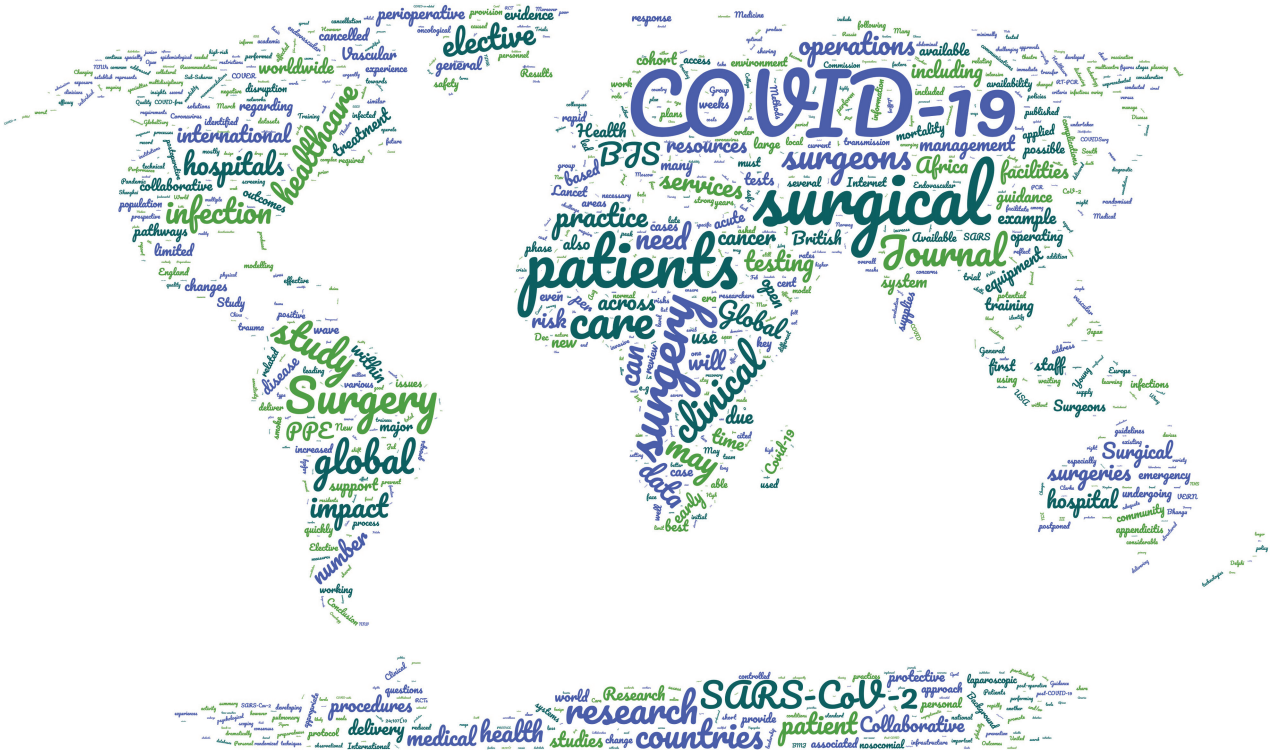



**Fig. 2** Word cloud depicting thematic analysis of the BJS Commission

**Table 2 Demographics of respondents to the Young BJS survey**

| | Representation |
|---|---|
| **Sex ratio (M : F)** | 2 : 1 |
| **Age 25–55 years (%)** | 84 |
| **Early career trainees (%)** | 22 |

**Table 3 Results of Young BJS survey: primary concern related to the impact of COVID-19 on surgery**

| Impact of COVID-19 on surgery | % of respondents citing this as primary concern |
|---|---|
| **Lack of access to performing surgical procedure** | 42 |
| **Delay in screening/diagnostics** | 30 |
| **Late presentations of advanced disease** | 15 |
| **Lack of surgical training** | 11 |

**Table 4 Results of Young BJS survey: challenges to future surgical care**

| |
|---|
| Challenges to future surgical care or changes to surgical practice |
| Delivery of surgical care in a safe environment |
| Reduced risk of nosocomial SARS-CoV-2 infection |
| Backlog of oncological/non-oncological workload; impact on infrastructure, finance, medicolegal protection |

General Surgery Guidance on COVID-19[8] recommended that acutely ill patients remain a priority.

The impact on diagnostic tests and operations was considerable, within days of the pandemic reaching its peak at various points in early to mid 2020[9–11]. For example, COVID-19 reached Russia on 31 January 2020, and its borders to foreign travel were closed. The pandemic caused profound changes in routine and emergency surgical care in Moscow and across Russia, including increased demand for beds (including intensive care), with medical and nursing staff being asked to treat patients infected with COVID, anaesthetists asked to be involved in the emergency care of patients with COVID and therefore not able to support surgery, and limited access to operating rooms (ventilators were used for intensive care). Many Moscow hospitals were reoriented to medical care for patients with confirmed or suspected COVID-19 infection. Several surgeons were retrained to care for patients with COVID-19. A similar picture was seen in Shanghai and other Chinese regions. Chinese and Russian colleagues, among the first countries hit by the pandemic, had to solve a number of important issues that immediately affected the provision of surgical care and diagnostics: emotional problems (ranging from denial to panic attacks and refusal to perform professional duties); unpreparedness of medical personnel to care for potentially infected patients (fear, confusion); inadequate level of knowledge about how to work in conditions of increased infectious threat; lack of adequate premises to work with quarantine infections; insufficient quantity and inventory of personal protective equipment (PPE); densely overpopulated wards; and a large percentage of patients with compromised immunity (because of the cancer specialty population treated in the institution).

In several communications from around the world, the main reasons for surgical cancellations and postponements echoed these experiences, and included shortage of surgical beds, staff (especially nurses and anaesthetists), and medical supplies among hospitals accepting patients with COVID-19 (including protective equipment, especially in the first few weeks); temporary restrictions on working availability owing to COVID-19 infections and close contact among healthcare staff; and patients voluntarily avoiding healthcare facilities.

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## Financial difficulties for healthcare facilities

Healthcare financing will be a major challenge in the post-COVID-19 era in low- and middle-income countries[12]. Health insurance coverage is abysmally low, particularly in the larger-population African nations. Many surgical patients pay out of pocket. The potential additional costs of testing, PPE, and responsibility for care will be transferred to the patients. Healthcare systems may also suffer additional costs from requirements for new facilities and personnel[13].

In Japan, the observed decrease in tests and surgery delivered during the pandemic has caused healthcare facilities to operate at a loss. Performance indicators, such as number of outpatients, number of inpatients, and number of operations, hit their lowest point in May 2020. These figures have been improving, but have still not recovered to the prepandemic level. Although various hospitals have been asked to treat patients with COVID-19, hospitals that accept these patients must impose restrictions on visits for patients without COVID, leading them to operate at a loss. In Russia and China, there was a considerable reduction in the number of procedures performed as early as February and March 2020. Slowly during the course of 2020, surgeons were able to start treating patients with non-COVID-related pathologies again (such as surgery for cancer); however, as of October 2020, the services in these regions were still operating at below 80 per cent capacity compared with pre-COVID-19 status.

## Prohibitive cost and poor availability of testing and results of testing

Ideally, patients should be tested for COVID-19 by the conventional reverse transcriptase (RT)–polymerase chain reaction test before undergoing surgery. However, this approach has a number of shortcomings. The limited availability and high costs of regular PCR testing for every surgical patient before surgery may render this endeavour cumbersome and unfeasible, especially in resource-limited settings. In comparison to countries in Europe, many countries in Sub-Saharan Africa have tested relatively fewer people because of poor availability of testing kits[12,13]. Many have resorted to testing only those with contacts and symptomatic patients. The issue of asymptomatic patients presenting for surgery needs to be resolved[7,14]. Moreover, a significant number of patients with COVID-19 present with abdominal pain as the primary complaint with a similar presentation to acute pancreatitis, increasing the risk of nosocomial transmission[15].

