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Current Problems in Surgery

journal homepage: www.elsevier.com/locate/cpsurg

COVID-19: What are the challenges for NHS surgery?



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Introduction

In December, 2019 while COVID-19 was unfolding in China, surgeons in the United Kingdom were enjoying some of their last few months of normality. By April, 2020 all National Health Service (NHS) trusts in the United Kingdom had halted their nonurgent elective operating,¹ and much of the surgical community had been redistributed to roles far from their specialized career trajectories.

The first UK identified case of COVID-19 was recorded in February, 2020.² By March 11, 2020, the World Health Organization (WHO) had declared a global pandemic.³ It became rapidly apparent that despite the NHS being a highly revered healthcare system, it was sorely underprepared. With some of the lowest ratios in Europe of beds per population (2.5 per 1000) and doctors per population (2.8 per 1000), combined with the lack of experience of recent epidemics (Severe Acute Respiratory Syndrome-1, Middle Eastern Respiratory Syndrome, Ebola), which were successfully contained by other continents, COVID-19 presented an emergent humanitarian crisis for the United Kingdom.

The risk of nosocomial infection to the surgical workforce through both direct contact with surfaces, droplet or aerosol spray, or through intraoperative generation of fomites have led to abrupt changes in surgical practice during this unprecedented period. In the face of COVID-19, the risk profile of surgery to both patients and the operative team has dramatically increased. Routine procedural activities such as open suctioning, smoke generation (monopolar, bipolar diathermy, LASER), and the opening of pressurized cavities or orifices, are now considered high-risk.⁴ To mitigate these risks, surgical services (across all surgical specialties) have made pandemic-response changes to their practice as guided by their specialist organizations, the Department of Health, Public Health England, and input from the Royal Surgical Colleges.

This monograph focuses on the challenges facing surgical practice within the NHS during the COVID-19 crisis, acknowledging the state of fluidity. As the global pandemic unfolds, there has

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<https://doi.org/10.1016/j.cpsurg.2020.100856>

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Table 1

Current challenges, by category.

| Surgical patients | Surgical workforce | Surgical process |
|-------------------|--------------------|-------------------------------|
| Surgical services | Staff | WHO checklist |
| Patient screening | PPE | Operating room infrastructure |
| | Personnel testing | Operating room availability |
| | Surgical training | Technical aspects of surgery |

PPE, personal protective equipment; WHO, World Health Organization.

been a corresponding increase in the COVID-19 literature, informing practice across all fields of surgery. In light of the rapidity of pandemic spread, the majority provides low level evidence and is not directly translatable into NHS practice; however, these articles have provided important insights during these unprecedented times.

A significant volume of UK national guidance has been produced in response to the pandemic, with frequent updates on the published recommendations. Remaining current, for the individual, is a challenge in itself. Most surgeons have been navigating through the uncharted territory of their surgical specialty *en-pandemic*, employing adaptive working by drawing on, and implementing, relevant national guidance. Given the number of active occupational challenges, surgeons are either embroiled in managing their local responses to COVID-19 or adjusting to redeployment.

By reviewing the published literature and national guidance (including literature from public health organizations, specialty groups, the Royal Surgical Colleges and affiliated groups) combined with our own on-the-floor experiences of the COVID-19 response, we have produced a review of current surgical challenges in the NHS.

This manuscript consolidates the current challenges into 3 key areas: surgical patients, surgical workforce, and surgical process. Each limb of the current challenges and their component parts (Table 1) will be discussed. On account of the broad scope of this manuscript, we have elected not to discuss the specifics of anesthesia.

Current challenges must be considered in light of the NHS structure: a tax-based, free-for-all users' health care system. NHS trusts as organizational units can include several hospitals within a geographical area, operating in conjunction with shared principles, guidelines, and funding. Accordingly, not every hospital offers the complete range of surgical specialties. Surgical services are often centralized in concordance with a hub and spoke framework. Variety exists between the area covered, population demographics, and presence of specialist networks such as major trauma and burns care. Consequently, national guidelines for the COVID-19 response are designed accepting heterogeneity in the context of publicly funded services.

As the NHS emerges from the pandemic, many additional challenges will surface. We discuss some of the emerging challenges for surgery that will continue to shape the NHS's response to COVID-19. How these will be managed will require lateral thinking, adaptability, and, above all, an emphasis on safety.

Current challenges

Surgical patients

Restructuring of surgical services

As part of the immediate NHS response to the pandemic, surgical services were restructured to enable redistribution of resources. Surgical patients were grouped (obligatory inpatients, nonoperative, inpatient management, day case surgery, and outpatients), with guidance offered on the management of each category.⁵ Key recommendations included consultant led decision making, daily review of inpatient status, and extension of imaging (whenever required) to

Table 2
NHS prioritization system in COVID-19 pandemic.¹²

| NHS prioritization system | |
|---------------------------|--|
| Level 1a | Emergency – operation needed within 24 hours |
| Level 1b | Urgent – operation needed with 72 hours |
| Level 2 | Surgery that can be deferred for up to 4 weeks |
| Level 3 | Surgery that can be delayed for up to 3 months |
| Level 4 | Surgery that can be delayed for more than 3 months |

include chest screening. All operative scheduling should be consultant sanctioned, with an emphasis on conservative management when feasible.

Decision making for acute surgical presentations, namely between operative and nonoperative management, or modifications to routine surgical strategies (such as open techniques versus laparoscopy, or other adjustments to surgical approach), have been informed by specialty guidance, but, ultimately, are the responsibility of the on-call or lead consultant. Most departments have initiated multiple consultant decision making for acute admissions, in response to the pandemic. With there being a short interval from the time of the first COVID-19 case presentation, to the development of a global pandemic, validated management algorithms to support changes in operative strategies are lacking.⁶

The Royal Surgical Colleges stipulated that maintaining emergency surgical capacity, including major trauma provision, was the primary aim during the COVID-19 pandemic.⁷ NHS surgical organizations have worked in collaboration with the international community to pool knowledge and adopt recommended practices from countries earlier exposed to the pandemic.

Internationally, grading systems have been adopted to denote the services available at each stage, depending on a hospital's pandemic burden. In some examples, these are quantified by number of cases,⁸ whereas the NHS guidance is based on low, medium, high, or very high prevalence due to nationwide variation in hospital capacity.⁹ Some specialties have adopted a 2-tier consultant-on-call arrangement to aid emergency work load, as well as providing contingency cover for unpredictable changes in professional fitness to practice, or isolation requirements.¹⁰

Similarly, a prioritization system for cancer surgery has been implemented throughout the NHS (Levels 1a - 3), to provide uniform understanding of oncological urgency (Table 2).^{11,12} Operations proceed based on their assigned prioritization level, often in conjunction with daily prioritization meetings that enable multiple specialty discussions to ensure an agreed case order. Ultimately, the reduction in capacity has, for some patients, led to delays in cancer treatment and rescheduling of cases.

The NHS 2-week wait standards (for review of new or suspected cancer diagnoses) has been maintained, with an acceptance that first contact may be via telephone clinic.¹³ Oncological management (whether medical or surgical) requires careful consideration between (1) safety and availability of treatment in the current climate, versus (2) the risk of metastasis. Surgeons have been required to liaise closely with oncologists, their Multidisciplinary Team (Multidisciplinary Team), and adopt a service-limited, less invasive approach.

Patient screening

The key components of NHS preoperative patient screening for COVID-19 are structured questionnaires with temperature monitoring, viral real-time polymerase chain reaction (RT PCR) for SARS-CoV-2, and chest imaging. The aim of screening is to prevent pandemic spread and minimize the risk to patients and staff. On the other hand, COVID-19 screening investigations are performed only in response to risks identified through questionnaires, patient temperature, or clinical presentation. Not all surgical patients are screened by all possible modalities.

