Guideline

SARS-CoV-2 infection, COVID-19 and timing of elective surgery

A multidisciplinary consensus statement on behalf of the Association of Anaesthetists, the Centre for Peri-operative Care, the Federation of Surgical Specialty Associations, the Royal College of Anaesthetists and the Royal College of Surgeons of England

K. El-Boghdadly,[1,2] **T. M. Cook,**[3,4] **T. Goodacre,**[5] **J. Kua,**[6] **L. Blake,**[7] **S. Denmark,**[8] **S. McNally,**[9] **N. Mercer,**[10] **S. R. Moonesinghe**[11] and **D. J. Summerton**[12,13]

1 Consultant, Department of Anaesthesia and Peri-operative Medicine, Guy's and St Thomas' NHS Foundation Trust, London, UK
2 Honorary Senior Lecturer, King's College London, London, UK
3 Consultant, Department of Anaesthesia and Intensive Care Medicine, Royal United Hospitals Bath NHS Foundation Trust, Bath, UK
4 Honorary Professor, University of Bristol, Bristol, UK
5 Consultant, Department of Plastic and Reconstructive Surgery, Manor Hospital, Oxford, UK
6 Fellow, Health Services Research Centre, London, UK
7 Clinical Services Co-ordinator, University of Arkansas for Medical Sciences Library, Little Rock, AR, USA
8 Chair, Patient Lay Group, Royal College of Surgeons of England, London, UK
9 Consultant, Department of Orthopaedic Surgery, Eastbourne Hospital, Eastbourne, UK
10 Consultant, Cleft Unit of the South West of England, Bristol Dental School, Bristol, UK
11 Professor and Head of Centre for Peri-operative Medicine, University College London, London, UK
12 Consultant, Department of Urology, Leicester General Hospital, Leicester, UK
13 Honorary Professor, University of Leicester, Leicester, UK

Summary

The scale of the COVID-19 pandemic means that a significant number of patients who have previously been infected with SARS-CoV-2 will require surgery. Given the potential for multisystem involvement, timing of surgery needs to be carefully considered to plan for safe surgery. This consensus statement uses evidence from a systematic review and expert opinion to highlight key principles in the timing of surgery. Shared decision-making regarding timing of surgery after SARS-CoV-2 infection must account for severity of the initial infection; ongoing symptoms of COVID-19; comorbid and functional status; clinical priority and risk of disease progression; and complexity of surgery. For the protection of staff, other patients and the public, planned surgery should not be considered during the period that a patient may be infectious. Precautions should be undertaken to prevent pre- and peri-operative infection, especially in higher risk patients. Elective surgery should not be scheduled within 7 weeks of a diagnosis of SARS-CoV-2 infection unless the risks of deferring surgery outweigh the risk of postoperative morbidity or mortality associated with COVID-19. SARS-CoV-2 causes either transient or asymptomatic disease for most patients, who require no additional precautions beyond a 7-week delay, but those who have persistent symptoms or have been hospitalised require special attention. Patients with persistent symptoms of COVID-19 are at increased risk of postoperative morbidity and mortality even after 7 weeks. The time before surgery should be used for functional assessment, prehabilitation and multidisciplinary optimisation. Vaccination several weeks before surgery will reduce risk to patients and might lessen the risk of nosocomial SARS-CoV-2 infection of other patients and staff. National vaccine committees should consider whether such

patients can be prioritised for vaccination. As further data emerge, these recommendations may need to be revised, but the principles presented should be considered to ensure safety of patients, the public and staff.

Correspondence to: K. El-Boghdadly
Email: elboghdadly@gmail.com
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Twitter: @elboghdadly; @doctimcook; @scarlettmcnally; @NigelMercer; @rmoonesinghe

Recommendations

1 Shared decision-making regarding timing of surgery after SARS-CoV-2 infection between patient and multidisciplinary clinical teams must consider: severity of the initial infection; ongoing symptoms of COVID-19; comorbid and functional status, both before and after SARS-CoV-2 infection; clinical priority and risk of disease progression; and complexity of surgery.

2 Planned surgery should not be considered during the period that a patient may be infectious: 10 days after mild/moderate disease and 15–20 days after severe disease. For patients who are severely immunosuppressed (online Supporting Information Appendix S1), which may include patients treated with dexamethasone or monoclonal antibodies for severe COVID-19, specialist advice should be sought. If emergency surgery is required during this period, full transmission-based precautions should be undertaken for the protection of staff.