Testing every patient with symptoms such as fever in Sub-Saharan Africa will also increase the requirements for testing, which may not be available locally leading to in-hospital delays in surgical interventions and their consequences. With a large number of operations being performed in emergency settings (trauma, visceral perforation, and complications of advanced malignancies), the need for some form of testing for COVID-19 will require the availability of testing facilities in or near the hospital. In many countries, such facilities are currently available at state or regional locations remote from acute care.

Within a large country like Brazil, there are differences in healthcare systems. Private healthcare is very strong. Even with a large number of big hospitals, the private hospitals in Rio are facing a difficult reality. Some of them became hospitals of one disease only. Elective surgery has been cancelled in the majority of cases. The public health system is collapsing in the more affected areas. There are no ICU or normal beds in the majority of hospitals, with occupation close to 100 per cent in some cities. Surgeons in Brazil have limited access to COVID-19 serology tests. Instead, they use medical interview, temperature, and sometimes thoracic CT in patients scheduled for abdominal operations, considering all positive until proven otherwise[16,17].

New Zealand finds itself in an almost unique position with regard to COVID-19 as, at present, it has eliminated the disease and has no community spread. New cases are only those coming into the country, which are picked up at isolation centres in which people returning to New Zealand are required to stay for 2 weeks and return two negative swabs. This unique situation has been the result of the government reacting quickly to the initial cases identified in New Zealand; following the pandemic playbook properly; the community support for such action; and a rare advantage of its geographical isolation. As a result, New Zealand has been able to almost return to normal treatment pathways that were in place before COVID-19. At the moment, it is not necessary to isolate or swab patients before operation or take any special action while they are in hospital[18].

## Exhaustion of medical supplies such as personal protective equipment

PPE is in short supply in many countries[17]. Japanese hospitals have faced shortages of supplies of PPE such as surgical masks, N95 masks, plastic gowns, sterile surgical gowns, shoe covers, face shields, and eye shields. The shortage of masks, in particular, has been a major problem because widespread use of masks among the general population has caused a sharp increase in their market price. Although the situation is improving, individual healthcare facilities have continued to impose limits on the use of disposable medical supplies. In Sub-Saharan Africa, ICUs, intensivists, ventilators, and other organ support facilities are either in short supply or not available in many public hospitals[12,13]. In some instances, local surgeons are already reporting an influx of low-quality products with the danger of compromising the safety of patients and personnel.

There has been variation in how countries use their resources on prophylactic measures such as PPE, and use of different COVID/non-COVID workstreams to separate patients. In Egypt, despite a rapid depletion of healthcare resources and growing imbalance between the limited supplies and staff and patient safety, surgeons treating patients are never left without adequate PPE[17].

## Changing pathways for surgical patients without COVID-19

Trauma surgeons, including a correspondent in Oslo, Norway, reported adjustments of transfer criteria and of changes to trauma logistics[19]. Increasing the threshold for transfer represents a risk to the patient. Changes in hospital accreditation have also been described, that is decisions to dedicate one hospital to admitting patients with COVID-19 and another to injured patients. Such changes might promote quality, but any change of system or function represents a potential risk, and the overall outcomes should be evaluated. Correspondents from China and Russia echoed the experiences of colleagues in Norway and across Europe. For patients with cancer from high-risk areas whose preoperative imaging suggests an earlier disease stage, operation is postponed if deferral does not affect disease control and treatment. For example, in Shanghai, early in the pandemic, for middle and late stages of cancer (without COVID-19), personalized diagnosis and treatment plans were developed for each patient based on multidisciplinary team meeting discussions. Whenever possible, neoadjuvant therapy was preferred instead of surgery first. Patients were asked to stay in Shanghai until

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neoadjuvant therapy and subsequent surgery were finished (centralization of cancer services). Online remote medical treatment is being applied more than ever before. For postoperative patients, online follow-up has been the rule for patients with early-stage disease. Identical pathways were communicated from hospitals in South Africa, Moscow, the UK, and USA[7,9–11]. In most instances, remote consultation/telemedicine now seems to be the norm for surgical patients, even after the height of the pandemic; as late as November 2020, many patients were being followed up remotely where possible.

## Increased acuity of emergency non-COVID admissions

During the current pandemic, patients with acute conditions may become reluctant to visit hospitals and tend to postpone seeking medical advice because they are afraid of contracting COVID-19. The delay in seeking medical care for serious conditions such as myocardial infarction and stroke has led to increasing presentation of patients with more severe and complicated conditions[20,21]. This has been reflected in surgical practice as an overall reduction in acute appendicitis presentations, but a higher proportion of complicated and perforated appendicitis[22,23].

## Delayed knock-on effect of reduced elective capacity in 2020

Elective surgery cancellation can result in collateral damage because hospitals will be required to increase their normal surgical volume by 20 per cent after the resolution of the pandemic, and it would take a median of 45 weeks to clear the backlog of operations[5]. All correspondents in mid–late 2020 from across the world have reported unprecedented pressures on waiting surgical lists, including patients with cancer. Plans to address these do not seem very clear, especially as most countries are facing continued viral spread. This is a major area of concern worldwide, which will require careful planning and very considerable resources to resolve. It will have to be dealt with at a national level, rather than by each institution separately, to ensure better access to available surgical resources.

## Major challenges experienced by hospitals and care providers

The majority of public hospitals in Sub-Saharan Africa use congested open wards for surgical admissions, owing to large number of patients treated in such hospitals. The congestion is usually worse in district and cottage hospitals run largely by not-for-profit non-governmental organizations. Inadequate nursing staff implies that family members are involved in the postoperative care of patients. Recommendations regarding social distancing may be challenged by the available space and personnel for surgery.

## Impact on gender disparities in surgical practice

The COVID-19 pandemic is deepening pre-existing gender inequalities, from health to the economy, security to social protection. Economic impacts are felt especially by women who generally earn less and have insecure jobs. Although early reports revealed that more men are dying as a result of COVID-19, the health of women has been influenced adversely in other ways[24]. Unpaid care work has increased, with children out of school and heightened care needs of older people. Economic stress coupled with social isolation measures have resulted in an increase in gender-based violence. Many women are being forced to lock down at home with their abusers at the same time that services to support survivors are being disrupted. The BJS Commission received communication from Professor Hilary Sanfey, a leading figure in gender-related issues in modern medical practice. Overall, it is well established that not only do women tend to progress through the academic surgical ranks more slowly than men, but women begin their careers with fewer resources, and receive significantly lower salaries than their male counterparts. This gender disparity is not explained by specialty, academic rank, or working hours, begins at entry to the workforce, and persists throughout women's careers. Strategies to address these issues can be found elsewhere[25,26].

Gender inequality is transformed into health risk through discriminatory values, norms, beliefs, and practices. Women will be hardest hit by the COVID -19 pandemic, but will also be the backbone of recovery in communities[24]. Worldwide, women surgeons remain outnumbered by their male counterparts. Currently there are only around three female surgeons for every one million people in the countries with the highest burden of surgical disease. The global surgical workforce shortage cannot be addressed if 50 per cent of the population is excluded. Gender diversity is especially vital in parts of the world where women may be more comfortable seeking healthcare from other women owing to cultural norms. To quote the former UN Secretary, General Kofi Annan: 'Gender equality is a precondition for meeting the challenge of reducing poverty, promoting sustainable development and building good governance. There is no tool for development more effective than the empowerment of women'. Although equality means treating everyone the same way, because of bias, discrimination or geographical location, certain individuals start from a different place in life and need extra encouragement or sponsorship to achieve the same outcomes—this is equity. Only when we tear down the barriers that exist so that all have the same opportunities will there be justice.