Patients can be categorized as confirmed COVID-19 positive, suspected COVID-19 (includes any patient with or without symptoms who has not been screened), and COVID-19 negative (following robust screening). As hospitals are high-risk environments, a patient's status may change

during an inpatient admission. Attention should be paid to possible symptoms, accepting that multiple viral screening swabs may become necessary.

Increasingly, surgical patients are tracked down 1 of 2 pathways: COVID-19 positive (includes confirmed and suspected patients) or likely COVID-19 negative, recognizing that absolute certainty about status is not possible. Segregation of patients based on viral status occurs throughout NHS surgical pathways; however, complete separation of patients to different hospital sites has generally not been possible. Accordingly, hospital sites are deemed high-risk areas for potential transmission of COVID-19. As part of the exit strategy, independent hospitals have been recruited in the effort to return to elective operating. As these institutions have not housed acute COVID-19 positive patients, they are viewed as "COVID-free," "COVID-light," or "COVID-cold" zones. The use of a traffic light system has been adopted in many NHS trusts for clinical areas, including operating rooms. Using this system, red denotes areas with confirmed COVID-19 cases, amber for suspected cases when results are not yet available, and green for patients where COVID-19 is not suspected. Strategies employed to increase safety within the operating suite are discussed in more detail in the section on surgical process.

All NHS patients are questionnaire screened to identify risk of COVID-19 prior to surgery. Questions determine the presence of symptoms, history of exposure, isolation status, temperature status, presence of high-risk factors (eg, key workers) and vulnerable patient features.

In the case of acute or unplanned surgical admissions, preoperative screening questions are completed on admission. Patients may have symptoms, as part of their surgical pathology, that could be associated with COVID-19. Low-grade pyrexia is particularly troublesome and should be monitored carefully for signs of progression. In true emergency operating, screening may be impractical, and therefore, cases have had to be managed as suspected COVID-19.

For scheduled cases (planned trauma or elective operating), where delays to operating may be possible, screening occurs prior to admission. The aim is to determine COVID-19 status prior to surgery and, if possible, to delay operating until the patient can be managed through a COVID-19 negative pathway. Screening questionnaires are performed by phone and, if the patient is deemed low risk, a provisional date for surgery is given with enough time for viral swabs to be performed and reported. Any case in which there is a suspicion of COVID-19 infection or the presence of risk factors will be referred to the lead consultant for discussion. All patients are re-screened by questionnaire and temperature checks on the day of surgery as part of the admission and preoperative assessment. Patient screening tools are essential for minimizing pandemic spread; however, they are not uniform across all NHS hospitals, rely on patient reporting, and are not formally validated.

The gold standard for testing for COVID-19 is pharyngeal swab RT-PCR for SARS-CoV-2 which detects viral RNA *in situ*. Routine testing involves nasopharyngeal and oropharyngeal swab, with sampling of the tonsillar region. Performing swabs is therefore difficult in some groups, which may affect the sensitivity of the test, making screening less reliable and unsuitable for patient directed home-testing. Location of viral expression appears to change with disease progression, impacting site detectability, and further complicating screening.¹⁴ COVID-19 has been detected in blood, urine, peritoneal fluid, and stool; however, transmission from these modalities is thought to be low.¹⁵⁻¹⁷ Fecal viral RT-PCR for SARS-CoV-2 may remain positive for a longer duration than other modalities,¹⁸ particularly in children, which has implications for endoscopic, general surgery, urology, and pediatric procedures.

In the advent of COVID-19, the UK government's pandemic strategy differed from the strict measures of testing, tracing, and isolation recommended by the WHO.¹⁹ The decision not to perform widespread testing and contact tracing was highly scrutinized and led to significant implications for the healthcare workforce.²⁰ Compared to many countries, the United Kingdom's facility for COVID-19 RT-PCR testing has been very limited. In response to public outrage, the government pledged to prioritize increasing the capacity of viral testing. Unlike most countries, routine patient testing for all hospital admissions is not yet conceivable. Revisions to the UK testing and tracing strategies seem to have missed the metaphorical "boat."²¹

Limitations in screening capacity, unsatisfactory delays to result reporting (initially up to 72 hours),²² and a high false negative rate (up to 20%)^{23,24} have complicated preoperative

screening. The prolonged incubation period of COVID-19 (up to 14 days) has also been problematic.²⁵ The triad of asymptomatic carriers, non-specific symptoms, and absence of routine viral screening, reaped havoc to surgical workflow in the early weeks of the pandemic. Subsequently, all aerosol generating procedures (AGP) required full personal protective equipment (PPE), regardless of the RT-PCR result.

In response to these challenges, the Royal College of Surgeons released a consensus statement in April, 2020 detailing the screening pathway prior to elective surgery.²⁶ Patients require isolation (with shielding) for 14 days prior to surgery, to be asymptomatic for the preceding 7 days, and have a negative RT-PCR pharyngeal swab within 48 hours of surgery. International guidance recommends dual testing for preoperative surgical patients who have no history of exposure or symptoms.²⁷ Accordingly, patients with 2 consecutive negative results may be managed as COVID-19 negative in the operative setting.²⁸ Many NHS trusts do not yet have this system in place; however, with the UK government warning of a prolonged emergence from the pandemic, effective pathways will need to be followed to combat the backlog of surgical cases safely.

Chest imaging has been shown to have a key diagnostic role in COVID-19 and is the final modality of screening employed for some surgical patients.²⁹ The British Society for Thoracic Imaging released guidance supporting the use of computerized tomography (CT) and chest radiographs to identify features of COVID-19 infection.³⁰ Screening of the chest is not routine for all surgical patients; however, chest CT is indicated in patients requiring intensive care postoperatively.²⁶ Extending imaging to include the chest (either CT or chest radiographs) is recommended in acute abdominal presentations,²⁶ and may be considered in other surgical presentations. Again, radiological signs vary with the course of disease and, therefore, imaging findings can be open to interpretation. A COVID-19 diagnostic algorithm has been developed to aid decisionmaking.³¹ The increased imaging demand has been matched by an expanded capacity for hot reporting. Acute staffing changes, required to maintain these requirements, may be problematic as normal NHS workflow returns.

Ultimately, there are many complexities regarding screening for COVID-19. The unique risks of upper airway viral titers, in relation to anesthesia and AGP, require careful consideration of all surgical cases. Variable carriage of viral load, progression of disease signs and symptoms, and problematic investigation sensitivities all complicate the picture.

Accordingly, surgeons are required to review the whole patient panel of results, which includes screening questionnaires, swabs, supporting blood tests, and any imaging performed, with a low threshold for repeat investigations. Developments in RT-PCR for SARS-CoV-2 testing within the NHS include decentralization of processing (enabling quicker turnover locally) and use of quicker detection systems.³²

Ideally, rapid and reliable point of care testing for COVID-19 would be available with a low false negative rate; however, due to the characteristics of the virus, it is unlikely that this will be realized. Focus should instead be on how to improve investigation effectiveness, processing time, and reliability of reporting.

Surgical workforce

Staff experience

The protection and preservation of the surgical workforce was listed as the second priority in the "Guidance for surgeons working during the COVID-19 pandemic."³³ The widespread impact on staffing numbers has been dramatic due to isolation requirements, sickness, and redeployment. Surgical services have required adequate staffing, with the potential to adjust to changing disease prevalence, despite a depleted workforce. Accordingly, staff flexibility and resilience have been crucial. Most schedules include the provision of standby staff; residing at home, these personnel are readied for work and can be called in to cover shortfalls in staffing levels and/or sickness. The main aims are to minimize the exposure of the surgical workforce, enable adequate rest, and have escalation plans in place, if required. Redeployment strategies implemented

at the local level vary hugely between NHS trusts. Professionals across the board have faced redeployment, often to unfamiliar roles.

Some of the 10,000 NHS returners who responded to the national “Bring Staff Back” initiative will have returned to the surgical workforce.³⁴ These individuals require additional training and support as part of their reintroduction to practice.