3 Surgery within 7 weeks of SARS-CoV-2 infection is associated with increased morbidity and mortality. Elective surgery should not be scheduled within 7 weeks of a diagnosis of SARS-CoV-2 infection, unless outweighed by the risk of deferring surgery such as disease progression or clinical priority.

4 Most patients infected with SARS-CoV-2 have either transient or asymptomatic disease and require no additional precautions beyond a 7-week delay, but those who have persistent symptoms or have been hospitalised require special attention.

5 Patients with persistent symptoms of COVID-19 are at increased risk of postoperative morbidity and mortality even after 7 weeks. Therefore, delaying surgery beyond this point should be considered, balancing this risk against their risk of disease progression and clinical priority. Specialist assessment and personalised, multidisciplinary peri-operative management is required.

6 The time before surgery should be used for functional assessment, rehabilitation from severe illness, prehabilitation and multidisciplinary optimisation.

7 Vaccination several weeks before surgery will reduce risk to patients and might lessen the risk of nosocomial SARS-CoV-2 infection of other patients and staff. National vaccine committees should consider whether such patients can be prioritised for vaccination.

8 As a result of the increased risk of morbidity and mortality of peri-operative COVID-19, precautions to prevent admission of patients who are incubating SARS-CoV-2 and infection within the hospital should continue.

These recommendations are based on evidence available at the time of writing and may be subject to future review.

Introduction

SARS-CoV-2 infection has contributed to more than 118 million infections globally and more than 2.6 million deaths from COVID-19 [1]. The impact of COVID-19 has been particularly significant in the UK, with more than 4.2 million cases and 125,000 people dying within 28 days of a positive SARS-CoV-2 test [2]. The scale of the pandemic has created substantial pressures on healthcare systems globally, leading to sustained reductions in surgical activity. An estimated 28 million operations were cancelled in 12 weeks of the first pandemic surge [3], with millions of patients still waiting for surgery [4, 5]. To support delivery of surgical services throughout the pandemic, prioritisation of different procedures has been undertaken [6].

One of the challenges of surgery during the COVID-19 pandemic is the peri-operative risk of morbidity and mortality to patients with active SARS-CoV-2 infection. Evidence suggests a 19.1% 30-day mortality in elective (planned) and 26.0% 30-day mortality in emergency surgical patients, with around half of patients having surgery when infected with SARS-CoV-2 experiencing

postoperative pulmonary complications [7]. In addition, given the scale of the pandemic, peri-operative outcomes after a previous SARS-CoV-2 infection are an important concern, as a significant number of patients who have previously been infected (estimated at 15–20% of the UK population [8]) will require surgery.

Surgery after a previous SARS-CoV-2 infection should be timed to ensure the safest delivery of peri-operative care. SARS-CoV-2 infection may cause multisystem disease with both short and long-term sequelae, including chronic pulmonary dysfunction, myocardial inflammatory states, renal impairment, psychological distress, chronic fatigue and musculoskeletal deconditioning [9–12]. These short and long-term complications of SARS-CoV-2 infection could have an impact on postoperative recovery, and therefore must be considered in order to plan safe surgery.

This consensus statement aims to use evidence and expert opinion to highlight key principles in the timing of surgery for the growing number of patients who have had a SARS-CoV-2 infection to support safe surgery in those requiring it. The document refers in parts specifically to UK practice, but the underlying principles are likely to be relevant internationally.

Prevention of peri-operative SARS-CoV-2 infection

Peri-operative SARS-CoV-2 infection (de novo or re-infection [Hall et al., pre-print, https://doi.org/10.1101/2021.01.13.21249642]) is associated with a more than 10-fold increase in short-term mortality [7, Abbot et al., pre-print, https://doi.org/10.1101/2021.02.17.21251928]. Therefore, it is essential to minimise the risk of patients either arriving in hospital whilst incubating SARS-CoV-2 or acquiring it in hospital. This is particularly important in patients who are at high risk of severe disease and mortality from COVID-19, such as older people, men, Black, Asian and minority ethnic groups and comorbid patients. The principal actions to achieve this for all patients are:

1. SARS-CoV-2 vaccination of patients several weeks before hospital admission, where appropriate and as prioritised by national vaccination strategies;
2. Self-isolation for a period that exceeds the incubation period of SARS-CoV-2 illness [13] combined with polymerase chain reaction (PCR) testing before admission;
3. Adherence to practices that reduce the risk of community-acquired SARS-CoV-2 infection, such as hand hygiene, wearing masks and social distancing, as well as shielding advice where indicated;
4. Screening of hospital staff to prevent contact with infectious staff [14];
5. Maintaining dedicated pathways that separate screened and PCR-negative patients from contact with patients with suspected or confirmed SARS-CoV-2 infection and the staff and locations involved in their treatment [15];
6. Minimising time spent within healthcare environments.