## Impact on organ transplantation

At the most basic level, the chief consideration is to balance the risk of patients undergoing transplantation with the potentially increased risk and severity of SARS-CoV-2 infection against the risk of death or disability from not having a transplant. Indeed, UK data suggest that the mortality from SARS-CoV-2 for patients attending dialysis units has also been very substantial. Most transplant societies have advocated a tiered suspension of transplant activity during the pandemic with deferral of the more elective transplants, such as kidney, pancreas, and elective heart transplantation for patients with ventricular assist devices. This was similar to the approach in, for example, Toronto during the severe acute respiratory syndrome (SARS) outbreak in 2003[27]. If, however, transplantation is required as a life-saving procedure, there is general assent within societies that it may be conducted with appropriate assessment of infection in both donor and recipient, and with appropriate informed consent.

Consensus-based immediate decision-making is reasonable and reassuring for individual practitioners and units as a bridge to a time when evidence becomes available. It does not, however, address the potentially profound implications of ongoing SARS-CoV-2 prevalence in the community for the solidorgan transplant (SOT) system worldwide. To address concerns regarding what the 'new normal' might look like, the transplant community first needs to address a number of key questions.

There is unanimous assent in transplant societies that patients testing positive for SARS-CoV-2 should not undergo a transplant procedure[28]. The more pertinent question is how to

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ensure that neither the donor nor the recipient is positive at the time of transplant and, in the case of the recipient, how safe are current practices of immunosuppression in the setting of a community risk of contracting SARS-CoV-2 after surgery. Finally, on altering any or all of these practices, how can the inherent adjustment in risk to the patients be accounted for, communicated, and consented?

In terms of excluding SARS-CoV-2 positivity at the time of transplant, evidence to date has focused on symptomatic and confirmed cases. For example, it is known that PCR assay of bronchoalveolar lavage yields the highest rate of positivity in symptomatic patients[29], and the viral load is much greater in lower respiratory samples than in either the nasal or throat swabs[30]. However, these are not the potential donors who would be considered. Further big-data studies are needed on patients without SARS-CoV-2 in the ICU who may be suitable for donation, aimed at asking the following questions. What test or combination of tests has the highest predictive value of a truly negative test? It is likely that nucleic acid testing will always form a part of this combination as some people who previously may have had mild-to-moderate disease can still test positive up to 3 weeks after symptoms abate[31], implying that viral replication and, therefore, viral nucleic acid shedding can occur for a long period before conversion. Similarly, how many tests in potential donors are actually needed before testing can be stopped? Some patients require up to three tests, which may not turn positive until after remission of symptoms. What does it mean in those who have improved symptomatically (or in the case of donors, never declared) but who then have positive PCR results—can they ever be considered donors or recipients?

Then, the question arises of the length of time spent waiting for these tests to take place. In the case of the donor, there may be limitations on how long an ICU can accommodate a brain-dead person in the face of significant pressure on bed capacity. As regards recipients, the role of recent excellent work done in the field of *ex situ* organ preservation comes to the fore[32,33]. Ensuring negative tests and recipient safety while preserving organ function will surely be among the principal considerations of all involved, both at local and policy level.

Extrapolating data from other viruses and SARS, it can be anticipated that immunosuppressed patients will have an increased susceptibility to SARS-CoV-2 infection with high viral loads and a higher risk of a severe disease course. The Transplantation Society has discussed paying close attention to transplant patients with medication-induced lymphopenia because low lymphocyte count in patients with COVID-19 is associated with a severe course of disease[28]. The longer-term question is whether altering immunosuppression can be considered in new transplant recipients in the setting of ongoing community exposure of patients to SARS-CoV-2. Immunosuppression with T cell-specific antibody induction is widely accepted in SOT. There are as yet unknown implications of these agents on SARS-CoV-2 and vice versa. For example, induction therapy with alemtuzumab results in a long-term shift toward naive B cells with altered phenotypic and functional characteristics[34]. In particular, long-term ability to produce IgG is inhibited. Would this limit or affect the production of specific antibodies to SARS-CoV-2 aimed at neutralizing the virus? Similarly, T cells can take years to repopulate to pre-treatment levels following alemtuzumab induction or even antithymocyte globulin treatment. Specific data on the response of the human immune system during the SARS-CoV-2 infection are still lacking and will be key to allowing the use or otherwise of these agents going forward. There are alternatives to such agents of course, but there is level 1 evidence supporting their use[35,36]. To change their use, and potentially risk an inferior outcome is to alter the basis of current practice. This would require input from all concerned, not least the recipients themselves. This change in practice mandates qualitative studies with public and patient involvement. It would also mandate a fundamental shift in the consent process, which is already extremely complex. Entire effectiveness analyses would have to be rewritten to accommodate the new risks implied on all sides of these arguments, including cost, quality of life, hazard, and life expectancy.

In summary, two difficult questions arise: how safe is safe enough, and what is an acceptable risk? These questions not only underline standard, value-judgement perspectives in risk-based decision-making, but, on a more basic level, underline the changing priorities in the field of SOT as a result of this pandemic.

## Global surgery ecosystem response to the pandemic

A strong and equitable healthcare system should be able to provide the right care to the right patient at the right time with the right number of resources. When faced with a pandemic, such systems should flex resources and triage patients to ensure that both infected patients and those with non-pandemic-related illness can be cared for safely. Although no existing healthcare system is perfect, a strong one can conscript resources to serve dual roles when demand overwhelms normal routine. Exceptionally strong healthcare systems, and particularly high-risk but well run surgical services, represent the attributes of what are known as high-reliability organizations (HROs)[37]. Service lines within surgical care exemplify HRO principles: preoccupation with failure, reluctance to simplify, sensitivity to operations, commitment to resilience, and deference to expertise.

The infrastructure and organization required for provision of safe and timely surgical services may serve as an important scaffold that underpins a strong pandemic response. The COVID-19 pandemic has challenged several assumed strengths of modern facilities and operations as they relate to the delivery of surgical care. Two notable examples include the interconnectedness of supply chains with their lean delivery techniques exemplified by a just-in-time approach to supply chains[38,39], and hyperspecialization. When supply chains face global disruption, the lack of redundancy leads to major shortfalls in materials[20]. Similarly, hyperspecialization works when a deeply integrated health system coordinates to deliver services over time[22,23]. Yet during crisis, specialists suddenly find themselves either sidelined or forced into clinical work that they are not comfortable performing[21]. The more subspecialists, the more difficult the pivot to generalized care becomes.

The fragility of a system that is complex and inter-reliant has been exposed[6], yet has also highlighted important practices that underpin surgical care and which can also benefit facility preparedness. Preoccupation with failure is a major focus of a robust management infrastructure; it is exemplified in surgical practice, where mindfulness and situational awareness are incorporated into perioperative workflows supported by checklists, team briefings, and communication structures that allow information to move unfettered across a system[24,25]. In addition, such practices are accompanied by a reluctance to circumvent safety processes, even in seemingly simple circumstances, as the successful execution of risky surgical and anaesthetic tasks demands redundancy for safety purposes[40].

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An effective surgical delivery system also depends on robust infectious disease surveillance. Surgical infections are one of the most common healthcare-associated infections, and tracking trends in these infections is a critical component of infection surveillance and provision of safe surgery. During a pandemic, the same soft and hard infrastructure required to effectively track infectious pathogens among patients undergoing surgery can be applied to the pandemic response. Similarly, infection prevention protocols are standard in operating theatre environments. To provide adequate infection prevention, standard processes for the cleaning of surfaces, equipment, floors, and devices, appropriate air circulation and turnover, instrument cleaning, decontamination, and sterilization are all required, and adherence must be meticulous. Use of PPE is culturally engrained. Thus, the concepts of two-person checks and coaching for PPE donning and doffing protocols, especially for high-risk procedures and environments, are quickly adopted.