Since the advent of COVID-19, the operating rooms environment is a very different workplace. The general dynamic in operating rooms is less relaxed due to a multitude of challenges. Staff numbers are minimized for safety and their roles are more clearly defined. Operative cases are required to be consultant led. PPE is uncomfortable, impairs staff recognition, renders spoken communication difficult, and largely eliminates nonverbal communication from facial expressions. Unfamiliarity of staff with safety protocols can lead to inefficiencies and staff anxiety. As staff are assigned to a specific section of the operative suite, in keeping with their designated roles (operating room, anesthetic room, or corridor), there is increased segregation of staff and less interaction. With experience, there is an improvement in staff confidence and efficiency with COVID-19 safety protocols. Over time, individuals adapt to the cultural change involved in daily operating rooms turnover.³⁵ Postprocedural debriefs are crucial to staff development, as well as providing a platform to acknowledge any physical or psychological difficulties associated with current processes.

Staff requiring quarantine on account of their personal health requirements has been assigned low risk or contact-free activities. Changes to the on-call arrangements of the surgical specialties vary throughout the NHS, depending on staffing, services demand, and local policy. Some departments have maintained their pre-COVID-19 shift system, whereas others have required restructuring. Cross cover, doubling of staff cover, and contingency schedules are strategies employed in NHS trusts.³⁶ On account of occupational changes to working hours and roles, remuneration may be required in some incidences.

During the COVID-19 pandemic, there have been many changes to practice. For some individuals, this has been overwhelming and frequent guideline updates have been difficult to interpret. Dissemination of information to all members of the surgical team has been implemented largely by senior clinical staff. Using a communication task-force has been suggested as a strategy to reduce duplication of work and to keep team members informed.³⁷ Gaps in knowledge lead to increased staff anxiety. The use of daily trust-wide email updates has been employed by most NHS organizations to inform staff of updates within their own workplace.

PPE

In the surgical setting, COVID-19 transmission can occur through droplet, aerosol, and contact spread. PPE is required to mitigate against each of these routes. UK guidelines on PPE requirements have been subject to multiple changes and have been the source of controversy. In the early phase of the NHS COVID-19 experience, discussions about PPE dominated workforce concerns and the national media. Conflicting information, variance in local PPE recommendations, and restricted availability of required equipment led to significant workforce anxiety. Extensive workforce training has been required to ensure NHS staff is safely and appropriately using PPE. FFP3 mask or respirator fit-testing, as well as simulation training in donning and doffing PPE are now part of mandatory training for all patient facing personnel in the NHS.

Full PPE (fluid resistant gown, double gloving, visor or goggles, fit-tested FFP3 mask or respirator, disposable hat, shoe covers) should be worn in the operating rooms for any suspected or positive COVID-19 case, for AGP³⁸ (Table 3), and for procedures for which the risk is unknown. Despite initial discrepancies in the recommended PPE requirements, guidance released by the Royal Surgical Colleges and affiliated specialty organizations on March 27, 2020 reclassified laparotomy, laparoscopy, and endoscopy as high-risk procedures.³⁹

Updates detailing PPE requirements for surgery and reclassifying AGP were released by Public Health England⁴⁰⁻⁴² but did not answer the supply chain concerns. Later guidance, in response to acknowledged PPE shortages, suggested a reduction in intraoperative protection,⁴³ further inflaming the situation.

Table 3UK procedures classified as aerosol generating procedures.³⁸

| Aerosol generating procedures (AGP) |
|---|
| Intubation, extubation, and related procedures (eg, manual ventilation and open suctioning of the respiratory tract, including the upper respiratory tract) |
| Tracheotomy or tracheostomy procedures (insertion or open suctioning or removal) |
| Bronchoscopy and upper ENT airway procedures that involve suctioning |
| Upper gastrointestinal endoscopy where there is open suctioning of the upper respiratory tract |
| Surgery and post mortem procedures involving high-speed devices |
| Some dental procedures (for example, high-speed drilling) |
| Noninvasive ventilation (NIV); Bi-level positive airway pressure ventilation (BiPAP) and continuous positive airway pressure ventilation (CPAP) |
| High frequency oscillatory ventilation (HFOV) |
| Induction of sputum |
| High flow nasal oxygen (HFNO) |

ENT, ears-nose-throat.

AGP are recognized as high-risk for COVID-19 transmission. The initial classification of AGP was less prescriptive and terms such as "open suctioning" were open to interpretation. The updated guidance is superior;⁴¹ however, for many procedures, the risk level has not been clearly defined and thus decisions about the level of PPE required are difficult. Examples of this ambiguity include operations on the head and neck under local anesthesia, requiring close proximity to a patient's airway. Similarly, general anesthetic procedures in the same region would pose a significant risk if the closed-system ventilation tube were to displace. Accordingly, some trusts have made consensus decisions about local PPE safety, concerning procedural circumstances which have not been addressed in the national guidance. Specialty organizations have rallied for more extensive guidance, and in some cases, have produced additional recommendations for their members.⁴⁴

Surgical ward staff also require access to PPE. Routine procedural tasks such as replacing feeding tubes, as well as general care of tracheostomies and general stomas, are all associated with higher risk of transmission. COVID-19 safety protocols suggest that these skilled aspects of patient care should be performed by experienced staff.⁴⁵ The use of heat and moisture filters for tracheostomies has also increased safety. Nasogastric and nasojejunal tube insertion frequently induces aerosol generation by local irritation-induced cough or sneeze response.^{46,47} Likewise, chest physiotherapy can be considered from a similar stance. Routine care for COVID-19 positive patients with an active cough, also requires full PPE. Accordingly, the PPE requirement of the wider surgical team of healthcare professionals has been underestimated.

Supply of appropriate PPE has been a problem throughout the NHS, with severe shortages⁴⁸ compounded by a high case burden over a short period.⁴⁹ In April, a survey of UK surgeons and surgical trainees demonstrated that more than one half had experienced shortages of PPE over the preceding month, and approximately one third felt PPE was still inadequate and unsafe.⁵⁰ A survey of otorhinolaryngology surgeons revealed that 20% of trusts did not have the required PPE available and 95% of respondents felt the supply would run out during the crisis.⁵¹ Furthermore, concerns about trust rationing, self-funded PPE, and reports of emotional blackmail or gagging surfaced.^{52,53} Reuse protocols and cleaning of visors is now commonplace in the NHS. Across the surgical community, there are also concerns that UK guidance does not meet internationally reported standards.^{54,55} Inconsistencies in guidance, combined with difficulties in patient screening, have undoubtedly resulted in higher expenditure of PPE than necessary.

In most NHS trusts, a range of FFP3 masks were initially available to staff. With depletion of stocks, many healthcare workers have had to repeat fit-testing with alternative masks or respirators as certain models have become unavailable. A worrying gender imbalance in the suitability of PPE has surfaced.⁵⁶ The majority of PPE has been designed to fit an average man.⁵⁷ Masks and respirators are of particular concern, often being unsuitable, and resulting in high proportions of failed fit-tests in the female workforce. Given that 77% of the NHS workforce are women, many have been unable to work in high-risk areas, putting further strain on the system.⁵⁸

The wearing of full PPE is generally not a pleasant experience for most healthcare workers and can have a significant impact on morale.⁵⁹ Goggles, FFP3 masks, and respirators all have a significant impact on skin. Constant use can lead to abrasions, dermatitis, and pressure areas⁶⁰ which may necessitate the alternating of roles or days off work.⁶¹ Wearing full PPE during operations is hot and restrictive. In certain specialist operating rooms, additional requirements, such as high ambient temperatures for burns surgery or radiation protection in orthopedic procedures, exacerbate the unpleasantness. Operative discomfort may increase the risk of technical error. PPE can also interfere with important operative aids such as operating microscope, loupes, or headlights.⁶²

The impact of PPE on surgical efficiency is dramatic. Case duration is prolonged due to donning, doffing, down-time (to allow for air changes following intubation and extubation), surgical factors, and cleaning.⁴ With process familiarity there is upskilling, leading to improvements in procedural duration, but this does not match standard operating times.⁶³ As elective operating commences, adjustment of scheduling times will be necessary. Regardless of the backlog of cases, surgical centers will need to accept reduced efficiency as a trade-off for increased safety.