Protection of others

Elective surgery after SARS-CoV-2 infection must be safe for staff, other patients and the public [16–19]. Therefore, adherence to self-isolation guidelines is imperative. Symptoms of COVID-19 present 4–5 days following infection with SARS-CoV-2, and it is most contagious in the 2 days before and the 5 days after the onset of symptoms [20]. In asymptomatic and mild to moderately symptomatic patients, it is rare for the virus to be cultured beyond 10 days after symptom onset, which underlies both UK and World Health Organization recommendations for self-isolation of 10 days following a positive SARS-CoV-2 PCR test [13,21–23]. In the severely ill or severely immunocompromised patients, infectivity may continue for longer [20,24]. In the severely ill, the risk of replication-competent virus is approximately 5% at 15 days after symptom onset and extremely rare at 20 days [25,26]. Therefore, to protect staff, other patients and members of the public, patients should self-isolate for 10 days with mild to moderate disease, or 15–20 days with severe illness. This applies to any attendance for hospital services. Those who are severely immunocompromised (online Supporting Information Appendix S1) may need specialist advice on duration of self-isolation. Of note, PCR positivity does not correlate with secretion of live virus, so is of little or no value in assessing the risk of infectivity in the 3 months after confirmed SARS-CoV-2 infection.

Planned surgery should not be considered during the period that a patient may be infectious, and when emergency surgery is required during this period, full transmission-based precautions should be undertaken [27,28].

Timing of elective surgery after SARS-CoV-2 infection

Following infection with SARS-CoV-2, timing of surgery must account for severity and ongoing symptoms of COVID-19, the patient's comorbid status and the priority and complexity of surgery. Detailed methodology and results of the systematic review are reported in online Supporting Information Appendix S2.

Table 1 Phases of COVID-19 [29].

Phase	Definition
Acute COVID-19	Symptoms and signs of COVID-19 for up to 4 weeks after infection
Ongoing symptomatic COVID-19	Symptoms and signs of COVID-19 from 4 weeks up to 12 weeks after infection
Post-COVID-19 syndrome	Symptoms and signs that develop during or after an infection consistent with COVID-19, continue for more than 12 weeks and are not explained by an alternative diagnosis. It usually presents with clusters of symptoms, often overlapping, which can fluctuate and change over time and can affect any system in the body. Post-COVID-19 syndrome may be considered before 12 weeks while the possibility of an alternative underlying disease is also being assessed.
Long COVID	Symptoms and signs that continue or develop after acute COVID-19, which includes both ongoing symptomatic COVID-19 (from 4 to 12 weeks) and post-COVID-19 syndrome (≥12 weeks)
Resolved COVID-19	Previous symptoms and signs of acute COVID-19 that have completely resolved.

Table 2 Clinical progression scale of severity of COVID-19, adapted from [30].

Patient state	Descriptor
Ambulatory mild disease	Asymptomatic; viral RNA detected
	Symptomatic; independent
	Symptomatic; assistance needed
Hospitalised: moderate disease	Hospitalised; no oxygen therapy
	Hospitalised; oxygen by mask or nasal prongs
Hospitalised: severe disease	Hospitalised; oxygen by NIV or high flow
	Intubation and mechanical ventilation, $pO_2.F_IO_2^{-1} \geq 150$ or $S_pO_2.F_IO_2^{-1}$ 200
	Mechanical ventilation $pO_2.F_IO_2^{-1} < 150$ ($S_pO_2.F_IO_2^{-1} < 200$) or vasopressors
	Mechanical ventilation $pO_2.F_IO_2^{-1} < 150$ and vasopressors, dialysis or ECMO

RNA, ribonucleic acid; NIV, non-invasive ventilation; pO_2, partial pressure of oxygen; F_IO_2, fraction of inspired oxygen; SpO_2, arterial oxygen saturation; ECMO, extracorporeal membrane oxygenation.