## Solutions suggested by Commission contributors

### Simultaneous delivery of elective surgery while minimizing nosocomial COVID-19 infection in the perioperative phase

It is not sustainable to suspend elective surgery indefinitely, and there has been a growing focus on new models for delivering elective surgery that might allow surgery to be restarted safely, even during pandemic waves, in a way that is acceptable to patients[11,41–46]. Evaluation of the early implementation of COVID-free surgical pathways for elective cancer surgery found that they substantially reduced the risk of nosocomial SARS-CoV-2 transmission, postoperative pulmonary complications, and death, compared with that in patients operated in hospitals that had not implemented such pathways during pandemic waves[47]. However, COVID-free surgical pathways remain non-standardized and further research is required to determine their optimal configuration, including the role of rapid antigen testing on the day of surgery for patients, self-isolation of patients before and/or after surgery, and screening of hospital staff.

### Global leadership and planning

Global guidance for surgery during the pandemic has been publicized[4] and emphasized the importance of implementation of detailed context-specific pandemic preparedness plans, with regular update of specific guidance to reflect emerging evidence during the pandemic. During a pandemic, provider and community fear compound organizational and resource challenges. As noted during other SARS outbreaks and the Ebola crisis, the dread of contagion and contracting the disease affects everyone[48]. Precious resources may be used inappropriately out of an abundance of caution, to allay concerns by the general populace, owing to lack of trust in the system, or simply due to the rapidly evolving nature of the pandemic. Leadership must be transparent, with data regarding the risks to healthcare workers and the efforts taken to mitigate them. Inadequate testing, the disbelief of negative tests, and the absence of treatment options contribute to fear and suspicion, and sincere expressions of support from trusted leaders are paramount.

The greatest challenge in Africa would likely be the paradigm shift demanded by this pandemic. Africa would struggle with a mandatory need to consult and abide by changing local and international guidelines. There would need to be a cultural change to allow progress, provision of new technology, a compulsory change in teaching methods and, above all, a leadership structure to influence local policy and effect change. This will be more challenging in sub-Saharan Africa than the need for facilities and personnel. Local healthcare policy is usually influenced by both local and international politics: hence, the currently polarized views and misrepresentations of policies. Those aiming to implement international recommendations will require strong leadership to achieve success.

Many countries are seeing the beginning of reopening and normalization. The success of this phase relies on cooperation between political and clinical leadership in monitoring the situation. The global surgical community must start defining ‘the optimal new normal’.

### Managing medical supplies

Efforts are needed to minimize the impact of market changes on the supply of medical supplies such as PPE to healthcare facilities. To distribute proper quantities of medical supplies to facilities across the country, national and local governments must build a system to centrally manage inventory, production, and stocking of these supplies.

### Expanding testing infrastructure and support for healthcare facilities

To be able to perform diagnostic tests and operations during the pandemic, facilities must identify and then isolate patients with confirmed or suspected COVID-19 so they can be treated, while also actively working hard to perform tests and operations for other patients. It is particularly important that national and local governments lead the efforts to establish testing infrastructure that allows healthcare facilities to rapidly perform PCR testing for the patients they judge require it.

### Governmental financial support for healthcare providers

In Japan, national and local governments need to provide adequate financial support to frontline healthcare facilities to address the abovementioned operating losses of hospitals that accept patients with COVID-19. In Sub-Saharan Africa, healthcare will certainly require new budgetary commitment from the government and new funding models for individual institutions[13].

### Changing clinical management of patients with COVID-19

Given that bed and staff shortages are major factors that reduce a hospital’s capacity to perform tests and operations, healthcare facilities have needed to limit the use of medical resources by patients with mild cases of COVID-19 as much as possible, for example by asking these patients to recover at home or seek treatment in the community rather than in an acute hospital setting[49]. Although patients undergoing elective surgery may be eligible for this approach, those in need of emergency surgical intervention may not withstand waiting for the results of the test, which may take as long as 24 h. The sensitivity of RT–PCR on nasopharyngeal swab is not absolute and false-negative tests are quite possible[29], which may lead to dealing with an infected patient as COVID-19-negative, and the false sense of security may subsequently increase the transmission of infection. Despite the rapid depletion of healthcare resources and the growing imbalance between limited supplies and staff and patient safety, surgeons treating patients should never be left without adequate PPE[17].

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### Changing clinical management of surgical patients without COVID-19

Changes have been made around the flow of patients within hospitals, with measures including social distancing, both patients and staff wearing masks, keeping patients in hospital for the shortest possible time, and prohibiting visitors. Most implemented trauma systems list specific criteria for transfer to a specialized centre, but adjusted criteria have been described to cope with the challenges brought by the pandemic. Changes in hospital accreditation has also been described, such as decisions to dedicate one hospital to admitting patients with COVID-19 and another to injured patients.

### Effects on teams and schedules

Most institutions have had to make plans for alternative staffing of emergency departments, new ICUs, and COVID-19 wards. Surgical and trauma competence is a limited resource in most institutions. In Norway, short educational programmes to provide necessary competence to other personnel groups have been developed. A multitude of creative solutions now exist. These include simulation training for surgical teams jointly with colleagues from the emergency, anaesthetic, and critical care departments. Other strategies include open communication, for example, frequent departmental meetings to discuss new challenges, concerns regarding staff well-being and safety, and support systems for staff, such as buddy systems[50].

To protect personnel from cross-contamination and maintain necessary staffing, there has been extensive use of staggered cohort schedules[51,52].

## Impact on research

From the early stages of the COVID-19 pandemic in January 2020, it became evident that the way medical research is conducted would change. The immediate impact of the pandemic was felt worldwide on studies that were already recruiting patients in other disease areas, including RCTs. The latter were probably affected the most in the early weeks of the pandemic, given the considerable monetary and staffing resources required to continue recruiting into a surgical or interventional RCT. Further to this, the allocation of healthcare and economic resources (worldwide) towards COVID-19-related research meant that ongoing studies of any nature, including laboratory-based research, simply could not continue. For example, the National Institute for Health Research (the main funder of applied clinical research in the UK) and the UK Medical Research Council alongside regulators created a system whereby only studies assessing issues relating to COVID-19 could continue. To be able to do so, researchers should apply for approval to a body of regulators and healthcare research funders who policed which projects were approved[53]. *BJS* received communications for this Commission from a number of leading academics across a variety of surgical specialties in Africa (various countries), Canada, China, Italy, Japan, and the USA. These confirmed that a similar impact was seen in the earliest stages of the pandemic on all types of ongoing surgical research, owing to reallocation of staff, restructuring of academic units, and economic issues. This included basic (or laboratory) research and later-phase clinical applied research (RCTs or cohort studies). The impact of the pandemic on surgical research, however, is far wider than the immediate stall in early 2020 and will potentially be felt for years.

### New wave of global collaboration(s) in applied clinical surgical research

Because of the need to provide quick and contemporaneous accounts regarding the clinical impact of COVID-19 on surgery regardless of subspecialty, early 2020 saw the formation of a number of global collaborative surgical working groups. Examples are the COVIDSurg Collaborative[41,54], the PanSurg Collaborative[55–58], the Vascular and Endovascular Research Network (VERN) COVID-19 Collaborative Group[59], various groups of surgeons in Australia and New Zealand working in tandem[60], the Coronavirus Global Surgical Collaborative, the S-COVID Collaborative Group[61], and the AfroSurg Collaborative[62], to name a few. This model of working collaboratively, mostly led by surgical trainees, evolved in some ways based on the experience of surgeons (again, mostly trainees) working in collaborative groups to deliver applied clinical research. In fact, over the past decade, several trainee-led research collaboratives have delivered large-scale clinical studies which have informed and influenced surgical practice across a range of specialties[60,63,64]. These collaborative networks have allowed the delivery of COVID-19-related surgical cohort studies, documenting the immediate impact of the pandemic on surgery across several countries. Their model is based on a network of mostly trainee surgeons collecting data relating to morbidity and mortality of patients locally, and uploading that contemporaneously using relevant electronic case report forms. This has allowed surgeons to set up global prospective cohort studies within a matter of days, which is unprecedented, at least for studies of this scale[5,41,59,60,65].