Personnel testing

On account of the unavailability of COVID-19 testing in the UK, personnel testing for COVID-19 has been exceptionally limited. It is recognized that healthcare workers are at higher risk of exposure, could be asymptomatic carriers, and may unknowingly be the source of hospital-acquired infection in patients. NHS trusts have had to adopt a rough risk analysis of patients on admission (instead of routine testing), despite the fact that approximately 80% of people who test positive for COVID 19 are either asymptomatic, or experience only nonspecific symptoms.⁶⁴ Consequently, untested staff are frequently exposed to untested members of the public, providing potential for viral transmission to either party.

Without adequate testing solutions available, the NHS has faced a dramatic rise in absenteeism. In line with the UK government's isolation recommendations, individuals have been instructed to completely self-isolate for 14 days in the presence of symptoms, and 7 days following close contact with a symptomatic person. A high proportion of NHS staff have had to self-isolate either due to personal or close-contact symptoms. In practice, without access to testing, an enormous number of households have had to self-impose cautionary isolation due to the presence of a symptomatic individual. In families with young children this has been particularly problematic. Many staff had to take multiple absences without clarity on whether they had suffered from COVID-19. Not only has this been incredibly frustrating for those involved but has also put pressure on the rest of the workforce. A survey by the Royal College of Physicians in April, 2020, found that more than 20% of respondents were isolating either with symptoms, or due to contact with a member of the household with symptoms. Only 31% had access to testing.⁶⁵ The NHS employee absence rates for 2020 have not yet been released, but these are expected to be the highest in recorded history,⁶⁶ with a huge impact on the total cost of COVID-19.

Later, testing was offered for symptomatic staff (following sanction by the trust microbiology or infectious diseases teams), in an attempt to return a proportion of the isolating workforce. As the emphasis on viral testing has increased nationally, and availability of tests has expanded, staff displaying symptoms now warrant screening. Against the backdrop of a national data vacuum, small data samples arising from isolated NHS trusts, which have adopted routine testing for all symptomatic staff,^{67,68} unsurprisingly demonstrate the highest proportion of NHS workers testing positive for COVID-19 were those working in patient facing roles. In the absence of a proficient immunity test, multiple RT-PCR SARS-CoV2 viral swabs may be necessary per individual healthcare worker.

The lack of routine screening for asymptomatic staff has important social implications for healthcare workers and their families. With COVID-19 status unknown, as we move out of lockdown, NHS staff will be unable to be in contact with vulnerable individuals. The government has now pledged that with increased testing capacity, screening will be available regularly to asymptomatic staff³⁴ but a program for this has not yet been rolled out. Compulsory weekly viral screening for everyone may be the most robust strategy moving forward.^{69,70}

Surgical training

The COVID-19 pandemic has seen lower levels of training. From March 16, 2020, all courses, conferences, examinations, and other surgical education-based activities requiring physical attendance were cancelled.⁷¹ Planned rotations in April, 2020 were suspended by Health Education England to minimize disruption. Across all surgical specialties, the training curriculums are competency based. It is recognized that the COVID-19 pandemic has been hugely disruptive to training and individualized placement objectives may not have been met. Although the Annual Review of Competency Progression process will allow some concessions, based on the COVID-19 pandemic, surgical trainees will still be required to meet the same standards in order to complete their training. Accordingly, senior trainees may be more adversely affected and in some circumstances additional time may be required to meet these competencies. Postponement of the final specialty examinations will, for some unfortunate candidates, result in extended training.

For those trainees redeployed on account of COVID-19, alternative duties may provide unique experiences, but in most cases, will lack direct surgical experience. The Joint Committee on Surgical Training has emphasized that redeployed trainees will not be disadvantaged; however, it is recognized that the curriculum requirements will need to be achieved in future placements.

The impact on NHS surgical training is difficult to quantify. During COVID-19, clinical exposure within the trainee population has been varied, resulting in a broad spectrum of experiences. Vulnerable individuals were required to isolate, engaging in nonpatient facing or home-based practice only. Others have remained in their routine clinical positions, with modifications to practice ranging from schedule changes, extended responsibilities, a step-down in seniority, and cross-cover arrangements with other specialties. Many have faced redeployment to non-surgical areas. In light of this variation experienced during the COVID-19 pandemic, a highly individualized Annual Review of Competency Progression process is required. Under these unique circumstances, trainees are required to provide additional information (to aid the assessment process) in the form of professional COVID-19 activity logs and a record of lost training opportunities.

Understandably, due to both personal interest and the requirement to obtain minimum operative numbers in specialty specific indexed procedures, many trainees are most concerned with their operative exposure over the pandemic period. Training challenges include the suspension of elective operations, consultant led operating (as mandated by the Royal Surgical Colleges during COVID-19), shortages of PPE, and minimizing of surgical staff to only essential members.⁴ Although the total duration of surgical training is considerable, trainees have a finite amount of time to achieve a huge number of competencies.

Since the implementation of the European Working Time Directive (EWTD)¹, operative exposure has become more precious. Although acute disruptions to surgical services during the peak-period are warranted, consideration of training must be integrated into future plans to tackle the backlog of cases as the NHS emerges from the pandemic. It is recognized that known COVID-19 positive patients may not make ideal training cases; however, avoidance of all high-risk procedures is not practicable for trainees in specialties with a high burden of AGP, such as head and neck surgery and orthopedics. Protocols for the resumption of elective services and prioritization of cases, combined with the ongoing risk level of certain procedures, will continue to have an impact on trainee exposure during the post-pandemic phase.

Although opportunities to develop technical and operative competence may have diminished significantly, trainees will have experienced an exceptional period for the NHS, requiring adaptive working and differing professional skills. Surgically, the risk of AGP has been mitigated in some incidences by a return to more traditional techniques (such as hand drilling or blade only excisions),⁷² enabling exposure to different approaches. The use of simulation resources to bridge the training gap may have a role in preventing deskilling.

Changes to clinical assessments, performed through telemedicine portals, require clear communication, an emphasis on effective history taking and remote patient education. Frequent

¹ A piece of legislation that aims to protect employees by preventing excessive working hours in the UK

changes to departmental workflow and care guidelines provide opportunities for communication, leadership, management, and service improvement. Trainees can engage with a number of activities to support their professional training including data collection, local guideline development, dissemination of COVID-19 updates, and pastoral support. Those disappointed by scheduled examination cancellations are still facing uncertainty, with future dates not yet confirmed. Independent study, appropriate to trainee level, is recommended. Inevitably, current practice provides reduced specialty exposure and trainees would be wise to focus their reading on these deficiencies.

In response to the abrupt changes in surgical education, there has been a reciprocal increase in the availability of free online resources and webinars. A host of online video conferencing options have enabled high quality, international teaching.⁷³ Unsurprisingly, there has been a huge upscaling of traffic through online learning platforms,⁷⁴ as trainees seek opportunities wherever possible. The response to real-time teaching has exceeded expectations. Several UK-based surgical webinar program have been so oversubscribed, that the platforms employed for access have been unable to accommodate the number of learners. In these cases, organizations have had to upgrade their membership package, increasing their user capacity, in line with demand. As part of the response to COVID-19, the surgical community has collaborated internationally to support surgical education resulting in unique, global access to training. This serendipitous consequence of the COVID-19 pandemic is likely to encourage future collaborative teaching, representing an important landmark in medical education.

