



## Alur Bebas COVID-19 Memberi Keamanan bagi Pasien Operasi Elektif dari Infeksi Nosokomial SARS-CoV-2

Oky Susianto<sup>1\*</sup>, Mahendratama Purnama Adhi<sup>1</sup>, Bagus Fajar Rochman<sup>1</sup>, Rapto Hardian<sup>1</sup>, Yopi Meliandi<sup>2</sup>

1. Departemen Anestesiologi dan Terapi Intensif, Fakultas Kedokteran, Universitas Lambung Mangkurat - Rumah Sakit Umum Daerah Ulin, Banjarmasin, Indonesia

1. Rumah Sakit Umum Daerah Ulin, Banjarmasin, Indonesia

\*penulis korespondensi

DOI:10.55497/majanestcricar.v40i2.248

### ABSTRAK

**Latar belakang:** Pembedahan elektif selama pandemi COVID-19 harus dilakukan untuk mencegah terjadinya akumulasi kasus bedah. Beberapa institusi menerapkan alur bebas COVID-19 untuk mengurangi risiko penularan SARS-CoV-2. Penelitian ini bertujuan untuk menilai keselamatan pasien yang menjalani pembedahan elektif dengan alur bebas COVID-19 dari risiko infeksi nosokomial SARS-CoV-2.

**Metode:** Penelitian ini merupakan studi cross-sectional, dan populasi sampel terdiri dari 572 pasien yang menjalani operasi elektif dengan alur bebas COVID-19. Seluruh sampel menjalani karantina selama dua hari di rumah sakit untuk pemeriksaan RT-PCR. Hasil pemeriksaan negatif untuk SARS-CoV-2 berlaku dalam waktu 48 jam sebelum operasi, dan pembedahan dilakukan di ruang operasi non-COVID-19. Usia, jenis kelamin, klasifikasi ASA, jenis anestesi, kriteria operasi, lama rawat inap, dan masuk ICU merupakan karakteristik dasar pasien. Luaran penelitian ini adalah infeksi SARS-CoV-2 yang didapat di rumah sakit setelah pasien menjalani pembedahan elektif berdasarkan gejala COVID-19 selama perawatan pasca-operasi hingga 14 hari setelah keluar dari rumah sakit.

**Hasil:** Data demografi sampel menunjukkan bahwa 53% pasien laki-laki (303) dan 47% perempuan (269), dengan usia rata-rata  $40,16 \pm 11,35$  tahun (12 hari-84 tahun). Berdasarkan klasifikasi ASA, sampel terdiri dari 7,7% ASA I, 78,7% ASA II, 13,4% ASA III dan 0,2% ASA 4 dengan jumlah masing-masing 44, 450, 77, dan 1 pasien. Kriteria operasi mayor/kompleks menyumbang 48% (277 kasus) dari keseluruhan operasi. Selanjutnya 27,4% pasien menjalani rawat inap pasca operasi selama 0-3 hari, 33,3% selama 4-7 hari, dan 39,3% memiliki lama rawat inap 8 hari, yaitu masing-masing 157, 190, dan 225 pasien. Tidak terdapat pasien yang mengalami gejala COVID-19 selama perawatan pasca operasi. Terdapat tiga pasien meninggal pasca operasi, namun kematian tersebut tidak terkait COVID-19. Empat belas hari setelah keluar dari rumah sakit, delapan pasien (3%) mengalami demam atau batuk namun tidak melakukan pemeriksaan RT-PCR. Kedelapan pasien ini mengalami perbaikan klinis dan pemulihan.

**Simpulan:** Penerapan alur bebas COVID-19 memberikan keamanan bagi pasien dari risiko infeksi nosokomial SARS-CoV-2.

**Kata Kunci:** Alur bebas COVID-19, COVID-19, Infeksi nosokomial COVID-19, Infeksi SARS-CoV-2 di rumah sakit, Operasi elektif



## COVID-19-Free Pathway Provides Safety for Elective Surgery Patients from Hospital-Acquired SARS-CoV-2 Infection

Okky Susianto<sup>1\*</sup>, Mahendratama Purnama Adhi<sup>1</sup>, Bagus Fajar Rochman<sup>1</sup>, Rapto Hardian<sup>1</sup>, Yopi Meliandi<sup>2</sup>