An example of the scale and quality of surgical studies that have been delivered in 2020 based on this model is the CRC COVID Research Collaborative which examined the impact on colorectal cancer provision[10].

A VERN-led global qualitative study[59] in 53 countries found the early pandemic phase (March and April 2020) led to a complete redesign of vascular surgery services worldwide. The COVIDSurg group has also produced modelling data, based on the global information that was quickly collected on general surgery services and operations, to assess how many procedures have been cancelled and what surgical backlogs will be faced in 2021, during the recovery phase from the pandemic[5]. Another positive example of these collaborative networks that thrived in early 2020 is the fact that they have made it possible for areas outside the developed world to conduct high-quality applied clinical surgical research via networks such as AfroSurg and GlobalSurg[62,66–68].

These collaborative networks of mostly early-career researchers have established global prospective cohort studies within a matter of a few weeks. The approvals processes and other bureaucratic issues were dealt with in a very short period (in some instances within days). Ethical approval procedures were expedited, and research departments were able to open recruitment across multiple sites in less than a week. An example is COVER, a prospective cohort study that requires patient consent and is being delivered in 53 countries, delivered by VERN; the collaborative group acquired all necessary ethical and regulatory approvals within 9 days of producing a final study protocol[59].

At the same time, working as part of these networks to deliver COVID-19 studies has shone light on some negative aspects of existing research frameworks worldwide. Traditional barriers of regulation, interpersonal politics, and even poor study design have all been common issues faced by surgical researchers

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worldwide in 2020, and have become more evident in an environment where scientists and clinicians are all motivated to collaborate for a similar purpose.

According to communications to *BJS* and based on the experiences of Young BJS members while working as part of these international studies, barriers of mostly local and regional regulations in some instances obstructed the delivery of the COVID-19 collaborative studies on time and cost. This was mostly evident in countries where separate institutional ethical and regulatory approvals had to be sought. It is clear that national approval pathways may expedite clinical applied research delivery.

## Modern informatics, machine learning, and artificial intelligence

Modern informatics and machine learning provide a wide spectrum of research tools that could be useful in the age of COVID-19. An international epidemiological consortium (4CE) earlier in 2020 was able to quickly and accurately process routinely collected data that covered 27 584 COVID-19 cases with 187 802 laboratory tests[69]. These types of collaboration and consortia provide an excellent infrastructure to facilitate rapid pooling of data across many international sites for rapid epidemiology.

Clinical laboratories from various countries at the forefront of the pandemic shared genomes of the virus in open access databases, which enabled the rapid development of diagnostic tests for SARS-CoV-2; this type of open access sharing of large data sets was rare in the laboratory testing environment before the pandemic[70]. Other laboratories have shared experimentally determined and computationally predicted structures of some of the viral proteins and others have shared epidemiological data (*Fig. 3*)[71].

A good example is the Global Initiative on Sharing Avian Influenza Data (GISAID) initiative, which promotes the rapid sharing of data from all influenza viruses and SARS-CoV-2, including genetic sequence and related clinical and epidemiological data[72]. Furthermore, machine learning and artificial intelligence algorithms can be used for patient risk stratification, new diagnostics involving imaging (such as chest radiography or CT in the case of COVID-19), as well as drug repurposing and drug discovery.

Although the latter end of this spectrum may make for better headlines, the immediate impact of informatics will be from the former end—simple and scalable tools that facilitate rapid communication and reliable insights into the reality of day-to-day practice (S. Finlayson and G. Brat, personal communication). At the same time, as always, medical care begins and ends with

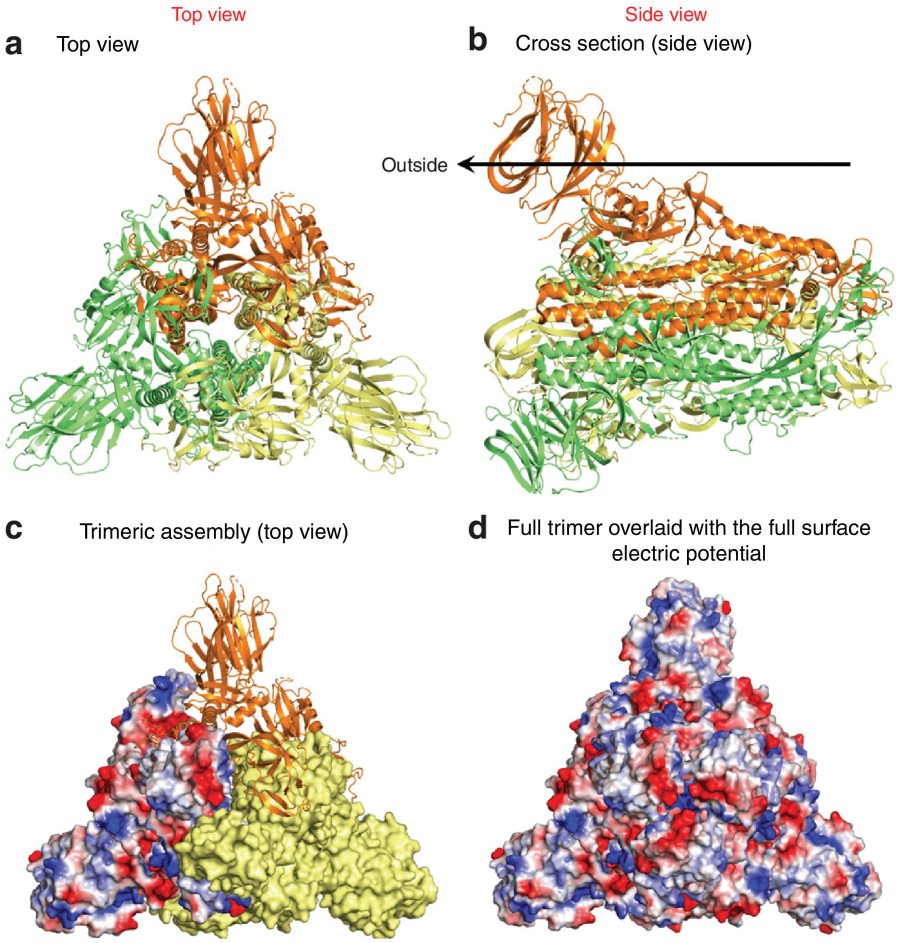



**Fig. 3 Structure and isoelectric properties of SARS-CoV-2 spike protein**

Reproduced from reference 71.

Structure of the SARS-CoV2 spike protein as viewed from top down (a) and in cross-section (b), based on Protein Data Bank (P DB) entry 6CRV. The trimeric assembly, as viewed from top down, is shown as an amalgam cartoon (top), solid surface (right, yellow) and electric potential (left) (c), and the full trimer overlaid with the full surface electric potential (d), highlighting a trefoil of negative charge (red) around the central point.

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humans. Informatics can help us move faster and more precisely, but it does not fundamentally change what medicine and healthcare are about. In particular, COVID-19 has demonstrated that, when it comes to highly uncertain environments, clinicians are ultimately to be relied upon for the type of judgement, creativity, and empathy that no machine has been capable of simulating.