Surgical training fellowships are problematic in the current climate. These would usually be undertaken during, or after, the last year of training, usually with a subspecialty focus. For UK trainees, fellowships often act as a bridge between surgical training and independent consultant practice. Those currently working as fellows are experiencing similar reductions in training. In most circumstances individuals have opted to remain in post, with the understanding that their role may be modified, extending outside of their desired subspecialty focus. Recruitment for many national and international fellowships has been frozen. With foreign travel currently on hold, many planned fellowships will not be going ahead for the foreseeable future.

The Training Interface Group fellowships are competitive, nationally appointed, advanced specialist training fellowships in the United Kingdom; these posts are open to multiple specialties and offer the unique opportunity to experience intensive surgical specialty training, through exposure to the contributing parent specialties. Both recruitment to, and the initiation of, this year's fellowship program, have been suspended while training needs cannot be met. Individuals at this level will need to either forfeit their fellowship plans or prolong their training. A clear strategy to address the training gap for current and postponed fellows has not yet been decided.

Surgical process

World Health Organization checklist

The role of the WHO Surgical Safety Checklist (developed in June, 2008 and mandated into routine NHS practice in January, 2009),⁷⁵ has been largely omitted from recommended COVID-19 guidelines, but has nevertheless played an intrinsic role during the pandemic. As is standard in surgical practice, meetings are held at the beginning of operative lists to disseminate case based information, using the WHO checklist as a guide. These meetings are compulsory and are attended by all members of the team. During the pandemic, routine checklists have been expanded to include vital case-specific COVID-19 information.

All surgical cases require a discussion about the patient's COVID-19 status, the degree of aerosol risk for each part of the procedure (induction of anesthesia, extubation, and for all operative phases), with PPE requirement stated for each stage. Important logistical considerations should also form part of the preoperative checklist, such as: wait-time for air changes following induction and termination of anesthesia, location of operating rooms donning and doffing areas, designated staff roles, and a detailed itinerary of the required (and potentially required)

surgical instrumentation.⁷⁶ A nominal period of rest time is required to normalize infection risk following intubation or extubation and should be discussed at the team brief, acknowledging the impact on total operative time.

The intraoperative use of the 3 phases of the WHO checklist (sign in, time out, and sign out) are compulsory. In response to PPE-related communication difficulties completing these, the Safer Surgery app (an electronic version of the WHO surgical safety check list) has been developed for intraoperative use during COVID-19. Under usual circumstances, operating room debriefs are encouraged and often occur at the end of a whole operating session. In the current climate, debriefing has become more formalized after each surgical case, enabling immediate reflection, identification of issues, and team learning.

Frequent, structured communications are key to safe practice and particularly important during the COVID-19 pandemic.⁷⁷ Workplace risk remains high; predictions expect heightened risk level to remain for months to years. Accordingly, changes made to systems, staff handover, and general communications may become incorporated into routine NHS practice for the longer term, despite originally introduced as COVID-19 related cultural changes.

Theatre infrastructure

It should be assumed that the operating room environment and its contents are contaminated,⁵⁴ providing exposure for development of nosocomial COVID-19 infection. Furthermore, AGP are high risk for viral transmission to healthcare workers, and must be managed in concordance with stringent safety protocols. Necessary adjustments to operating suite layout, staff working, and operating room flow have been implemented throughout the NHS surgical services to mitigate these risks. To ensure safety throughout the phases of a surgical procedure, modifications have been made to each component of the operative pathway. Viewed as separate parts, these include preprocedure team meeting (WHO checklist), transfer, induction of anesthesia, operative steps, extubation, and transfer to recovery. Wait times following instrumentation of the pharynx should be considered part of the anesthetic procedure.

Ventilation systems have been the subject of dispute. In the majority of NHS hospitals, operating room ventilation runs on positive pressure systems, with or without laminar flow. Literature from other countries recommending negative pressure ventilation in the management of COVID-19 cases,^{78,79} initially generated concern. A consensus statement between the Royal Surgical Colleges, affiliated organizations and Public Health England have approved that positive flow ventilation systems are considered safe for the management of COVID-19 cases,³⁹ and that laminar flow is recommended. Acute restructuring of NHS operating room ventilation systems has not been feasible during the pandemic, but safe ventilation management has been crucial. Doors between the operating room and adjacent spaces should be kept closed to maintain effective airflow.⁸⁰

Most NHS operating rooms have a degree of open plan design. The heightened requirement for ventilation and reduced contamination has changed the demands of the operating suite.⁸¹ Anesthetic rooms do not routinely have high frequency ventilation, and scrubbing up areas are usually confluent with the operating rooms space. Transforming operating suites into COVID-19 safe work spaces overnight has been challenging. Example operating room layouts are provided for our institution, prior to COVID-19 (Fig 1), and demonstrating the repurposing of workspace areas during the COVID-19 pandemic (Fig 2).

Under current circumstances, all parts of the patient's pathway (induction of anesthesia, the operating procedure and recovery), now occur in the main operating suite. In our institution, the absence of doors between the scrubbing up area and the main operating rooms has required scrubbing and donning to be performed in the repurposed, anesthetic room. Access to operating rooms for the delivery of additional equipment should occur through the newly assigned "Staff entrance and donning area." The lack of a designated storage space for equipment which is separate from the main operating rooms space has required "external runners" to deliver supplies into operating rooms, through the clean donning area (which would have previously been the anesthetic room).

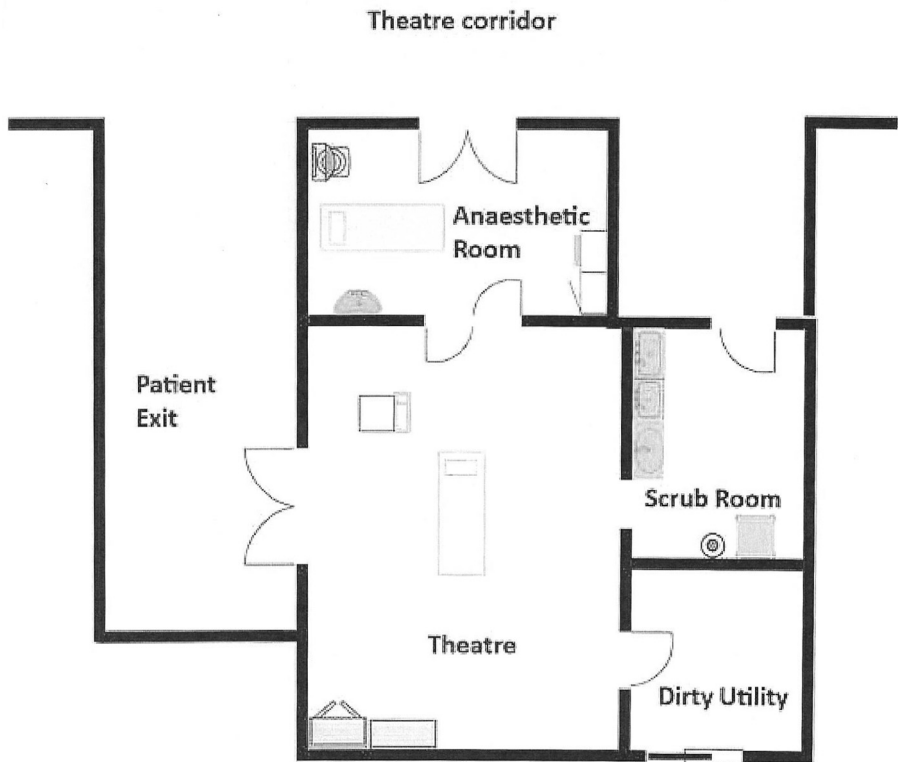


Fig. 1. Operating suite layout, prior to covid-19.

