COVID-19 Cross-Infection Rate After Surgical Procedures: Incidence and Outcome

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Objectives/Hypothesis: Severe acute respiratory syndrome coronavirus 2 (SARSCoV-2) is transmitted by droplet as well as airborne infection. Surgical patients are vulnerable to the infection during their hospital admission. Some surgical procedures are classified as aerosol generating (AGP).

Study Design: Retrospective observational study of four specialties associates with known AGP’s during the 4 months of the first wave of UK COVID-19 epidemic to identify post-surgical cross-infection with SARSCoV-2 within 14 days of a procedure.

Methods: Retrospective observational study in a tertiary healthcare center of four specialties associates with known AGP’s during the 4 months of the first wave of UK COVID-19 epidemic to identify post-surgical cross-infection with SARSCoV-2 within 14 days of a procedure.

Results: There were 3,410 procedures reported during this period. The overall cross-infection rate from tested patients was 1.3% (4 patients), that is, 0.11% of all operations over 4 months. Ear, nose, and throat carried slightly higher rate of infection (0.4%) than gastroenterology (0.08%). The mortality rate was 0.3% (one gastroenterology patient from 304 positive cases) compared to 0% if surgery performed after recovery from SARSCoV-2 and 37.5% when surgery was conducted during the incubation period of the disease. Routine preoperative rapid screening tests and self-isolation are crucial to avoid the risk of cross-infection. Patients with underlying malignancy or receiving chemotherapy were more prone to pulmonary complications and mortality.

Conclusion: The risk of SARS-COV-2 cross-infection after surgical procedure is very low. Preoperative screening and self-isolation together with personal protective measures should be in place to minimize the cross-infection.

Key Words: SARSCoV-2, surgery, outcome, mortality.

Level of Evidence: Level 4

INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARSCoV-2) was declared as a pandemic by the World Health Organization (WHO) on 11th March 2020.1 The first confirmed COVID-19 infected patient in the United Kingdom was reported on 31st January 2020.2 The transmission was thought to be droplet infection (large than 5 μm) by coughing, sneezing, and breathing.3 Coughs and sneezes primarily produce clouds of turbulent gas which contains droplets of various sizes, and which can travel several metres.3 This understanding has led to social distancing (1–2 m) and face masking being the cornerstone of public health advice.4 Furthermore, airborne transmission can occur through small particles (less than 5 μm) which have been shown to contain the virus.4 The risk of infection, whether droplet or airborne, is higher in rooms with poor ventilation which could be a factor in hospital settings even if social distancing of more than 2 m is practiced.4 Hence, infection control measures in healthcare centers such as wearing appropriate personal protective equipment (PPE) and utilizing proper procedures for donning and doffing in aerosol generating procedures (AGP) and all hot sites are important. Standard hand hygiene measures should also be practiced in all other hospital areas to minimize the spread of the virus inside hospital premises.3,5

Numerous multicenter national and international cohort studies have showed that operating on a patient during the incubation period of SARSCoV-2 infection carries high postoperative risk of pulmonary complications (33%–51.2%) and mortality rate (23.8%–26%).2,5,6 Another concern is that cross-infection of these surgical patients can happen from asymptomatic carriers or during the incubation period of the contact. However, literature on cross-infection rate from hospital admission for any elective or emergency surgical procedures is not available. It is a routine practice in many institutes across the United Kingdom to fill a separate consent form for cross-COVID-19 infection from all surgical procedures without adequate risk assessment data. We proposed this risk assessment study to evaluate the incidence of COVID-19 cross-infection among the patients admitted under four different specialties.
MATERIALS AND METHODS