## Use of existing large clinical data sets (routinely collected data)

Existing data sets can prove invaluable when trying to rapidly assess morbidity, mortality, and other key metrics in epidemiological crises such as COVID-19. Clinical data sets, in theory, can be repurposed to provide information in other areas. At the same time, the COVID-19 pandemic has brought to light some very important issues regarding the use of data. The Surgisphere scandal had demonstrated the need for much better regulation and data-sharing practices globally. COVID-19 has also sparked fundamental questions about the level of evidence necessary to alter clinical care. For example, the use of hydroxychloroquine was supported by some based on observational data alone. Care must be taken in the future over how observational information is translated into clinical practice.

A key lesson to be learned from the initial experience of this pandemic is that improved practices are urgently needed with regard to data collection in multicentre/multinational collaborations of an observational nature. This should be addressed by both researchers and the editorial processes followed by journals. The democratization of advanced analytical and statistical tools (see above) has dramatically increased the capabilities of individual researchers and research groups. This was amplified during the COVID-19 pandemic, and put a lot of pressure on researchers and various research groups to access and analyse global data in a very short period of time. The simple barriers of interoperability, unclear legal frameworks, and even personal competition can prevent the production of high-quality evidence in such an environment, and need to be addressed urgently in the post-COVID-19 era if similar scandals (SurgiSphere) are to be avoided. It needs to be possible to share data and insights from the efforts of clinicians around the world, and this sharing can facilitate great advancements, but first it is necessary to determine how to work together efficiently, ethically, and within a basic common regulatory framework.

## Delivering large-scale clinical trials in record time

The COVID-19 pandemic has made necessary the design and delivery of large scale RCTs in record time. Never in the history of medicine have international RCTs of investigational medicinal products been funded and completed so quickly. A good example is the RECOVERY RCT[73–75], which has been testing a number of different medications as adjuncts in the treatment of COVID-19, including dexamethasone, colchicine, tocilizumab, convalescent plasma, a combination of monoclonal antibodies directed against coronavirus, and aspirin. Data from this RCT are reviewed regularly so that any effective treatment can be identified quickly and made available to all patients. Despite being a complex adaptive trial, the study has recruited tens of thousands of individuals in its various arms and reported on the effectiveness of dexamethasone (and other drugs) in record time. RECOVERY had already recruited 20 000 patients by early December 2020. The lessons from setting up and delivering these RCTs with such efficiency will guide future generations of researchers to produce high-quality evidence in a timely fashion.

There have been similar examples of COVID-19 complex RCTs in several countries, which again were set up and started randomizing in record time[76–81]. Another good example of how the pandemic led to positive changes in the global research environment is the central coordination of large-scale academic efforts to tackle the pandemic. Early in the pandemic, the WHO, in collaboration with the Global Research Collaboration for Infectious Disease Preparedness and Response, an international network of funders to facilitate coordination and information sharing, organized a global forum on research and innovation for COVID-19 (Global Research Forum). This forum produced a strategy which aims to coordinate and accelerate global research work on COVID-19 and identified key research priorities in this field[82]: epidemiology, clinical management, infection prevention and control, and health system responses. This has been a catalyst in terms of securing funding and resources for developing countries, where setting up and delivering clinical research has traditionally been challenging[83].

## Data quality during the pandemic

There have been occasions where the need to address hypotheses as quickly as possible amplified existing problems related to how the global academic community conducts and publishes research. The Surgisphere scandal is a prime example. Surgisphere was an organization led by a surgeon, which aimed to produce analyses using 'large, real-world datasets', based on complex statistical models or artificial intelligence. An article entitled 'Hydroxychloroquine or chloroquine with or without a macrolide for treatment of COVID-19: a multinational registry analysis' was published based on an alleged data set associated with Surgisphere[84]. The investigators of this study claimed to have collected and analysed patient records from hundreds of hospitals worldwide. The paper's claim that antimalarial drugs increased the risk of death among patients with COVID-19 quickly unravelled; observers questioned the study's sample size as well as details about patient demographics and dosing. This led to a retraction of that paper and another report[85]. These high-profile retractions brought to light long-standing issues relating to editorial policies, authorship, data accountability, study design, and review of scientific work. It is surprising that none of the authors of these publications (some from esteemed institutions such as Harvard Medical School) failed to notice that the data sets used to produce the outputs were flawed. At the same time, this prompted journals to review their policies and procedures, which has improved accountability and publishing processes[84].

## Setting key priorities for surgical research in the COVID-19 era

A modified three-stage Delphi process (PRODUCE Study) was undertaken towards the start of the global pandemic (March–April 2020) to determine what the worldwide multidisciplinary surgical community felt were the most pressing questions that needed to be addressed[37]. Over 500 stakeholders, from 52 countries and six continents, took part in the three phases. These were predominantly general surgeons but also included professionals from other specialties, as well as patients, clinical scientists, and nurses. The process was endorsed by multiple international surgical societies. The steering committee that led the process consisted of a surgical trainee, 18 consultant/attending surgeons from three continents, a clinical scientist, and three lay representatives. During phase I, a total of 510 questions covering surgery-related COVID-19 topics were submitted by the stakeholders (median 4, range 1–10). Of these, following review by the steering

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committee, 96 were carried through to phase II prioritization, and subsequently 39 to phase III prioritization. The final list consisted of 13 highly prioritized surgery-related research questions. These questions can be summarized into predominantly five key areas: aerosolization of SARS-Cov-2 particles during surgical procedures; effective PPE to be used during surgery; preoperative screening before surgery; whether the presence of antibodies confer immunity; and SARS-CoV-2 infection and surgical outcomes (*Table 5*).

Although surgical outcomes (namely 30-day mortality) following SARS-CoV-2 infection are being tackled by the COVIDSurg group in general surgery and other similar cohort studies in associated surgical specialties, the remaining four key areas still need to be addressed. The 13 finalized questions reflect the consensual views of a group of stakeholders from across the world and from diverse backgrounds. To ensure that surgical practice begins to resume with a new sense of what can be considered normal, global surgical multidisciplinary teams are asked to work together in a collaborative setting to address these research questions. In this way, the aim is to deliver optimal care for patients in these very challenging times.

## How has COVID-19 changed surgical practice, techniques, and technology?

A prime example of where the COVID-19 pandemic has had an impact on the types of procedure and technology used in clinical practice is in vascular/endovascular surgery. The COVER study[59,86] has qualitative and quantitatively assessed the impact of the first wave of the pandemic on surgical care among vascular institutions in 53 countries, starting from the end of March 2020. During the first wave of the pandemic (6 weeks), at least 30 per cent of vascular centres in these countries had moved to offering exclusively endovascular minimally invasive solutions for aneurysmal disease, peripheral artery disease, and other key areas[87]. This change was gradual, starting from the first 2 weeks of the first wave, peaking towards the end of April 2020. A further analysis of the COVER study data in July 2020 (data being prepared for publication) has shown that several vascular centres (35 per cent) in the UK, Europe, USA, and Africa are still preferentially offering endovascular high-technology solutions for all pathologies when applicable. This has shown a considerable acute shift towards minimally invasive techniques.

There are a variety of issues relating to this change in practice. Training of practitioners to use endovascular technologies may not be possible in certain areas, especially the developing world. There is a significant cost associated with endovascular devices and new technologies. Investment in infrastructure is necessary to use these technologies, for example a hybrid operating theatre. Again, the developing world will struggle to meet these demands.

In addition to these logistical hurdles, the long-term efficacy and effectiveness of the new technologies is unknown. The vast majority of endovascular devices have not been tested in large randomized studies. Finally, although there may be an opportunity for vascular surgeons to develop endovascular skills, there may be loss of skills in terms of open operating, such as open aneurysm repairs, amongst the current trainees.