Equipment is passed from the "external runners" in the operating rooms corridor, to staff in full PPE stationed within the clean area. Knocking on the operating rooms door signifies to the internal theatre team that the equipment is available. The "internal runner," when ready, opens the door for a minimal period, accepting the required equipment. Pauses in operating, while this process is in action, can prolong the procedural time.

Operations on children should be avoided due to the unique risks of asymptomatic carriers and difficulty of performing pediatric screening, examinations, and procedures. In exceptional circumstances, essential procedures can be performed. All children are managed as high-risk for COVID-19 transmission. The surgical pathway for children has been modified for safety accordingly. Generally, children are cannulated on the ward and accompanied by a parent or guardian to the operating rooms entrance, where staff in full PPE meet them. The patient is then anesthetized without the parent present. In some parts of the United Kingdom, child services have been reduced in peripheral hospitals, favoring centralization of cases to designated pediatric hospitals, thereby maximizing expertise.

The need to segregate suspected or confirmed COVID-19 patients into designated operating rooms has spurred the use of traffic light systems to denote case status. Ideally, completely separate operating suites, with isolated ventilation systems, should be used for suspected or positive COVID-19 patients. All nonessential equipment should be removed from the operating room environment and essential apparatus should be covered with plastic wrapping.⁸² A detail run through of all required equipment should be detailed in the team briefing and kept sterile in

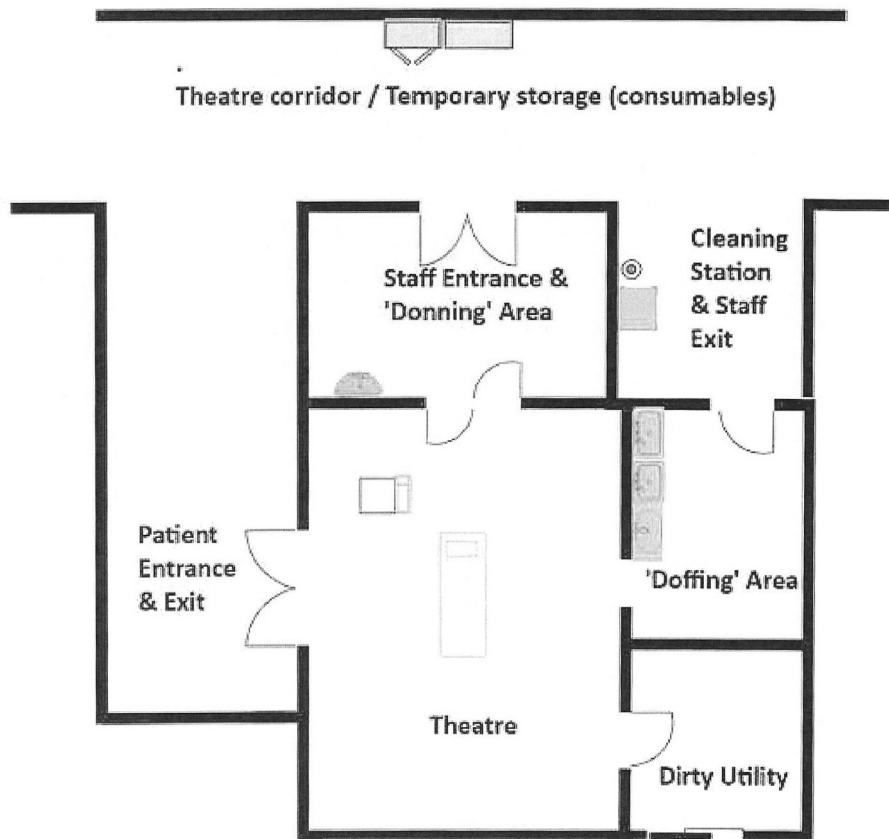


Fig. 2. Operating suite layout, prior to covid-19 pandemic.

a clean area within theatres enabling swift access. Unused items should be returned to stores without being contaminated.

Whenever possible, staff perform a dedicated role for the duration of an operation, thereby minimizing the number of people in the operating rooms, and reducing handovers. Due to additional steps and segregation of areas within the operating suite, the staffing requirement overall is greater.⁶³ Social distancing should be maintained, when practical, within the operating room environment. Based on national guidance, local NHS trusts individualize their COVID-19 response based on the existing infrastructure of individual hospital sites. Structural layout, PPE availability, and disease prevalence are taken into consideration.

Theatre availability

All NHS trusts, but not all hospitals, have a critical care capacity. The total number of NHS critical care beds for combined adults and pediatric occupancy (under usual circumstances), totals 5900 beds,⁸³ or 7.5 beds per 100,000 population.⁸⁴ This figure is lower than many European countries and posed an immediate concern in the advent of COVID-19. Halting elective operating and reassigning operating spaces has been the main contributor to NHS England's plan for an additional 30,000 critical care beds.⁸⁵

Difficulties in the procurement of essential equipment, including ventilators (due to supply flow problems and a global shortage) has, in some cases, resulted in redistribution of operating equipment. In other locations, due to an expanded critical care bed requirement, areas with

Table 4

COVID-19 pandemic principles for surgery.

| COVID-19 pandemic principles for surgery |
|--|
| Consider conservative management of surgical conditions |
| Avoid GA if possible |
| Avoid AGP if possible |
| Opt for less complex, adequate operations |
| Minimize staff exposure and operative duration whenever possible |

AGP, aerosol generating procedures; GA, general anesthesia.

capacity for ventilation were identified, recruited, and converted. Most commonly in NHS hospitals, these have been operating rooms, anesthetic rooms, and recovery areas, which has had an immediate effect on operative capacity. The consolidation of surgical cases (across all specialties) into the remaining operating room lists, has required daily multidisciplinary meetings to discuss prioritizations.

Operational adjustments to redirect elective surgeries to "COVID-19-free" zones, has seen the reopening of some surgical areas and utilization of private sector establishments. Block-buying of independent sector capacity has occurred on a national scale and is being managed by local NHS trusts.⁸⁵

Technical impact on surgery

During the COVID-19 pandemic, across all specialties, modifications to the technical aspects of surgical practice have been implemented. Within NHS practice, certain pandemic principles have emerged to reduce the risk profile of surgery (Table 4).

It is accepted that many surgical conditions may be managed conservatively. As a result, some patients who would have been transferred to specialist centers will have been managed locally.^{86,87} In the current climate, a trend is observed toward increased imaging to inform surgical decision making. Patients with acute general surgical conditions such as suspected appendicitis and cholecystitis, should either have open procedures (due to the unknown risk of laparoscopic surgery) or be managed conservatively. Similarly, management of acute mastoiditis should now be medical with imaging support.⁸⁸ A detailed, collaborative, COVID-19 response has redefined the trauma management standards during the pandemic.⁸⁹ Increasingly, trauma cases that can be managed with local anesthetic procedures are performed whenever possible in the emergency department or trauma clinic setting to reduce the operating room burden.⁹

The COVIDHAREM study has been announced to capture the impact on morbidity and mortality of differing approaches to the management of acute appendicitis during COVID-19.⁹⁰ Emergency surgery during this period has been complicated by later surgical presentations, most likely due to patient compliance with isolation or anxiety around entering a high-risk clinical area. Reports demonstrating a relative increase in the number of bowel obstructions during the COVID-19 pandemic are not surprising, making surgery more challenging and having a negative impact on patient outcomes.⁹¹ Given that conservative management is being considered for a larger cohort of patients, the use of surgical scoring systems may help stratify patients.⁸⁰

The avoidance of general anesthesia (GA) is primarily due to the associated aerosol risk; however, there are also secondary advantages such as potential reduction in postoperative bed requirement and anesthesia related complications. The move away from GA has seen a reciprocal increase in use of regional anesthesia. Newer techniques such as "wide awake local anesthetic no tourniquet" technique⁹² have gained an overnight increase in popularity. Wide awake local anesthetic no tourniquet has been recommended by the British Society for Surgery of the Hand for routine practice during COVID-19 and is increasingly being used for other anatomical regions.