1. Department of Anesthesiology and Intensive Care, Faculty of Medicine, Lambung Mangkurat University - Ulin Hospital, Banjarmasin, Indonesia
2. Ulin Hospital, Banjarmasin, Indonesia

\*corresponding author

DOI:10.55497/majanestcricar.v40i2.248

### ABSTRACT

**Background:** Elective surgery during the COVID-19 pandemic is often carried out to prevent a backlog of surgical cases. Several institutions are also implementing a COVID-19-free surgical pathway to minimize the risk of SARS-CoV-2 transmission. Therefore, this study aims to assess the safety of patients undergoing surgery against hospital-acquired SARS-CoV-2 infections by implementing a COVID-19-free pathway.

**Methods:** This is a cross-sectional study, and the sample population consists of 572 patients who underwent elective surgery with a COVID-19-free pathway. They also underwent two days of quarantine in the hospital for RT-PCR testing. The negative test result for the SARS-coV-2 is valid within 48 hours before surgery, and all surgical procedures were performed in an operating room free from the infection. Furthermore, age, gender, ASA classification, type of anesthesia, surgery criteria, length of stay, and ICU admission were the patients' baseline characteristics. The outcome in this study was hospital-acquired SARS-CoV-2 infections after the patient underwent surgery based on COVID-19 symptoms during hospitalization and 14 days after discharge.

**Results:** The participants' demographic data showed that 55% of them were male, while 47% were females, namely 303 and 269, respectively with a mean age of 40.16 years  $\pm$  11.35 years (12 days–84 years). Based on the ASA classification, they consisted of 7.7% ASA I, 78.7% ASA II, 13.4% ASA III, and 0.2% ASA 4 with a total of 44, 450, 77, and 1 patient, respectively. The major or complex surgery accounted for 48% (227 cases) of all surgeries. Furthermore, 27.4% of the patients underwent postoperative hospitalization for 0-3 days, 33.3% for 4-7 days, and 39.3% had a length of stay  $\geq$  8 days, namely 157, 190, and 225, respectively. None of them showed postoperative COVID-19 symptoms, but three died postoperatively, and their deaths were not related to the virus. Fourteen days after discharge, eight outpatients had fever and cough. They did not perform the RT-PCR test, and accounted for 3% of the sample population. Further examination showed that they experienced clinical improvement and recovery later.

**Conclusion:** Implementing a COVID-19-free pathway provides safety for patients from hospital-acquired SARS-CoV-2 infections.

**Keywords:** COVID-19, COVID-19-free pathway, elective surgery, hospital-acquired SARS-CoV-2, nosocomial COVID-19

## INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has profoundly affected the healthcare system, including elective surgery. In its early stages, several countries fully or temporarily suspended the procedure to reduce the risk of COVID-19 transmission, as well as to use the available resources for the treatment of patients affected by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).<sup>1</sup>

The delay and termination of elective surgery created additional problems for patients and the health care system,<sup>2</sup> such as increased morbidity and worsening of cancer sufferers' quality of life.<sup>1</sup> It also caused pain, deformity, and the inability of orthopedic patients to perform daily activities.<sup>3</sup> The postponement of elective surgery has led to an accumulation of cases that have been scheduled for the procedure. A study using a Bayesian Beta regression model in 190 countries showed that its delay for 12 weeks caused an accumulation, and a long period was required to complete the backlog.<sup>1</sup> Furthermore, increasing the number of surgical procedures by 20% after the pandemic will take 45 weeks to complete the backlog.<sup>1</sup>

Elective surgery must be continued during the pandemic due to the risk of patient accumulation as well as the increased morbidity and mortality caused by delays. However, before the process is carried out, the hospital resource capacity, safety, and the risk of transmitting SARS-CoV-2 to patients and healthcare workers (HCWs) must be considered.<sup>1</sup> Several strategies can be implemented to prevent the risk of transmission and its harmful impact, such as dividing the hospital into two zones, namely COVID-19 and non-COVID-19 with their own different HCWs. Other methods include conducting preoperative RT-PCR tests, restricting visitors, maintaining physical distance, washing hands, as well as wearing masks by inpatients and workers.<sup>4-6</sup>

Ulin Hospital Banjarmasin is a third-level referral hospital that provides health services to COVID-19 patients. Prior to the pandemic in 2019, it had performed a total of 3,720 elective surgeries. In the earliest stage of the pandemic, from April to September 2020, the hospital stopped the procedure. It was then resumed for uninfected patients after the implementation

of a COVID-19-free pathway in October 2020. Therefore, this study aims to determine the effectiveness of a COVID-19-free pathway during the pandemic at Ulin Hospital Banjarmasin in minimizing hospital-acquired SARS-CoV-2 infections among elective surgery patients.