## Training: will the next generation of surgeons be up to their role?

Training in surgery has been majorly affected by the COVID-19 pandemic[87,88]. Performance of elective procedures has been dramatically reduced[5,6] to limit the spread of SARS-Cov-2 infection in hospitals and to avoid the occupation of ICU beds. Non-urgent surgical procedures have been triaged and delayed[89] when appropriate, and elective surgical operations have been packed into shortened surgical sessions. At many oncological institutions, in order to support anaesthetic activities, major operations are being performed during shorter surgical sessions. This had led to significant physical and mental stress among surgeons and other healthcare workers. Worldwide, many surgical operations have been carried out only by consultants, leaving no time for trainees to perform even the easier steps of procedures.

**Table 5 Final list of prioritized research questions from the PRODUCE study**

| Category | Questions |
|---|---|
| **Theatre environment and technical consideration** | Are SARS-CoV-2 particles aerosolized during endoscopy, laparoscopy or open surgery? |
| **Theatre environment and technical consideration** | What are the most effective methods for preventing the spread of SARS-CoV-2 during aerosol-generating procedures? |
| **Theatre environment and technical consideration** | What are the risks of SARS-CoV-2 aerosol generation in the use of electrocautery devices during the COVID-19 pandemic? |
| **Theatre environment and technical consideration** | What are the safest approaches to protecting the theatre team from COVID-19 transmission during open and laparoscopic surgery? |
| **Laparoscopy** | Is laparoscopy an aerosol-generating procedure and, if so, what precautions should be taken before, during, and after laparoscopic surgery? |
| **Laparoscopy** | What is the risk of SARS-CoV-2 virus transmission during laparoscopic/minimally invasive surgery? |
| **Protective equipment** | What personal protective equipment should be donned by the operating team undertaking a surgical procedure (open, laparoscopic or robotic) during the COVID-19 pandemic? |
| **Elective surgery** | Should all patients undergoing elective surgical procedures be tested for COVID-19 before surgery and how should they be screened? |
| **General** | Are COVID-19-positive patients at risk of transmitting the SARS-CoV-2 virus to the healthcare team through bodily fluids or aerosolized particles? |
| **General** | Does the presence of SARS-CoV-2 antibodies confer protection from reinfection? |
| **General** | Is there an increased incidence of perioperative complications in COVID-19 positive patients following surgery (e.g., SSI, VTE/PE)? |
| **General** | What are the principal factors influencing mortality in COVID-19 surgical patients? |
| **General** | What is the impact of COVID-19 infection on surgical outcomes? |

SSI, surgical-site infection; VTE, venous thromboembolism; PE, pulmonary embolism.

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Ambulant surgical procedures, representing an opportunity for trainees to acquire basic surgical skills, have been either reduced or stopped and the learning curve of specific surgical techniques, such as laparoscopic and robotics-assisted operations, has been interrupted. Indeed, minimally invasive surgical operations were initially limited owing to concerns about viral transmission[8,23,90]. Laparoscopic training consoles have become important, whereas before the pandemic they were an accessory activity to hands-on experience. Theoretical training has been undermined too, with the interruption of face-to-face lessons on the one hand, and the cancellation of face-to-face conferences and courses on the other[87]. The positive side-effect of this has been improved virtual learning platforms, an emerging tool to promote surgical education that has been embraced by many societies.

Social distancing policies have reduced interactions between healthcare professionals, with a major impact on teamwork. The loss of opportunity to develop a mindset orientated to surgical teamwork could have an irreversible impact on training that may be difficult to overcome in subsequent years. In this context, feelings of dissatisfaction, mixed with the alienation caused by physical distancing and the uncertainty of surgical practice in the postpandemic period, could accelerate the onset of burnout syndrome[91,92]. Training programmes should include a psychological support service, especially during this pandemic, to prevent the decline of surgical accomplishment.

## Ethics

By the second wave of the COVID-19 pandemic, the role of surgeons had dramatically changed worldwide with rapid transformation of clinical pathways[5,6] and creation of COVID units. The medical ethics associated with these impromptu changes have been debated simultaneously[93], with a rush to create new algorithms[4] to ensure optimal allocation of resources along with the best clinical care available.

### When to operate?

The American College of Surgeons[89] has advocated delaying non-urgent elective surgery to limit the spread of the SARS-Cov-2 infection within hospitals. Other guidance advocates for the need to protect healthcare workers[94] and patients[7], and avoid occupation of intensive care beds. Unfortunately, this policy has collided with the surgical waiting list for oncological diseases, with huge disruption of its timely efficiency. In contrast to multiple clinical guidelines[3], many patients have been redirected to oncological treatments rather than surgery with the aim of playing for time until after the pandemic[9–11,44]. It seems worthwhile considering how this could lead to multiple oncological outpatient visits with an increased risk of exposure to SARS-Cov-2 infection for oncological/immunosuppressed patients. Moreover, in view of the potential need for a postoperative ICU stay, the frailest and oldest patients are the most likely candidates to be offered delayed surgery and/or neoadjuvant treatments. Similarly, patients who would usually have been offered complex surgical operations have been diverted to chemotherapy or radiotherapy pathways. Resection of low-grade tumours has been postponed because of a longer surgical waiting list. The selection of which patients undergo primary surgery has been critical[95], balancing the need to relieve pressure on hospitals with the risks of delaying surgical treatment for cancer.

Given all these considerations, there is an urgent requirement to establish a multidisciplinary ethics committee (MDEC)[96,97] composed of surgeons, oncologists, radiation oncologists, anaesthetists, and psychologists. This MDEC should meet weekly to discuss each surgical candidate in order to recommend the best available treatment plan for that patient at that time.

### How to operate?

Surgical technique is another hot topic for debate, with a significant shift towards open surgery during the first wave of the pandemic, even in patients equally suitable for a minimally invasive approach. Many surgical societies have published guidelines recommending this approach[8,90], using the rationale of avoidance of viral transmission risk related to gas outflow and to save the resources linked to the higher costs of robotics-assisted or laparoscopic surgery. On the contrary, open surgery is associated with a longer hospital stay and increased exposure to nosocomial COVID-19 infections[98].

A recent review of the limited evidence in combination with expert opinion concluded: 'Using existing knowledge of surgical smoke, a theoretical risk of virus transmission exists. Best practice should consider the operating room set-up, patient movement and operating theatre equipment when producing a COVID-19 operating protocol. The choice of energy device can affect the smoke produced, and surgeons should manage the pneumoperitoneum meticulously during laparoscopic surgery. There is not enough evidence to quantify the risks of COVID-19 transmission in surgical smoke. However, steps can be undertaken to manage the potential hazards. The advantages of minimally invasive surgery may not need to be sacrificed in the current crisis'[71].

### How to provide care?

Postoperative care has also been transformed. A key shift has been seen in transfusion policy, with conservation of blood products and stricter indications for their distribution, because of difficulties linked to blood donation[99]. In addition, the avoidance of physical contact between healthcare professionals and patients may hinder the usual postoperative respiratory and motor rehabilitation, resulting in a disruption of enhanced recovery protocols. This could be associated with longer hospital stay and also increased exposure to nosocomial SARS-Cov-2 infection.

Physical distancing policies adopted by departments have significantly limited actual clinical evaluation of patients, reducing diagnostic accuracy. Visitor restrictions, even in end-of-life situations, have caused psychological trauma. For this reason, the active role of psycho-oncologists during the hospital stay becomes of paramount importance to maintain a connection between caregivers, the patient, and their family. Psychotherapy and psychological counselling are essential to prevent any feeling of abandonment and isolation[100].

