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

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

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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 bodies 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.

Recommendations

- 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
    - Complexity of surgery
- 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 (Appendix 1), 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 protection of staff.
- 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.
- 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.
- 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.
- The time before surgery should be used for functional assessment, rehabilitation from severe illness, 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 bodies should consider whether such patients can be prioritised for vaccination.
- Because 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 114 million infections globally and more than 2.5 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 120,000 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% and 26.0% 30-day mortality in elective (planned) and emergency surgical patients, respectively, with around half of patients operated on 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 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 the older people, men, Black, Asian and minority ethnic groups and comorbid patients. The principal actions to achieve this for all patients are:

- SARS-CoV-2 vaccination of patients several weeks before hospital admission where appropriate and as prioritised by national vaccination strategies;
- 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;
- 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;
- Hospital staff screening to prevent contact with infectious staff [14];
- 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];
- Minimising time 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 (Appendix 1) 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 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 1.

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 (Figure 1). Approximately 15% of infected patients are hospitalised, 5% require advanced oxygen therapies and around 1% of

all cases require critical care admission (Figure 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 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 a 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 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 timing of surgery if deferring the procedure may provide an opportunity for improvement or resolution of post-COVID-19 pathophysiology especially if the additional time is used for prehabilitation, particularly when there has been deconditioning, or 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 wellbeing, 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, but at the time of writing is broken down into the following categories:

- **Priority 1a:** Emergency procedures to be performed in < 24 hours
- **Priority 1b:** Procedures to be performed in < 72 hours
- **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

Categories P5 (patient wishes to postpone surgery because of 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].

The complexity and the nature of the surgery is a further consideration, as more complex surgery is consistently associated with 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 patient 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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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.

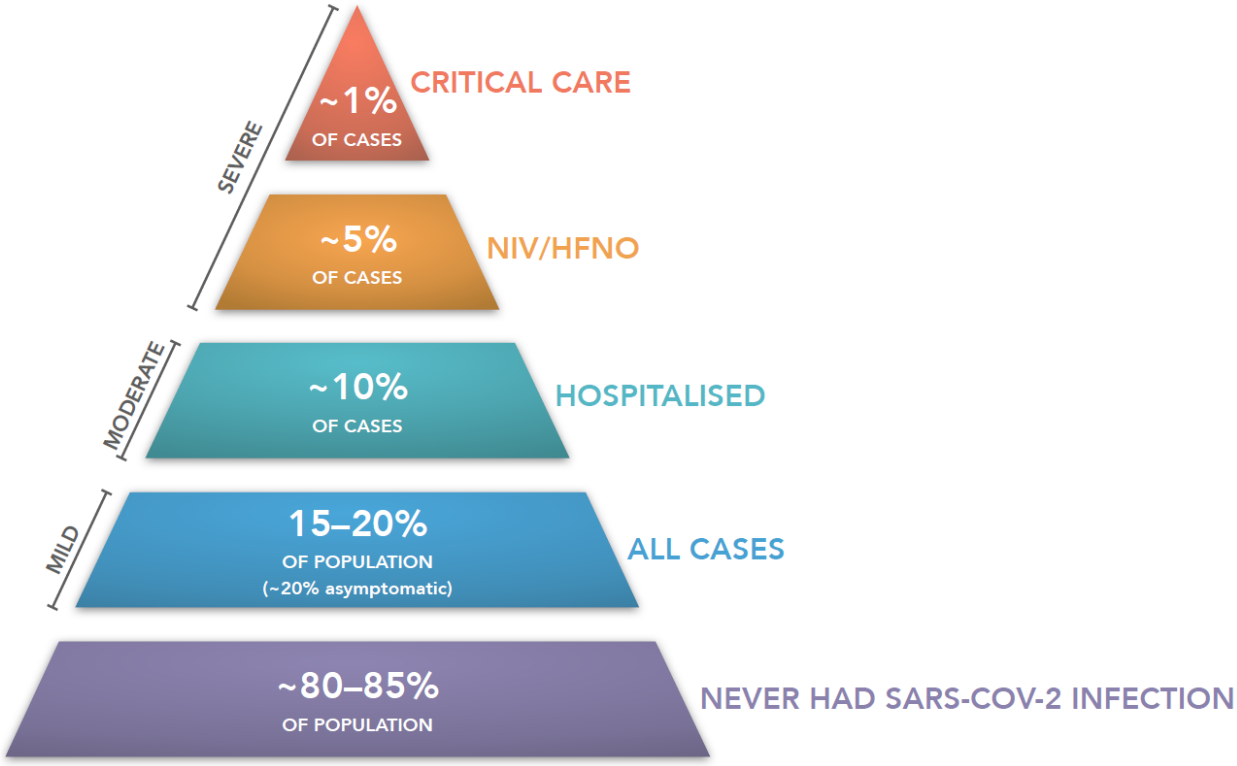
Table 2. Clinical progression scale of severity of COVID-19, adapted from [30].