Symptoms and severity of disease

The phases of COVID-19 [29] and the scale of clinical severity [30] are both important factors in planning surgery and are summarised in Tables 1 and 2.

It is important to note that for the majority of patients infected with SARS-CoV-2, it is either a transient or asymptomatic disease followed by full recovery (Fig. 1). Approximately 15% of infected patients are hospitalised, 5% require advanced oxygen therapies and around 1% of all cases require critical care admission (Fig. 1). Following SARS-CoV-2 infection, nearly 5% of all patients still have residual symptoms at 8 weeks [Sudre et al., pre-print, https://doi.org/10.1101/2020.10.19.20214494]. This rate is higher in patients who have been hospitalised with COVID-19. In a cohort study of 1655 hospitalised patients in China followed up at 6 months [10] and another of 143 patients in Italy followed up at 9 weeks [11], 76% and 87% of patients reported at least one persisting symptom, respectively. In the former study, more severe COVID-19 was associated with progression to post-COVID-19 syndromes including functional and physiological restrictions, [10] but in the latter study persisting symptoms correlated poorly with the severity of acute symptoms [11].

Peri-operative risks are increased in patients with persistent symptoms of COVID-19 compared with those who have been asymptomatic or those in whom symptoms have fully resolved at the time of surgery [31]. Pulmonary function may remain disturbed for several months after moderate or severe COVID-19, affecting up to a quarter of patients at 3 months [12], resembling long-term respiratory sequelae following SARS-CoV-1 infection [32–34]. Recent evidence suggests that risks associated with operating on patients who still have symptoms following SARS-CoV-2 infection decrease in a time-dependent manner [35]. Compared with patients who did not have previous SARS-CoV-2 infection, the odds ratio (95%CI) of 30-day mortality when operating at 0–2 weeks, 3–4 weeks, 5–6 weeks were 3.22 (2.55–4.07), 3.03 (2.03-4.52) and 2.78 (1.64–4.71), respectively. However, at ≥ 7 weeks after a SARS-CoV-2 infection diagnosis, the risk of mortality was similar to those who had never had SARS-CoV-2 infection (1.02 (0.66–1.56)). The timings of these mortality risks are also consistent in elective surgery, and when stratified by patient demographics, complexity of surgery and urgency of surgery. A similar trajectory is also seen in postoperative pulmonary complications, with risks being greater for the first 6 weeks after SARS-CoV-2 infection when compared with no infection, but returning to comparable rates beyond 7 weeks. Similar time-dependent findings have also been reported in smaller patient cohorts [36].

Notably, symptomatic patients are at greater risk of 30-day mortality than patients whose symptoms have resolved or those who have asymptomatic infection, even beyond a

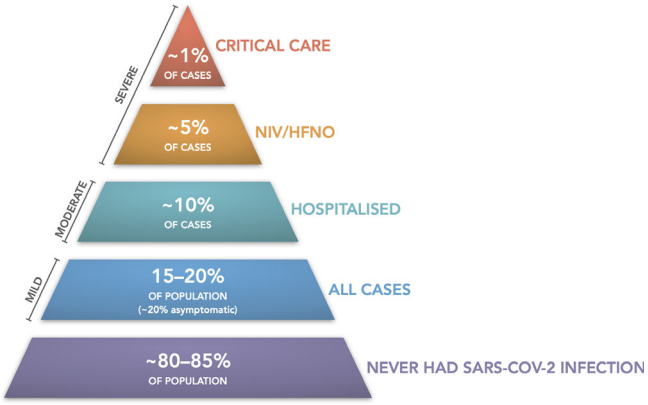

Figure 1 Estimated population distribution of SARS-CoV-2 presentation. NIV, non-invasive ventilation; HFNO, high-flow nasal oxygen.

7-week delay. Moreover, patients with resolved symptoms are also at greater risk of 30-day mortality than those who had asymptomatic infection [36,37]. Thus, both the previous and current clinical condition of patients appear to influence postoperative outcomes.

Timing of surgery in patients who have been in critical care requires special consideration. In addition to residual pathophysiological sequelae, many will be deconditioned and require physical rehabilitation. Many will also have had dexamethasone 6 mg (equivalent to 40 mg prednisolone) for 10 days and/or anti-inflammatory monoclonal antibodies (e.g. tocilizumab or sarilumab) as part of their COVID-19 treatment. These patients are on the cusp of meeting the definition of severe immunosuppression, and in the absence of explicit national guidance warrant discussion with specialists, including immunologists, within the multidisciplinary team before planning surgery.