This is a retrospective observational study of COVID-19 infection between February 2020 and May 2020 at a tertiary hospital in the United Kingdom, that is, during the first wave of the infection in the United Kingdom. This center was actively involved in the management of COVID-19-infected patients (hot site activity). Patients undergoing surgery under four specialties which deal with AGP’s were included. These specialties were Ear, nose, and throat (ENT), oral and maxillofacial, respiratory medicine, and gastroenterology (involving upper and lower gastroenterology (GI) endoscopy). All hospital admissions for any procedures under general, regional, or local anesthesia under these four specialties were recorded. All patients who contracted COVID infection (tested positive) within 14 days of the procedures were identified. COVID-19 infection in these patients was confirmed using viral RNA detection on quantitative RT-PCR. Nasal and oral swabs according to the hospital protocol were taken, along with bronchoalveolar lavage in the respiratory specialty for RT-PCR evaluation. Patients who developed COVID infection 14–21 days after surgery were identified separately due to previous variability in WHO SARS-COV-2 incubation period. The exclusion criteria were any proven infection before procedure and mortality was compared with the weekly local infection rate in the community of Leicestershire during the same period after using the electronic Leicester. opendataasoft.com database. Chi-square test was used in statistical significance for the overall perioperative mortality between positive and non-positive patients.

The anonymized data were collected with no change to clinical care pathways. The study was registered as clinical audit for service improvement following local institutional review board approval.

Outcomes of 36 COVID-19 Positive Patients

With regard to these peri-operative COVID-19-infected patients, three patients (8.3%) had their test done 16, 20, and 20 days before hospital admission. This means these patients had their procedure at the end recovery period of the disease. In addition, eight patients (22.2%) were tested positive within first week of their acute hospital emergency admission. They underwent required hospital procedure during the incubation period of the infection. One patient had positive COVID test on the 54th day of her hospital admission. Moreover, 21 patients who were tested positive after 14 days of hospital episodes (3 of them were positive within 15–17 days) were also excluded based on our inclusion criteria. Three patients developed COVID infection within 14 days from their original hospital episode (8–9 days from discharge) and more importantly, two of them had a negative swab on their admission day. Thus, 4 of 3,410 patients (0.11%) and 7 of 3,410 patients (0.2%) developed COVID-19 infection within 14 days and 21 days of hospital admission. The flowchart (Fig. 1) shows the distribution of patients included in this study and exclusion groups. Among the four included patients who developed COVID-19 infection within 14 days of hospital admission, one mortality was noted. The patient underwent drainage of ascites due to underlying metastatic non-seminomatous germ cell tumor with high grade neuroendocrine malignancy. The procedure was uneventful, and the hospital stay was 8 days. Unfortunately, the patient was readmitted due to COVID pneumonia and died on the 41st post-operative day (18th day from COVID test). Table II shows the distribution of patients and their outcomes based on different specialties included in this study. Table III showed a detailed analysis of the positive patients within 14 days (white) and 14–21 days (grey highlight). Of note, one patient under gastroenterology who had COVID infection after 14–21 days from the procedure was readmitted for severe weakness and aspiration pneumonia and subsequently died. Overall, nine out of the thirty-six positive patients for SARS-CoV-2 (25%) in the perioperative period died. The median between test result to death and admission to death was 19 and 32 days, respectively.
Outcome of Control Group Who Did Not Have Positive COVID-19 Infection

There were 3,374 patients who were either not tested or had negative test after surgery. Thirty-two patients (0.94%) died in the same period after their procedures (10 had negative SARS-CoV-2 test, 22 did not have any test). The duration from their hospital episode to death was more than 14 days. The median days from admission of the procedure to mortality was 38 days. The perioperative mortality for COVID-positive patients (9 in 36) was significantly higher as compared COVID-negative patients (32 in 3,374) with a $P$-value of <.05 (<.00001) using Chi-square test.

| TABLE II. Comparison Between 4 Specialties Included AGP Procedures for Risk of Cross Infection and Mortality Outcome. |
|---------------------------------------------------------------|
| Total Op | Total Op | Total Op | Total Op | Total Op | Total Op |
| ENT | Max fax | Resp | Gastro | Colon | Total |
| Total Op | 446 | 143 | 79 | 2,554 | 188 | 3,410 |
| Sample test (+, −ve) | 51 | 8 | 33 | 199 | 13 | 304 |
| COVID ≤14 d | 2 (3.9%) | 0 | 0 | 2 (1%) | 0 | 4 (1.3%) |
| % of total op | 0.4% | 0% | 0% | 0.08% | 0% | 0.11% |
| COVID >14–20 d | 0 | 0 | 0 | 1 | 2 | 3 |
| Mortality | 0 | 0 | 0 | 1 | 1 | 2 |

ENT = ear, nose, and throat.
Outcomes Based on Incubation Period of COVID-19 Infection

Three of 8 patients (37.5%) who underwent surgery during their incubation period (average 3.5 days) died (average 34 days from test to mortality). There was no mortality when the procedure was carried out after the recovery period from SARC-CoV2 infection (IQR [interquartile range] = 20–16, least was 16 days).