Many standard operative devices such as laser, bone saws, high-speed drills, skin dermatome, harmonic scalpel, and other tissue-sealing devices have been evaluated as high aerosol risk and have been temporarily replaced with alternative techniques. In real terms this has meant a temporary return to more traditional surgical techniques.⁷² Settings of cautery devices should be

as low as possible to reduce the generation of smoke and used with suction or intrinsic vacuum.^{93,94}

There is an ongoing debate about the risks of open surgery versus laparoscopic surgery. The Intercollegiate general surgery guidance advised against laparoscopic surgery due to the unquantified risk.^{93,95} Insufflation of body cavities may be associated with aerosol generation due to escape of fluid with high pressure gas. More detailed guidance later suggested that laparoscopic techniques for cases with clear benefit, could be used over alternative techniques, with use of full PPE to mitigate against potential transmission.⁹⁶ Prior to use, all equipment must be checked meticulously and operating room ventilation should be appropriate. Adjustments to technique to maximize safety include careful introduction of trocars to minimize leak, aspiration of abdominal cavity insufflation prior to removal of trocars, and the use of air filters. A consensus on safety of laparoscopic surgery has not been reached. The Association of Laparoscopic Surgeons of Great Britain and Ireland has provided a series of safety recommendations for laparoscopic practice in cases where there is a clear benefit.⁹⁷

Certain procedures involving the head and neck cannot eliminate exposure to AGP. For these high-risk operations, procedural planning is key. An emphasis on clear stepwise processes increases safety.⁹⁸ Tracheostomy placement and changes, whenever possible, should be delayed until the patient is proven COVID-19 negative. When necessary, strict protocols should be followed incorporating modifications to standard practice, such as advancement of the endotracheal tube below the incision level to mitigate aerosol generation.⁶³

In keeping with the "essential surgery only" approach, many complex surgeries are simply not being performed. Surgical choices focusing on reduced operative time, low complication rates, and minimizing the inpatient stay are favored. In the current climate, breast cancer patients are not being offered primary reconstructions. Similarly, in the severely injured limb, early amputation should be considered over limb salvage and reconstruction, requiring multiple procedures. In gastrointestinal surgery, patients are more likely to be offered a temporary stoma formation to reduce the risk of anastomotic leak and longer inpatient stays.^{4,99} Surgical management of fragility fractures (the incidence of which remains high) are a priority, with acceptance that hemi-arthroplasty and sliding hip screw fixation in the current climate offer a beneficial reduction in operative time.¹⁰⁰ Surgical techniques to reduce complexity and follow-up contact are preferential. Examples include the use of absorbable sutures and percutaneous K-wires for fracture fixation.

Minimizing staffing numbers in the operating room also extends to the number of surgeons. Operator requirements are dependent on the technical challenges of the procedure. In some operations, such as pediatric otolaryngology cases, a minimum of 2 surgeons are still recommended during the pandemic for safety reasons.⁶³ Long surgeries such as head and neck procedures may benefit from teams of surgeons performing different component parts of the procedure. Duration of surgery should also be minimized⁹⁹ and quicker techniques are preferential. In the NHS, implementing less complex surgical management and consultant led operating have been employed strategies.

Factors associated with adverse outcomes from COVID-19 (age, frailty, high BMI, and associated co-morbidities) should be identified and discussed with patients when considering urgent (but not immediately life-saving) surgery.¹⁰¹ Patients should be informed of the impact of COVID-19 on their surgical management. Risk of COVID-19 infection and ceiling of care decisions should be discussed and clearly documented,¹⁰² forming part of the surgical consent process.¹⁰³

Emergent challenges

The UK's daily figures for COVID-19 proven infections, hospital admissions, and deaths, appear to suggest that we are emerging from the peak. Lockdown measures have been, to some extent loosened, without a detectible effect on these trends. With the most vulnerable groups of people still under strict isolation, and with no clear strategy for their safe emergence, we may be falsely reassured. Recorded figures are valuable, but should be interpreted cautiously, taking

into consideration the UK's screening challenges and the international variation in testing and recording practices.

Some of the surgical specialty organizations have released literature detailing the next phase of the pandemic response, encouraging a move towards resuming elective services.¹⁰⁴ The priority must be for safe return to surgical pathways and the readiness to do this will vary across NHS trusts. Gradual resolution of elective surgery will be limited by a multitude of factors, many of which have been discussed in this monograph. Prolonged procedure time will continue to have a dramatic effect, and it is unlikely that services will return to the pre-COVID-19 level of turnover. Should subsequent surges in COVID-19 prevalence occur, there may be a similar regression in availability of surgical services.

All surgical staff will continue to play a role in reducing the risk of transmission, thereby continuing to mitigate against the impact on patients and staff. Surgical trainees, who have been flexible during the pandemic period, will need their training requirements planned into the next phase response. Changes to working patterns and surgical schedules have been extremely disruptive and decisions will need to be made about how these will be readjusted. Since January, 2020, the UK is no longer part of the European Union, which could lead to major changes in workplace standards. It is unclear if the European Working Time Directive (EWTd) rules for safe working will be abolished. Proposals to target the disruption to services, may encourage a move toward 7-day working. At the same time, COVID-19 delivered rapid delivery of flexible working, previously unimagined in the NHS. It is likely that the NHS will be challenged to maintain more adaptable ways of working for some individuals.

The effect of COVID-19 on patients has been dramatic and very difficult to quantify. The COVID-19 pandemic has brought a novel sense of risk around healthcare, with particular caution surrounding surgery. The psychological effects of social isolation, and the impact of media should not be underestimated. As we emerge from the peak, an emphasis on high quality research is now needed to generate data on critical deficiencies in knowledge, and to help inform decision making in surgical care.

Mortality risk

Early data suggest that COVID-19 has a detrimental effect on surgical outcomes. The overall mortality rate, in the presence of COVID-19 infection prior to, or following surgery, is higher than would be expected.^{105,106} This is highly concerning for patients, surgeons, and healthcare providers. Robust research is required into the impact of COVID-19 on surgical outcomes.

One quarter of the UK population are deemed high-risk.¹⁰⁷ Patients' vulnerability factors will influence their level of anxiety around attendance to healthcare institutions and treatment decisions. Delays to cancer operations, on account of service availability, oncological prioritization, or patient choice will have magnified the stress and uncertainty experienced by cancer patients and their families.

Increasingly, data are emerging suggesting there may be patterns in susceptibility to COVID-19. Broadly, these could be grouped into potentially modifiable and nonmodifiable factors¹⁰⁷⁻¹¹¹ (Table 5). Although some of the literature is speculative, these potential links are the cause of significant anxiety and require expedient scientific investigation. The increased risk of COVID-19-related-mortality is particularly problematic for cancer patients requiring treatment. Ultimately, in some cases, the presence of risk factors will complicate treatment discussions and decisions.

Clearly, trends in susceptibility affect patients and staff alike. Looking forward, possible implications include the need for differential management of patients or staff based on the presence of risk factors, increased preoperative or occupational screening, and potentially, public health initiatives to address modifiable risks. This raises the question: as the largest employer in the United Kingdom, should be the NHS be more responsible for addressing the health of its workforce? If so, COVID-19 could result in an infrastructural shift towards greater emphasis on occupational health and well-being.

Table 5

Summary of possible nonmodifiable and potentially modifiable vulnerability factors affecting COVID-19 susceptibility.^{107,111}

| Nonmodifiable factors | Potentially modifiable factors |
|------------------------|--------------------------------|
| Age | Weight |
| Co-morbidities: | Co-morbidities: |
| Cancer | Hypertension* |
| Cardiovascular disease | Diabetes* |
| Respiratory disease | |
| Ethnicity | Smoking status |
| Gender | Deprived background* |

* Indicates potentially modifiable factor in some patients.