Some data suggest that peri-operative outcomes of children with SARS-CoV-2 infection are favourable compared with adults [38], but there remains a dearth of evidence regarding timing of surgery after infection in this group. Detailed consideration of timing of surgery in children is outside the scope of this document.

Comorbid and functional status

The patient's comorbid and functional status, both before SARS-CoV-2 infection and after it, should be considered in planning, in the same manner as for any interventional procedure. Comorbidity may influence the timing of surgery if deferring the procedure may provide an opportunity for improvement or resolution of post-COVID-19 pathophysiology; the additional time can be used for prehabilitation, particularly when there has been deconditioning, or for rehabilitation of patients recovering from a critical care admission. Further discussion of functional assessment and prehabilitation is beyond the remit of this document.

Priority and complexity of surgery

To support the organisation and delivery of surgical services during the COVID-19 pandemic, prioritisation of surgical urgency for patients based on clinical conditions has been implemented [6]. This process categorises surgical procedures into priority groups based on immediate and longer-term risks to patient health and well-being, including the risks of pain, adverse sequelae and disease progression, and a 'recovery prioritisation matrix' enables prioritisation of cases within each group [39]. This prioritisation is under constant review and subject to change; the most recent version is presented in Box 1.

Box 1

Prioritisation of urgency of surgical procedures [6]. Categories P5 (patient wishes to postpone surgery due to COVID-19 concerns) and P6 (patient wishes to postpone surgery due to non-COVID-19 concerns) were added in October 2020 as part of the national validation of waiting lists [40].

Priority 1a: Emergency procedures to be performed in < 24 h.

Priority 1b: Procedures to be performed in < 72 h

Priority 2: Procedures to be performed in < 1 month

Priority 3: Procedures to be performed in < 3 months

Priority 4: Procedures to be performed in > 3 months

The complexity and the nature of surgery is a further consideration, as more complex surgery is consistently associated with increased postoperative morbidity and mortality, including in patients with COVID-19 [7]. Validated risk prediction tools account for complexity and urgency of surgery, and can be used to aid decision-making regarding timing of surgery after SARS-CoV-2 infection [41].

Anaesthetic technique

There is currently no strong evidence that anaesthetic technique is associated with an alteration in postoperative outcome in patients who have had peri-operative SARS-CoV-2 infection [7]. In patients with persistent respiratory pathophysiological changes after severe COVID-19, the benefits of avoiding general anaesthesia are likely to be the same as in other respiratory disease. The use of local or regional anaesthetic techniques may have outcome and resource-utilisation benefits, but this is not specific to patients with previous or current SARS-CoV-2 infection.

Discussion

As the population of patients requiring surgery following SARS-CoV-2 infection grows, so will the need to ensure safe peri-operative care for this cohort. The same general principles of safe and effective peri-operative care as for patients with no history of SARS-CoV-2 infection apply. However, timing of surgery must also be sensitive to the impact of SARS-CoV-2 on both patients and others. In particular, the variable presentation and disease course of SARS-CoV-2 infection means that personalised assessments are required, and rigid timelines unsuitable. This is often complex, and must account for the multifactorial implications of patient, surgery and SARS-CoV-2 status. Current data suggest that after SARS-CoV-2 infection, the majority of patients who have had no symptoms or whose symptoms have resolved should have surgery scheduled at least 7 weeks after diagnosis, unless clinical urgency and risk of disease progression outweigh the risks of delayed procedures. For patients with persisting symptoms or who have more severe COVID-19, waiting beyond 7 weeks may be beneficial and personalised multidisciplinary peri-operative care plans are recommended. Peri-operative SARS-CoV-2 infection is associated with significantly increased morbidity and mortality. Current measures to prevent peri-operative SARS-CoV-2 infection, before and during admission and after discharge, need to continue while this remains a significant risk. As further data emerge, these recommendations may need to be revised.