The graph in Figure 2 shows the relationship between weekly infected patients in the region (plotted in Tens) and their mortality rate. This has been compared to the number of weekly recorded procedures in the healthcare center. The second week of April had the lowest number of weekly procedures and the highest number of positive patients after the procedure. As expected, there was a peak of infectivity and mortality in the community during that week.

The correlation between the number of comorbidities at the time of the procedure and the outcome is shown in Figure 3. The survival outcome was the same irrespective of increase in the number of underlying morbidities for infected patients in the perioperative period. The overall reported comorbidities in infected patients noted in descending order were chronic cardiac condition, chronic lung disease, ongoing malignancy, and diabetes. Among the patients who died, around half of them had a diagnosis of cancer (4 out 9, 44.4%).

DISCUSSION

Interventional procedures have been hampered significantly due to the COVID-19 pandemic. The reasons for this include altered theatre environments, increased changeover times between cases, evolving PPE requirements, and communication difficulties while wearing PPE in the theatre. In addition to these factors, there has been a concern of cross-infection among the admitted patients for elective surgery in the hospital. Also, the risk of mortality and morbidity following surgery in such uncertain times is a matter of debate. Nearly 10 million people in the United Kingdom are now waiting for surgical procedures, up from 4 million before the pandemic was declared. There is no literature available on cross-infection of COVID-19 infection among the admitted patients in the hospital. Hence, we performed this study to evaluate the incidence, especially with AGP’s.

The incubation period of SARS-COV-2 is on average 5–6 days but can be longer than 14 days according to WHO and meta-analyses consisting of eight shortlisted studies with 1,208 patients. The mean and the median of the incubation period were 5.8 and 5.1 days, respectively. The 97.5 percentile can reach 17 days. Hence, if a patient develops COVID-19 infection after 14 days from hospital discharge, it is less likely to be from the hospital episode. One patient in the study who was admitted before the epidemic with prolonged hospital stay became positive during their admission although they were not in any hot zones of the hospital suggesting the possibility of cross-infection. A similar measure of the cross-infection rate (3%) is observed in the collaborative multicenter study.

It is noted in this study that incubation period post-surgery is shortened in infected individuals (2–5 days) as compared to the proposed WHO incubation period (8 days). The study performed in Wuhan showed a similar result of shortened incubation period after surgery (3.5 days instead of 8 days). As the surgery and prolonged mechanical ventilation is associated with surge in the pro-inflammatory cytokine and immunosuppressive responses, surgical patients are more vulnerable to SARS-CoV-2 in the hospital. This might shorten the incubation period of the disease as well.

There has been an ongoing debate on classifying various procedures based on the risk of transmission of the virus and labelling them AGP. This is important especially with the scarcity of the available PPE. Systematic review on the percentage of agreement among the contributing consensus documents defined 3 levels, that is, strong aero-sol generating (such as bronchoscopy and cardio-pulmonary resuscitation [CPR]), possible AGP (as non-invasive

| Case 1 | Case 2 | Case 3 | Case 4 | Case 5 | Case 6 | Case 7 |
|--------|--------|--------|--------|--------|--------|--------|
| Age    | 77     | 70     | 69     | 53     | 88     | 66     | 76     |
| Gender | F      | M      | M      | F      | M      | F      | F      |
| Ethnic | White  | White  | White  | White  | Black  | White  | White  |
| Specialty | ENT  | ENT    | Gastro | Gastro | Colon  | Colon  | Gastro |
| 1st Admit | NOE  | Epistaxis | Drain Ascites | Central Line | Colonoscopy | Colonoscopy | OGD   |
| 1st Admit | Emergency | Emergency | Electro | Inpatient | Day case | Day case | Day case |
| Days to test | 9 | 9 | 8 | 54 | 15 | 15 | 17 |
| Length 1st stay | 7 | 1 | 2 | 57 | 0 | 0 | 0 |
| Morbidity | AF, Asthma, HTN | Mechanical Heart valve, HTN, BPH | metastatic non-seminomatosus germ cell tumour | endometriosis | Stroke, Prostate Cancer, HTN, chronic familiar neutropenia | Hemicolectomy for Appendicular neoplasm | IHD, DM, COPD |
| Mortality | No | No | Yes | No | Yes | No | No |