## METHODS

This is a cross-sectional study, which was carried out at Ulin Hospital Banjarmasin, and approved by the ethics committee with reference number 102/X-Reg Research/RSUDU/21. It also serves as an audit of implementing a COVID-19-free pathway for elective surgery at the facility. All patients who enrolled for procedure from October 7, 2020, to February 28, 2021, were included in this study, while others were excluded. The sample population was selected using the total sampling technique.

The baseline characteristics in this study include age, gender, surgical criteria,<sup>7</sup> American Society of Anesthesiologists (ASA) classification,<sup>8</sup> type of anesthesia, length of stay, and postoperative ICU admission. The outcome observed was hospital-acquired SARS-CoV-2 infection after the surgery based on COVID-19 symptoms, such as anosmia, fever, cough, and shortness of breath. The study facility has a policy that the RT-PCR test is only performed on symptomatic patients. All participants were contacted through a phone or WhatsApp message to determine whether they had symptoms of COVID-19. Furthermore, their compliance with health protocols after 14 days of discharge was also assessed. The data obtained were then presented in the form of a frequency table for categorical data types including gender, age, operating criteria, ASA classification, type of anesthesia, length of stay, and patient survey results after 14 days of discharge. For the numerical data type, it was presented in the form of an average.

Ulin Hospital has 635 beds of which 160 were used in the isolation wards during the pandemic. Furthermore, 40 were allocated to quarantine for elective surgery patients, while 435 were for uninfected inpatients. The hospital was divided into two separate zones, namely COVID-19 and non-COVID-19 with different HCWs as well as entry and exit routes. For the non-COVID-19 zones, all workers were on level 1 PPE standards,

while inpatients in wards and ICUs adhered to the physical distancing and hand hygiene protocols.

The hospital also implemented a COVID-19-free pathway to resume elective surgery procedures. The surgery was only carried out for urgent and essential cases in an uninfected operating theatre. Patients were educated about the different services offered compared to the pre-pandemic period as well as the risk of contracting SARS-CoV-2 during surgical procedures and hospitalization.

Furthermore, the patients were required to undergo a preoperative examination at an outpatient clinic, including screening for coronavirus symptoms, contact and travel history using a questionnaire,<sup>9</sup> chest x-ray, as well as physical and laboratory examinations. They were also given a surgery schedule when the clinical condition is optimal. Two days before the procedures, the patients underwent quarantine in the hospital unaccompanied, but one companion is allowed with limited activity for geriatric and pediatric cases. The companion must be in good health, pass the COVID-19 screening using the questionnaire, and adhere to health protocols. The patients then underwent an RT-PCR test the following day, with valid results 48 hours before the procedure. The elective surgery was carried out the next day when the test result is negative for SARS-CoV-2. Meanwhile, the schedule of others with positive results was canceled. RT-PCR test results obtained from other facilities were not accepted at the hospital.

All patients were required to undergo postoperative care in a COVID-19-free zone in the ward or ICU and they were monitored for coronavirus symptoms during hospitalization. The hospital imposed restrictions on visits and accompanying patients during this period. Both patients and their companions during hospitalization must comply with health protocols.

## RESULTS

From October 7, 2020, to February 28, 2021, there were 662 cases of scheduled elective surgery at Ulin Hospital Banjarmasin of which 90 were canceled. Furthermore, forty-one of them

had positive RT-PCR results for SARS-CoV-2, while 49 were canceled due to their clinical condition and unpreparedness of the surgeon and equipment.