### Communication

Issues related to the elongation of surgical waiting lists and delay to planned surgical interventions generate a conflict between patients, their relatives, and the surgical community. The therapeutic relationship might be damaged, with a consequent climate of suspicion that can adversely affect the clinical course of the patient (for example, refusal to undergo chemotherapy). Psycho-oncologists become of fundamental importance in promoting understanding and adherence to treatment pathways. It is necessary to remain in contact with patients and their relatives

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**Table 6 Key recommendations of the BJS Commission on Surgery and Perioperative Care post-COVID-19**

| |
|---|
| **Research**: global collaboration to address research questions about the future of surgery in the post-COVID-19 era |
| **Global leadership and planning**: development of context-specific pandemic preparedness plans |
| **Simultaneous delivery of elective care to minimize nosocomial infections**: development of COVID-safe pathways, including remote virtual consultations |
| **Development of healthcare provider organizations as high-resilience organizations** |
| **Innovative leadership to plan/prioritise delivery of surgical care at a national rather than institutional level** |
| **National and international procurement of resources including PPE** |
| **Governmental financial support for healthcare organizations including rapid expansion of testing facilities** |
| **Training**: residency training programmes should include targeted surgical practice, incorporating the use of simulation training. Psychological support services must be implemented urgently to avoid trainees developing burnout syndromes. |
| **Ethics**: establishment of a multidisciplinary ethics committee should be encouraged at surgical oncology centres. |

PPE, personal protective equipment.

throughout the preoperative phase to prevent, above all, feelings of abandonment[43,100].

It has been apparent that patients living in areas geographically remote from tertiary referral centres have struggled to access the best surgical—or even oncological—care, owing to government-imposed travel restrictions (such as cancelled flights). Telemedicine should therefore be endorsed by hospital administrations, to facilitate virtual medical evaluation when appropriate.

## Virology and immunology

### Identification of cases

Identifying infected patients is challenging because a certain percentage of cases are asymptomatic[2], and there are issues with the sensitivity and specificity of PCR testing. The sensitivity of RT–PCR performed on nasopharyngeal swabs is not 100 per cent and false-negative tests are quite possible[29], which may lead to an infected patient being managed as COVID-19-negative, leading to transmission of infection.

Healthcare facilities can take two measures in the current circumstances: thorough screening of patients (for symptoms and exposure) before testing or surgery; andaggressive RT–PCR testing of patients with suspected COVID-19.

Rapid IgG/IgM antibody testing for patients undergoing surgery may be more affordable, yet is far less precise than RT–PCR[101]. Although patients undergoing elective surgery may be eligible for this approach, those in need of emergency surgical intervention require more rapid solutions to the issue.

### Alternatives to virology/serological testing

Testing of surgical patients may include CT of the chest in patients with acute abdominal conditions who need abdominal CT[16]. Concomitant chest CT may detect subtle changes suggestive of COVID-19, such as ground-glass opacity in otherwise asymptomatic patients. It should be noted that CT is not sensitive enough to be recommended as a screening tool for COVID-19 alone. In addition, the use of full PPE during the care of surgical patients is mandatory[8,90].

### Vaccines

There have been intensive efforts to produce SARS-CoV-2 vaccines[102] and several of these have now been approved[103,104]. At the time of writing, these are being administered worldwide. An international prospective cohort study[105] has suggested that vaccines reduce mortality in surgical patients. However, access to vaccines is limited in many countries, their efficacy in the long term is unclear, and it remains to be seen whether they will herald an altered surgical environment.

## Discussion

The COVID-19 pandemic is a disaster of historic proportions that continues to threaten life and has uncovered a variety of problems in healthcare systems, including negative impacts on surgical practice. The surgical community has responded to the challenge by uniting to share experiences and learn. Global surgical multidisciplinary teams are working collaboratively to address research questions about the future of surgery in the post-COVID-19 era, many of which have been outlined by this Commission (*Table 6*).

The COVID-19 pandemic is severely damaging surgical training and is detrimental to the acquisition of technical competencies and skills required for effective teamwork. In the post-COVID era, residency training programmes should include targeted surgical practice, including the use of simulation training to fill the gap. Psychological support services should be implemented to avoid trainees developing burnout syndromes.

The establishment of a MDEC should be encouraged at all surgical oncology centres. Shared decisions permit the committee to tailor the clinical pathway for each patient, according to the available resources with the lowest acceptable risk of nosocomial COVID-19 infection. Optimal clinical care should include psychological support for patients and their families, with a psycho-oncologist playing a vital role.

How can surgery grow in the post-COVID era? This can be achieved by innovative leadership and collaboration to share solutions and motivate how to best work, teach, learn, and live. The COVID-19 pandemic has highlighted some of the critical weaknesses of current healthcare systems as well as the benefits that can be leveraged from perioperative practices. In particular, the qualities of high-reliability organizations , as exemplified by perioperative processes, management practices, and human factors, can be directed towards managing further crises. There is a long battle ahead and there are many challenges to overcome, but the global surgical community is strong, and more resourceful and united than ever.

## Collaborators

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*Disclosure*. The authors declare no conflict of interest.

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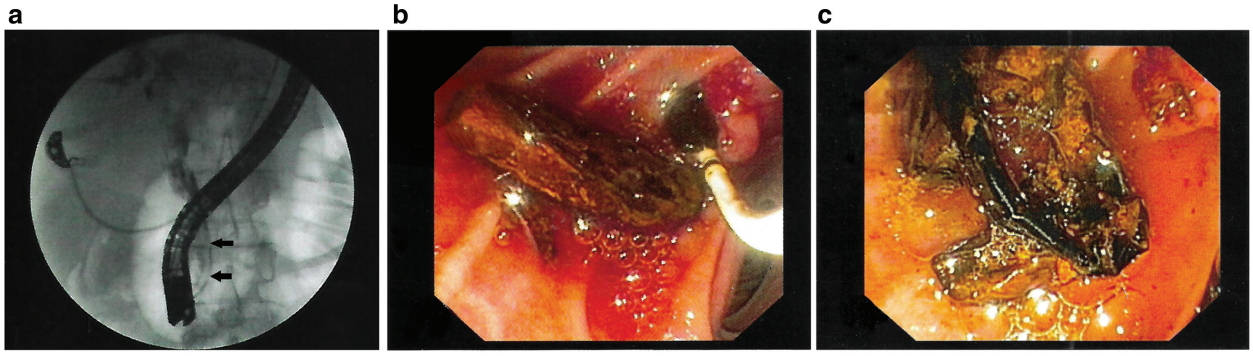

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# Snapshots Quiz

*BJS*, 2021, **108,** 1180
DOI: 10.1093/bjs/znab236
Advance Access Publication Date: 26 July 2021
**Snapshots Quiz**

**Question:** A 60-year-old woman underwent emergency therapeutic endoscopic retrograde cholangiopancreatography for three episodes of right hypochondriac pain, fever, and jaundice. The following findings were demonstrated on endoscopic views and on the cholangiogram. What is the diagnosis?




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*Disclosure*. The authors declare no conflict of interest.

**Answer: a** The cholangiogram shows a linear filling defect in the common bile duct (CBD). **b** Endoscopic sphincterotomy and extraction of dead *Ascaris lumbricoides* was performed. **c** Dead worm with small stones in duodenum. In endemic areas, *A. lumbricoides* are often seen in the duodenum, CBD, gallbladder, and main pancreatic duct. Presenting symptoms include recurrent cholangitis and vomitus containing worms. Movement of worms in and out of the CBD produces pain. Lack of nutrition and concentrated bile within the CBD leads to the death of worms, which leads to formation of pigment stones, cholangitis, and hepatobiliary abscesses. Most patients with hepatobiliary ascariasis require frequent deworming medications.

**Received:** May 26, 2021. **Accepted:** June 03, 2021
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