AF = atrial fibrillation; BPH = benign prostatic hyperplasia; COPD = chronic obstructive pulmonary disease; DM = diabetes Mellitus; ENT = ear, nose, and throat; HTN = hypertension; IHD = ischemic heart disease; NOE = necrotizing otitis externa; OGD = oesophagogastroduodenoscopy.
ventilation, tracheostomy), and non-AGP (such as oral/dental, upper GI endoscopy and thoracic surgeries). However, the government has published a recognized AGP list, which was recently updated in January 2021, listing intubation, bronchoscopy, tracheostomy, upper ENT airway procedures, and upper GI endoscopy as potentially having increased risk of transmission. Procedures such as colonoscopy, oral/dental, and ophthalmology were not recognized as AGP by the New and Emerging Respiratory Viral Threat Assessment Group. They also removed chest compression for CPR from the list probably as there is no cough and active breathing from the patient. However local protocols in many healthcare centers including our hospital are in force which mandates face covering during any CPR. Therefore, we have selected patients under four specialties which we presumed undertaking potential AGP’s.

Susceptible persons in the vicinity of an infected and asymptomatic carrier can become infected through multiple routes, including inhaling close to the source, or touching and transferring particles that have landed on surfaces. The virus is mainly transported via aerosols and droplets. The hospital premises where standard treatment for the virus is carried out, could be a potential risk for cross-infection despite the appropriate personal protective equipment and adequate air ventilation. The current study showed the very low risk of cross-infection with overall risk of 0.11% (IQR 0.4%–0.08%). The risk was highest among ENT procedures (0.4%, 2 out of 446) and lowest among gastroenterology (0.08%). Meanwhile, the post-operative mortality rate was slightly higher in the gastroenterology procedures (0.05%). On the other hand, surgery during the incubation period had the highest mortality rate (37.5%). The risk dropped to baseline level if surgery was undertaken after 2 weeks of infection without pulmonary complication (0% in our study). The median time from admission to mortality for positive patients was 38 days. However, it was shortened when surgery was conducted during the incubation period as compared to the post-procedure cross-infection (35 vs. 41 days).

Before the SARS-CoV-2 epidemic, studies established the baselines rate for pulmonary complication up to 10% and mortality rate up to 3% after surgical procedures. The current study authenticates the significant mortality risk in the perioperative COVID positive compared to non-positive patients.

Early data from China showed that older patients and those with comorbidities, particularly hypertension and diabetes, were most vulnerable to COVID-19. The Wuhan study recognized that risk factors of complex operations, hypertension, cardiovascular, and malignancy were associated with higher mortality rate of 20.5%. Another multicenter national study in the United Kingdom from 208 centers during first wave of epidemic showed a mortality rate of 26%. The high-risk factors identified were increasing age, male gender, chronic cardiac disease, non-asthmatic chronic pulmonary disease, chronic kidney disease, liver disease, and obesity. This study has shown that 44.4% (4 of 9) patients who had underlying malignancy or receiving chemotherapy are
more prone to pulmonary complications and mortality if they contract COVID infection in the perioperative period. The number of survivors versus mortality did not change irrespective of the increase in the co-morbidities.

An international observational cohort study in 26 countries of 1,137 patients who had primary head and neck (H&N) cancer surgery with curative intent showed 1.2% overall mortality within 30 days, 3% risk of SARS-CoV-2 infection, 33% developed severe pulmonary complications of which 10% died. About 78% of the hospitals where primary H&N surgeries took place were classified as hot sites for SARS-CoV-2 management. The authors concluded that H&N surgery was predominately safe even in complex prolonged procedures, however, postoperative pulmonary complications would significantly impact the outcome.6

After the first pandemic wave, routine preoperative rapid tests screening for SARS-CoV-2 became available with low false positive rates.6 It is now necessary for a patient to be isolated for a certain period (such as the WHO recommended 14-days quarantine period and or tested before elective surgery).9 However, preventing hospital-acquired cross-infection remains a challenge.6 In the line with Government advice, visiting is restricted in our center. All exceptional visitors should wear face mask and follow on-site safety guidance on hand washing and social distance. Any symptomatic visitor is instructed to stay home. Temperature and check list questions were in force while checking in outpatient appointment. Rapid lateral flow test was offered to all staff twice weekly at home before going to workplace.