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 $.FiO_2^{-1} \geq 150$ or $SpO_2.FiO_2^{-1}$ 200
	Mechanical ventilation $pO_2.FiO_2^{-1} < 150$ ($SpO_2.FiO_2^{-1}$ <200) or vasopressors
	Mechanical ventilation $pO_2.FiO_2^{-1} < 150$ and vasopressors, dialysis or ECMO

RNA, ribonucleic acid; NIV, non-invasive ventilation; pO_2, partial pressure of oxygen; FiO_2, fraction of inspired oxygen; ECMO, extracorporeal membrane oxygenation.

Figure 1. Estimated population distribution of SARS-CoV-2 presentation.

NIV, non-invasive ventilation; HFNO, high-flow nasal oxygen.



Appendix 1

Severe immunosuppression as defined by Public Health England in regard to stepdown of infection control precautions in COVID-19 patients [42].

- immunosuppression due to acute and chronic leukaemias and lymphoma (including Hodgkin's lymphoma)
- severe immunosuppression due to HIV/AIDS
- cellular immune deficiencies (such as severe combined immunodeficiency, Wiskott-Aldrich syndrome, 22q11 deficiency/DiGeorge syndrome)
- being under follow up for a chronic lymphoproliferative disorder including haematological malignancies such as indolent lymphoma, chronic lymphoid leukaemia, myeloma and other plasma cell dyscrasias
- having received an allogenic (cells from a donor) stem cell transplant in the past 24 months and only then if they are demonstrated not to have ongoing immunosuppression or graft versus host disease (GVHD)
- having received an autologous (using their own stem cells) haematopoietic stem cell transplant in the past 24 months and only then if they are in remission
- those who are receiving, or have received in the past 6 months, immunosuppressive chemotherapy or radiotherapy for malignant disease or non-malignant disorders
- those who are receiving, or have received in the past 6 months, immunosuppressive therapy for a solid organ transplant (with exceptions, depending upon the type of transplant and the immune status of the patient)
- those who are receiving or have received in the past 12 months immunosuppressive biological therapy (such as monoclonal antibodies), unless otherwise directed by a specialist
- those who are receiving or have received in the past 3 months immunosuppressive therapy including:
    - adults and children on high-dose corticosteroids (>40 mg prednisolone per day or 2 $mg.kg^{-1}.day^{-1}$ in children under 20 kg) for more than 1 week

- adults and children on lower dose corticosteroids (>20 mg prednisolone per day or 1 $mg.kg^{-1}.day^{-1}$ in children under 20 kg) for more than 14 days
- adults on non-biological oral immune modulating drugs, for example, methotrexate >25 mg per week, azathioprine >3.0 $mg.kg^{-1}.day^{-1}$ or 6-mercaptopurine >1.5 $mg.kg^{-1}.day^{-1}$
- children on high doses of non-biological oral immune modulating drugs

Online Supporting Information 1. Methodology and results of the systematic review.

Methods

A systematic review was performed by a professional medical librarian (LB) according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The following online databases were included in the search: MEDLINE through PubMed, Embase, CINAHL, Web of Science, the Cochrane Database of Systematic Reviews and the World Health Organization (WHO) Global research on COVID-19 database. Pre-print and grey literature sources included: OpenGrey, MedRxiv and BioRxiv. We used separate Medical Subject Headings (MeSH) terms or other controlled vocabulary when available, and keywords 'COVID-19', 'surgery' and 'timing' combined with relevant Boolean operators. Study designs included in the search consisted of randomised controlled trials, observational studies, reviews and case reports with more than 10 cases. Studies involving adult patients (≥18 years) undergoing a surgical procedure that reported both the timing of SARS-CoV-2 infection before surgery and peri-operative outcomes were considered for inclusion. All databases were searched from inception to 1 February 2021, with no language exclusions. We also searched the reference lists of included studies to maximise saturation of relevant studies.

Screening was performed using Rayyan QCRI software (Qatar Computer Research Institute, Qatar) and full-text articles meeting inclusion criteria were retrieved. Any disagreements on inclusion were adjudicated by KE before study inclusion.

Data were extracted in to standardised Microsoft Excel (Microsoft, Redmond, USA) spreadsheets, including study demographics; patient demographics; surgery details; and

patient outcomes. Given the expected heterogeneity in study design, conduct and outcomes, we made an a priori decision to analyse the data qualitatively. No statistical analyses were planned.

Results

We screened 3253 studies, but only three were included in our qualitative synthesis [35–37]. Full reporting of these studies is shown in the table below.