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References

1. World Health Organization. WHO Coronavirus Disease (COVID-19) Dashboard. 2021. https://covid19.who.int (accessed 14/03/2021).
2. UK Government. Coronavirus (COVID-19) in the UK. 2021. https://coronavirus.data.gov.uk/#category=nations&map=case (accessed 14/03/2021).
3. Nepogodiev D, Omar OM, Glasbey JC, et al. Elective surgery cancellations due to the COVID-19 pandemic: global predictive modelling to inform surgical recovery plans. *British Journal of Surgery* 2020; **107**: 1440–9.
4. Lancet Rheumatology. Too long to wait: the impact of COVID-19 on elective surgery. *Lancet Rheumatology* 2021; **3**: e83.
5. Harwich E, Fetzer M, Rees S, Batchelor G, Connolly J, Starovoitova M. *What's next for the NHS? Building the resilience of the health and care system*. London: Reform, 2021.
6. Federation of Surgical Specialty Associations. Clinical guide to surgical prioritisation during the coronavirus pandemic. 2020. https://fssa.org.uk/_userfiles/pages/files/covid19/prioritisation_master_240720.pdf (accessed 03/03/2021).
7. COVIDSurg Collaborative. Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infection: an international cohort study. *Lancet* 2020; **396**: 27–38.
8. Office for National Statistics. Coronavirus (COVID-19) roundup. 2021. https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/articles/coronaviruscovid19roundup/2020-03-26 (accessed 18/02/2021).
9. Rivett L, Sridhar S, Sparkes D, et al. Screening of healthcare workers for SARS-CoV-2 highlights the role of asymptomatic carriage in COVID-19 transmission. *ELife* 2020; **9**: e58728.
10. Huang C, Huang L, Wang Y, et al. 6-month consequences of COVID-19 in patients discharged from hospital: a cohort study. *Lancet* 2021; **397**: 220–32.
11. Carfì A, Bernabei R, Landi F; Gemelli Against COVID-19 Post-Acute Care Study Group. Persistent symptoms in patients after acute COVID-19. *Journal of the American Medical Association* 2020; **324**: 603–5.
12. Zhao Y-M, Shang Y-M, Song W-B, et al. Follow-up study of the pulmonary function and related physiological characteristics of COVID-19 survivors three months after recovery. *EClinicalMedicine* 2020; **25**: 100463.
13. Cevik M, Tate M, Lloyd O, Maraolo AE, Schafers J, Ho A. SARS-CoV-2, SARS-CoV, and MERS-CoV viral load dynamics, duration of viral shedding, and infectiousness: a systematic review and meta-analysis. *Lancet Microbe* 2021; **2**: e13–e22.
14. Black JRM, Bailey C, Przewrocka J, Dijkstra KK, Swanton C. COVID-19: the case for health-care worker screening to prevent hospital transmission. *Lancet* 2020; **395**: 1418–20.
15. Glasbey JC, Nepogodiev D, Simoes JFF, et al. Elective cancer surgery in COVID-19–free surgical pathways during the SARS-CoV-2 pandemic: an international, multicenter, comparative cohort study. *Journal of Clinical Oncology* 2021; **39**: 66–78.
16. Kane AD, Paterson J, Pokhrel S, et al. Peri-operative COVID-19 infection in urgent elective surgery during a pandemic surge period: a retrospective observational cohort study. *Anaesthesia* 2020; **75**: 1596–604.