This study offers a new risk assessment evaluation of COVID infection after surgical hospital episodes for different specialties. This tool is very important when COVID consent is completed before any operation. It could lower the anxiety of patients by providing evidence-based SARS-CoV-2 risk on any offered procedure. This could minimize unplanned cancellation before scheduled procedures with better utilization of the limited theatre resources during the epidemic.

The limitation in the study relates to results from a single center. The surgical services were widely affected in terms of the number and level of surgery during this period. Hence, a multicenter study might provide a more accurate statistical representation. There may be a debate on the source of the infection for the positive cases within 14 days from hospital episodes, including considering if it was related to hospital admission or from the community. It is important to recall that during this period, there was a national lockdown for non-essential travel. All workplaces except involving key sectors were closed, and only essential exercise and shopping activities continued. Accordingly, the result of the study assumed a true representation of the infection risk from surgical procedures. Moreover, most (3/4) of the patients were tested negative on admission. Another limitation is possibility of the false negative in tested asymptomatic infected patients.

CONCLUSION

The risk of SARS-COV-2 cross-infection after surgical procedure/hospital admission is very low in our cohort. Preoperative screening and self-isolation are recommended measures to minimize the risk of cross-infection and postoperative complication. Surgery during the incubation period of COVID-19 infection is associated with high risk of mortality and it should be postponed till the recovery of the infection.

BIBLIOGRAPHY

1. WHO Director-General’s opening remarks at the media briefing on COVID-19 - 11 March 2020. Available at: https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19—11-march-2020. Accessed March 21, 2021.

2. Docherty AB, Harrison EM, Green CA, et al. Features of 20 133 UK patients in hospital with COVID-19 using the ISARIC WHO clinical characterisation protocol: prospective observational cohort study. BMJ 2020;369:m1985.

3. Jackson T, Deibert D, Wyatt G, et al. Classification of aerosol-generating procedures: a rapid systematic review. BMJ Open Respir Res 2020;7:e000730. https://doi.org/10.1136/bmjresp-2020-000730.

4. The Lancet Respiratory Medicine. COVID-19 transmission-up in the air. Lancet Respir Med 2020;8:1159. https://doi.org/10.1016/S2213-2600(20)30514-2.

5. COVIDSurg Collaborative. Head and neck cancer surgery during the COVID-19 pandemic: an international, multicenter, observational cohort study. Cancer 2020;21. https://doi.org/10.1002/cncr.33320.

6. 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. https://doi.org/10.1016/S0140-6736(20)31182-X.

7. Too long to wait: the impact of COVID-19 on elective surgery. Lancet 2021;3:383. https://doi.org/10.1016/S2665-9913(21)00001-1.

8. McAloon C, Collins A, Hunt K, et al. Incubation period of COVID-19: a rapid systematic review and meta-analysis of observational research. BMJ Open 2020;10:e039652. https://doi.org/10.1136/bmjopen-2020-039652.

9. Lei S, Jiang F, Su W, et al. Clinical characteristics and outcomes of patients undergoing surgeries during the incubation period of COVID-19 infection. Rheumatol 2020;9:e039652. https://doi.org/10.1136/rheum2020-039652.

10. COVID-19 infection prevention and control guidance: aerosol generating procedures. Available at: https://www.gov.uk/government/publications/wuhan-novel-coronavirus-infection-prevention-and-control/covid-19-infection-prevention-and-control-guidance-aerosol-generating-procedures. Accessed January 21, 2021.

11. Myles PS, Maswime S. Mitigating the risks of surgery during the COVID-19 pandemic. Lancet 2020;396:2–3. https://doi.org/10.1016/S0140-6736(20)31296-3.