Figure 1. Flow diagram of study identification, screening, eligibility assessment and inclusion.

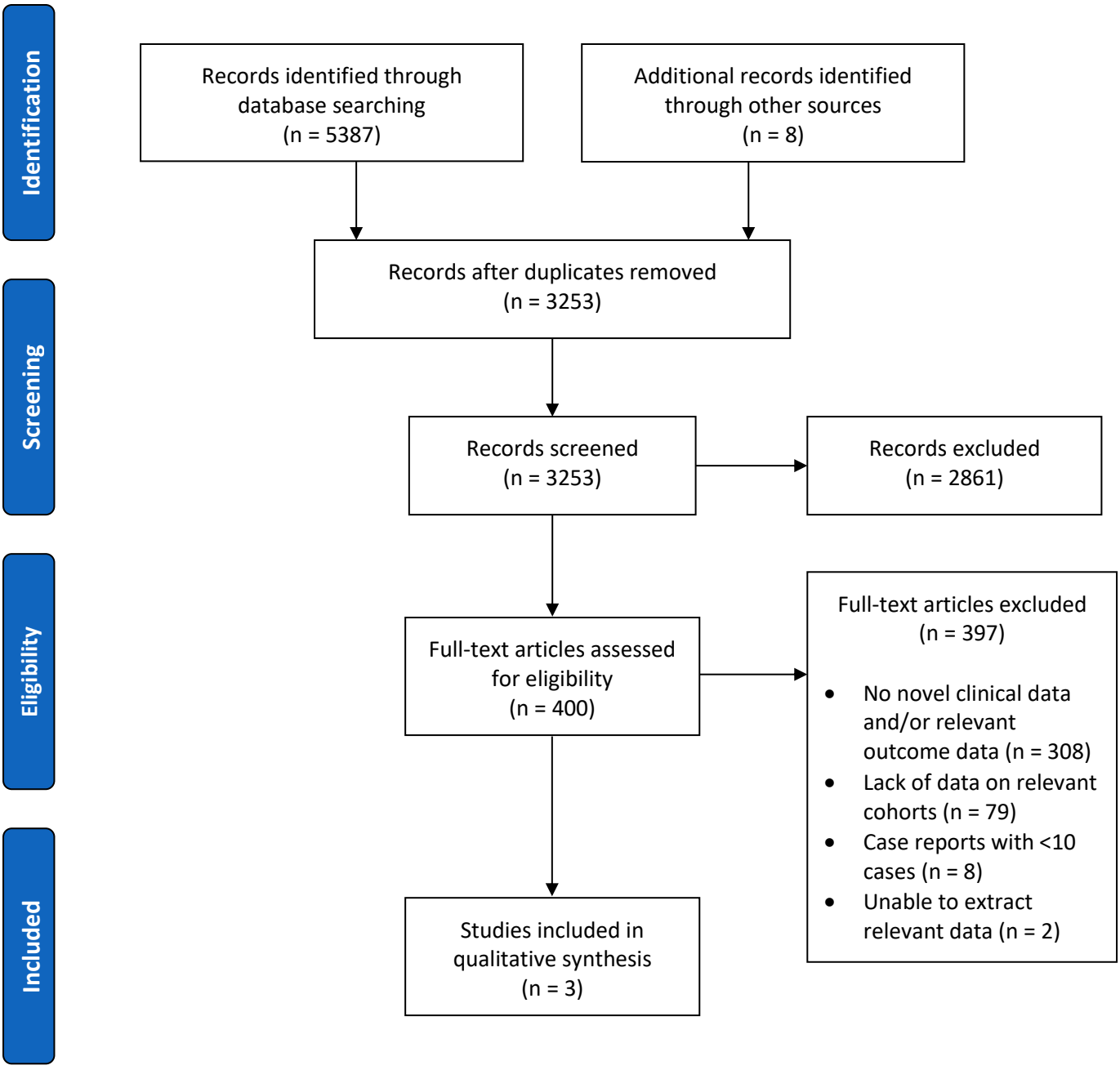


Table 1. Results of studies included in this systematic review.