Interestingly, in the UK healthcare workers have not been shown to have higher death rates when compared to the general population.¹¹² Healthcare workers from Black, Asian and Minority Ethnic (BAME) groups, have been shown to have a significantly increased risk of mortality when compared to white healthcare workers.¹¹³ Furthermore, national data suggest that Black, Pakistani, and Bangladeshi individuals are at increased risk of mortality from COVID-19.¹⁰⁸ Although the data are striking, they are unlikely to represent ethnicity factors alone. Essential research investigating the link between ethnicity and risk of mortality, as well as other contributory factors, should be a national priority. As the UK moves into the next phase of COVID-19, a focus on understanding and managing vulnerability factors will be key.

Delays to treatment

Globally, an estimated 37.6% of cancer surgeries and 81% of benign operations will be delayed on account of the pandemic.¹¹⁴ Many patients will have accepted alternative treatment pathways on account of COVID-19, with unknown effect on outcomes. Pathways designed to aid decision making between surgeon and patient do have a role, but are not validated.¹⁰⁵

The NHS safeguards patient care by delivering treatment pathways within a series of strict timelines. Cancer waiting times include standards for the time to diagnosis (31 days) and time to treatment (31 days from treatment decision, 62 days from initial referral). Clearly, in the current climate these may be more difficult to maintain; however, cancer care will be most protected. The management of benign conditions will inevitably suffer delays. The maximum duration for treatment of nonurgent conditions should be 18 weeks. Any breach of these standard waits results in a fine for the NHS trust.

Currently, most patient pathways have been frozen (on account of the exceptional circumstances), therefore, not incurring these penalties. How suspensions to pathways, prolonged wait times for operations and, patients' expectations will be managed, has not yet been publicized. An emphasis on cancer management and other time-dependent operations will be the primary focus as services resume. The cancellation of some operations may have already led to harm, or may require adjustment to planned surgical interventions due to disease progression.

Rapid resolution of transplant, cardiothoracic, and vascular surgery services will be necessary to reduce the secondary morbidity and mortality associated with COVID-19. Transplant services in the United Kingdom have been dramatically affected by COVID-19. Live donations were held due to the relative risks to both patients. The complex infrastructure required for rapid organ retrieval, matching, and transplantation could not be maintained uniformly over the peak pandemic. Pancreas, liver, and kidney services have been particularly affected, with the majority of centers still closed.¹¹⁵ The national reduction in transplantation and donor availability will have contributed to the number of potentially preventable deaths.^{116,117}

Nonurgent benign operations are likely to be suspended indefinitely until a strategy has been agreed for the urgent procedures. These patients are likely to be disappointed by prolonged

waiting times. Delays to surgery will in many cases result in progression of disease and an associated impact on the technical complexity of surgery.

Pediatric surgery is a particularly difficult area. In general, surgeries are only performed in children when they are clinically urgent. Due to the challenges of performing adequate pharyngeal swabs in children and the frequent requirement for GA, all pediatric operations will need to be managed as high-risk cases. Age dependent operations such as cleft lip and palate are generally performed within a narrow window, based on a delicate balance of risks. With ongoing uncertainty about the risks of surgery in the presence of COVID-19 infection, pediatric surgeons will need to carefully consider the safe return to elective operating.

Outpatient cancer surveillance and imaging has largely been held. Telemedicine clinics, which are reliant on patient reported signs and symptoms, are unlikely to have been a substitute for professional assessments.¹¹⁸ As a consequence, we are likely to see a rise in cancer recurrence, presenting later. High-risk imaging for oncological surveillance will resume, but managing the backlog will be challenging. The longer imaging gap in some patients will mean later detection of oncological metastasis or recurrence.

Combating the backlog

The government's decision to halt elective operating over the COVID-19 pandemic peak was necessary, but has led to an accumulation of cases. It has been estimated that clearing the backlog of these operations will take an estimated 45 weeks, working at a 20% increase in productivity.¹¹⁴ Trusts invested in targeting these delayed procedures will, however, be confronted with limited surgical capacity and reduced efficiency. An expansion of staff provision, operating room availability, and associated support services will be necessary. In practice, this translates into a systems approach to increased capacity, with as much emphasis on dressings clinics, physiotherapists, and radiographers as it has on surgeons and operating room staff. How this will be funded is not yet clear, but the United Kingdom is facing estimated costs of £2 billion.¹¹⁴

The use of independent sector hospital services will play a key role in the expansion of NHS surgical capacity. Many patients will prefer to have procedures in COVID-19 "light" or "cold" sites, which may be safer. The logistics of managing patients through additional sites, is problematic. Information technology systems are different and are often not compatible with the parent NHS trust systems, leading to challenges with access to patient records and data protection. Many hospitals have not yet confirmed their position on trainee access to alternative sites, which, if denied, could have an ongoing detrimental effect on training.

Litigation

On account of the many delays and unplanned changes to patient management decisions, the NHS will experience a unique wave of healthcare litigation. Cases of clinical negligence may target NHS trusts or the individual. Organizations such as the British Medical Association and the General Medical Council have provided guidance for members on practicing during the COVID-19 pandemic; however, there is ongoing professional concern about the personal level of risk. Returning NHS professionals may be particularly vulnerable. Undoubtedly there will have been preventable harm and deaths suffered as a consequence of the COVID-19 pandemic. Surgical specialty organizations have adopted a key role in the dissemination of available evidence to aid safe practice and should be used as a guide for professionals. Individuals should carefully discuss and document all patient management decisions influenced by the COVID-19 pandemic.

Current indemnity arrangements will cover events incurred over the COVID-19 period; however, the UK government has launched an additional COVID-19 clinical negligence scheme for additional scope.¹¹⁹ The Coronavirus Act 2020 covers the services outsourced to independent hospitals on account of COVID-19.¹²⁰ Other high-risk areas of potential litigation include the manufacture of equipment and pharmaceuticals.¹²¹

Use of telemedicine clinics has bridged an important gap in the availability of services, but the rapid development of virtual services, with temporary slackening on data protection standards, will have implications for patient confidentiality, with legal implications.¹²² The rapid introduction of new systems are often associated with greater potential for error and breach of information standards. The development of increasingly data-safe systems will be paramount.

Conclusion

COVID-19 has resulted in a significant number of challenges for surgery in the United Kingdom. By detailing the unique NHS experience, as well as the evolving responses to the COVID-19 pandemic, we offer a view into the current impact on surgical services. At the time of writing, the United Kingdom is thought to be emerging from peak prevalence. Navigating a safe return to surgical pathways, as the pressure on the health system changes, will be a slow process and will generate further challenges. With many countries entering their pandemic experience later, a map of the NHS surgical challenges will likely inform expectations and practice.

The consolidation of the challenges into the subgroups of surgical workforce, surgical patients, and surgical process has aimed to address the concerns of different NHS stakeholders, within a constantly evolving landscape. Many uncertainties remain, and the effects of COVID-19 on surgical practice are likely to be longstanding. The first weeks of the pandemic were an unsettling time for the nations as new ground was being navigated. The dynamic nature of the COVID-19 pandemic has made the generation of this monograph both interesting and challenging.

Despite the devastating loss of life, healthcare disruption, and international anxiety, we must identify the wealth of lessons gleaned from the COVID-19 pandemic and cultivate from them positive changes for our healthcare systems. The sharing of international experiences has been invaluable in tackling the COVID-19 response. Consensus statements have been crucial in guiding care decisions, but as we move forward an increased emphasis will be on evidence based medicine. The response of both the public and the international healthcare community in tackling COVID-19 has been impressive. We will need continued vigor to manage the ongoing challenges facing surgery.

CRedit authorship contribution statement

Natasha L. Wielogórska: Conceptualization, Methodology, Writing - original draft, Writing - review & editing, Visualization. **Chidi C. Ekwobi:** Writing - review & editing, Visualization, Supervision.

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