17. Wilson NM, Norton A, Young FP, Collins DW. Airborne transmission of severe acute respiratory syndrome coronavirus-2 to healthcare workers: a narrative review. *Anaesthesia* 2020; **75**: 1086–95.
18. Cook TM, Harrop-Griffiths W. Kicking on while it's still kicking off – getting surgery and anaesthesia restarted after COVID-19. *Anaesthesia* 2020; **75**: 1273–7.
19. El-Boghdadly K, Wong DJN, Owen R, et al. Risks to healthcare workers following tracheal intubation of patients with COVID-19: a prospective international multicentre cohort study. *Anaesthesia* 2020; **75**: 1437–47.
20. Rhee C, Kanjilal S, Baker M, Klompas M. Duration of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infectivity: When is it safe to discontinue isolation? *Clinical Infectious Diseases* 2020; **2**: 23–8.
21. World Health Organization. Clinical management of COVID-19. 2021. https://www.who.int/publications/i/item/clinical-management-of-covid-19
22. NHS England. How long to self-isolate. 2020. https://www.nhs.uk/conditions/coronavirus-covid-19/self-isolation-and-treatment/how-long-to-self-isolate (accessed 02/02/2021)
23. Singanayagam A, Patel M, Charlett A, et al. Duration of infectiousness and correlation with RT-PCR cycle threshold values in cases of COVID-19, England, January to May 2020. *Eurosurveillance* 2020; **25**: 2586–8.
24. Aydillo T, Gonzalez-Reiche AS, Aslam S, et al. Shedding of viable SARS-CoV-2 after immunosuppressive therapy for cancer. *New England Journal of Medicine* 2020; **383**: 2586–8.
25. van Kampen JJA, van de Vijver DAMC, Fraaij PLA, et al. Duration and key determinants of infectious virus shedding in hospitalized patients with coronavirus disease-2019 (COVID-19). *Nature Communications* 2021; **12**: 8–13.
26. Centers for Disease Control and Prevention. Interim guidance on duration of isolation and precautions for adults with COVID-19. 2021. https://www.cdc.gov/coronavirus/2019-ncov/hcp/duration-isolation.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fcommunity%2Fstrategy-discontinue-isolation.html (accessed 03/03/2021)
27. Public Health England. COVID-19 infection prevention and control guidance: transmission based precautions (TBPs). 2021. https://www.gov.uk/government/publications/wuhan-novel-coronavirus-infection-prevention-and-control/covid-19-infection-prevention-and-control-guidance-transmission-based-precautions-tbps (accessed 18/02/2021).
28. Cook TM. Personal protective equipment during the coronavirus disease (COVID) 2019 pandemic – a narrative review. *Anaesthesia* 2020; **75**: 920–7.
29. National Institute for Health and Care Excellence, Royal College of General Practitioners, Healthcare Improvement Scotland. COVID-19 rapid guideline: managing the long-term effects of COVID-19 (NG188). 2020. https://www.nice.org.uk/guidance/ng188. (accessed 14/03/2021).
30. Marshall JC, Murthy S, Diaz J, et al. A minimal common outcome measure set for COVID-19 clinical research. *Lancet Infectious Diseases* 2020; **20**: e192–e197.
31. COVIDSurg Collaborative, GlobalSurg Collaborative. Timing of surgery following SARS-CoV-2 infection: an international prospective cohort study. *Anaesthesia* 2021. Epub 9 March. https://doi.org/10.1111/anae.15458
32. Chan JCK. Recovery pathway of post-SARS patients. *Thorax* 2005; **60**: 361–2.
33. Hui DS, Joynt GM, Wong KT, et al. Impact of severe acute respiratory syndrome (SARS) on pulmonary function, functional capacity and quality of life in a cohort of survivors. *Thorax* 2005; **60**: 401–9.
34. Ngai JC, Ko FW, Ng SS, To KW, Tong M, Hui DS. The long-term impact of severe acute respiratory syndrome on pulmonary function, exercise capacity and health status. *Respirology* 2010; **15**: 543–50.
35. Glasbey JC, Nepogodiev D, Omar O, et al. Delaying surgery for patients with a previous SARS-CoV-2 infection. *British Journal of Surgery* 2020; **107**: e601–e602.
36. Lal BK, Prasad NK, Englum BR, et al. Periprocedural complications in patients with SARS-CoV-2 infection compared to those without infection: a nationwide propensity-matched analysis. *American Journal of Surgery* 2020. Epub 28 December. https://doi.org/10.1016/j.amjsurg.2020.12.024.
37. Baiocchi G, Aguiar S, Duprat JP, et al. Early postoperative outcomes among patients with delayed surgeries after preoperative positive test for SARS-CoV-2: a case-control study from a single institution. *Journal of Surgical Oncology* 2020; Epub 31 December. https://doi.org/10.1002/jso.26377.
38. Nepogodiev D. Favourable perioperative outcomes for children with SARS-CoV-2. *British Journal of Surgery* 2020; **107**: e644–e645.
39. Federation of Surgical Specialty Associations. Recovery prioritisation matrix. 2020. https://fssa.org.uk/_userfiles/pages/files/covid19/recovery_prioritisation_matrix_rpm_v_240820.pdf (accessed 08/02/2021).
40. NHS England. Clinical validation of surgical waiting lists: framework and support tools. 2020. https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/10/C0760-Clinical-validation-of-surgical-waiting-lists-1-2.pdf (accessed 01/02/2021).
41. Wong DJN, Harris S, Sahni A, et al. Developing and validating subjective and objective risk-assessment measures for predicting mortality after major surgery: an international prospective cohort study. *PLoS Medicine* 2020; **17**: 1–22.

Supporting Information

Additional supporting information may be found online via the journal website.

Appendix S1. Severe immunosuppression as defined by Public Health England in regard to stepdown of infection control precautions in COVID-19 patients.

Appendix S2. Methodology and results of the systematic review.