Study	Number of participants	Inclusion criteria	Outcome measures	Control group	COVID-19 group	Results Relevant to Systematic Review
Baiocchi et al. (2020) [37] Case-Control (Matched cohorts 1:2) Single centre	147	All patients undergoing surgical procedures screened for SARS-CoV-2 by nasopharyngeal swab	Outcome(s): 30-days postoperative complications, Clavien-Dindo classification Grade ≥3, pulmonary complications, 30-day mortality, 45-day mortality	Patients that had surgery according to the first schedule that were SARS-CoV-2 negative (COVID-neg group, n = 98)	Patients with delayed surgery due to being SARS-CoV-2 positive (COVID-rec group, n = 49)	Median delay for COVID-rec group was 25 days (range 12 – 84) 30-days postoperative complications were 16.3% for COVID-rec vs. 14.3% COVID-neg (odds ratio (OR) 1.17; 95% Confidence Interval (95%CI) 0.45 – 3.0; p = 0.74) Clavien-Dindo Grade ≥3 complication rates were 8.2% for COVID-rec vs. 6.1% for COVID-neg (OR 1.36; 95%CI 0.36 – 5.0, p = 0.64) No pulmonary complications, SARS-CoV-2 related infection, or 30-day mortality in either group For 45-day mortality, 3 deaths recorded for COVID-rec group vs. 2 deaths in COVID-neg group
COVIDSurg Collaborative 2020 [35] Pre-planned subgroup analysis (including propensity score matching 1:4) of Prospective Observational Cohort Multicentre	122	For CovidSurg-Cancer: All adult (≥18 years old) patients planned or would have been planned for curative cancer surgery during the COVID-19 pandemic	Primary Outcome: 30-day postoperative pulmonary complications Secondary outcome(s): 30-day postoperative mortality	Propensity matched group of patients with no positive swab (n = 448)	**Group 1** - Patients who had surgery within 1 to 2 weeks from previous SARS-CoV-2 positive swab (n = 27) **Group 2** - Patients who had surgery within 2 to 4 weeks from previous SARS-CoV-2 positive swab (n = 60) **Group 3** - Patients who had surgery >4 weeks from previous SARS-CoV-2 positive swab (n = 35) Propensity matched group of patients with a previous positive swab (n = 112)	30-day postoperative pulmonary complications for Group 1 was 18.5% (6.3% – 38.1%), Group 2 was 11.7% (4.8% – 22.6%), and Group 3 was 0.0% (0.0% - 10.0%) 30-day postoperative mortality for Group 1 was 7.7% (0.9% – 25.1%), Group 2 was 3.4% (0.4% – 11.7%), and Group 3 was 0.0% (0.0% - 10.3%) In propensity score matched model, 30-day postoperative pulmonary complications for patients with previous positive swab was 10.7% vs. 3.6% for those with no infection (adjusted OR 3.84; 95%CI 1.51 – 9.74, p = 0.004)
Lal et al. 2020 [36] Prospective Observational Cohort Multicentre	53,697	All patients undergoing a surgical procedure between 1st March 2020 to August 15th 2020	Primary outcome(s): 30-day mortality, 30-day readmission, 30-day reoperation, and hospital length of stay (LOS) Secondary outcome(s): Outcomes related to pulmonary complications and outcomes related to	Overall, patients who never tested positive for SARS-CoV-2 infection (n = 51,328) Propensity matched group of patients who never tested positive for SARS-CoV-2 infection (n = 1256)	Overall, patients who tested positive for SARS-CoV-2 infection (n = 449) Propensity matched group of patients who tested positive for SARS-CoV-2 infection (n = 432) **Group 1** - Patients who had surgery ≤10 days from	Median delay for delayed group was 42 days (interquartile range 21 – 73) Compared to control, COVID-19 positive patients had longer median LOS (7 vs. 5 days, p < 0.001) and higher 30-day rates of pneumonia (20.6% vs 6.0%, p < 0.001), postoperative mechanical ventilation (7.6% vs. 4.1%, p < 0.001), and ARDS (17.1% vs. 6.8%, p < 0.001). 30-day mortality, reoperations, and readmissions were no different between control vs. COVID-19 groups. OR for 30-day postoperative pneumonia was 7.7 for Group 1 (95%CI: 4.4 – 13.3), 6.2 for Group 2 (95%CI: 3.7 – 10.1), and 2.7 for Group 3 (95%CI: 1.8 – 4.1) compared to Control group (Ref)

	inflammatory, thrombotic, and ischaemic syndromes	previous COVID-19 positive test (n = 70) **Group 2** - Patients who had surgery between 11 and 30 days from previous COVID-19 positive test (n = 96) **Group 3** - Patients who had surgery >30 days from previous COVID-19 positive test (n = 266)	OR for 30-day postoperative mechanical ventilation was 3.1 for Group 1 (95%CI: 1.3 – 6.4), 3.1 for Group 2 (95%CI: 1.5 – 5.9), and 1.3 for Group 3 (95%CI: 0.7 – 2.3) compared to Control group (Ref) OR for 30-day postoperative acute respiratory distress syndrome (ARDS) was 4.0 for Group 1 (95%CI: 2.2 – 7.2), 4.5 for Group 2 (95%CI: 2.7 – 7.5), and 2.0 for Group 3 (95%CI: 1.3 – 3.0) compared to Control group (Ref)