A total of 572 patients underwent elective surgery consisting of 303 males and 269 females, and they accounted for 53% and 47% of the population, respectively with a mean age of 40.16 years  $\pm$  11.35 years (12 days–84 years). Based on the ASA classification, the samples consisted of 7.7% ASA I, 78.7% ASA II, 13.4% ASA III, and 0.2% ASA 4 with a total of 44, 450, 77, and 1 patient, respectively. Furthermore, 222 of them (39%) underwent minor surgery, while 73 (13%) and 277 (48%) underwent the intermediate and major/complex procedures, respectively. A total of 175 patients (27.4%) stayed at the hospitals for three days, while 190 (33.3%) and 225 (39.3%) were hospitalized for 4-7 days and  $\geq$  8 days, respectively. None of the inpatients had postoperative COVID-19 symptoms, hence, RT-PCR tests were not required during hospitalization.

Thirty-five patients (6%) required postoperative care in the ICU, while 4 (0.7%) used a ventilator comprising 2 cases of neurosurgery, 1 case of thoracic surgery, and 1 case of orthopedic surgery. Furthermore, 3 death were recorded in the ICU, namely two ASA 3 and one ASA 4 cases. The ASA 3 patients that died had postoperative craniotomy tumor removal with complications of rebleeding. Another ASA 3 patient was diagnosed with sepsis and developed septic shock after the surgery, while the ASA 4 patient had a preoperative diagnosis of thrombi embolism accompanied by acute lung injury and diabetes mellitus. The 3 death cases recorded were not related to COVID-19.

Survey through phone calls and WhatsApp messages were used to determine patient condition and compliance with health protocols after 14 days of discharge. Among 569 outpatients, 253 were successfully contacted to fill out the survey. Furthermore, 238 of them (94%) maintained health protocols during the pandemic by wearing masks, washing hands, and observing the physical distancing protocol. Two patients (0.75%) had fever, while 6 (2.25%) had cough, but did not perform the RT-PCR test. The follow-up result showed that they later

improved and recovered.

## DISCUSSION

Elective surgery during the pandemic raised concerns about the risk of nosocomial SARS-CoV-2 transmission, especially in hospitals with COVID-19 and non-COVID-19 patients, hence, new strategies are needed to minimize the risk. This study showed that implementing a COVID-19-free pathway can help to conduct elective surgery from various specializations safely.

Several studies also revealed that the use of the pathway can minimize nosocomial coronavirus infections.<sup>5,10</sup> A previous study revealed that hospitals that do not provide COVID-19 services can safely carry out various elective surgeries, even at the pandemic's peak or high SARS-CoV-2 transmission.<sup>11</sup> The use of two separate zones, each of which has special entry access and its HCWs, is required in health facilities with infected and uninfected patients.<sup>5,10</sup> A study conducted at Columbia University Irving medical center shows that the incidence of nosocomial transmission after dividing the wards was 0-2%.<sup>12</sup>

In the early stages of the pandemic, several studies showed that people infected with SARS-CoV-2 who underwent surgery experienced increased morbidity and mortality. Lei et al. reported that 34 patients who underwent the surgical procedure at Wuhan Hospital had postoperative COVID-19 pneumonia of which 15 (44%) required intensive care, while the remaining seven (20%) died.<sup>13</sup> It was suspected that they were asymptomatic before the surgery. There was no preoperative RT-PCR screening, and it was only performed after the patients showed symptoms of the virus. An international multicenter observational study by the COVIDSurg Collaborative reported a 30-day postoperative mortality rate of 23.8% among infected people.<sup>14</sup> These findings indicate that screening for COVID-19 with preoperative RT-PCR assays is indispensable. This current study confirmed 41 patients to be positive for SARS-CoV-2 using the test. However, during evaluation at the outpatient clinic, they did not show symptoms, and the chest X-ray examination showed no signs of pneumonia. The elective surgical procedures schedule of the positive cases was canceled. The COVIDSurg Collaborative

recommends delaying surgery for seven weeks in asymptomatic patients to reduce morbidity and mortality.<sup>15</sup>

Several COVID-19-free pathways use preoperative isolation for 14 days on patients scheduled for surgery to prevent the spread of SARS-CoV-2 from the community.<sup>5,11</sup> However, the pathway at the study hospital did not use this method, but patients were quarantined on admission for RT-PCR test until the day of surgery. Negative RT-PCR results were declared valid up to 48 hours before the procedure, hence, the maximum quarantine period was two days. A previous study showed that isolation for more than three days can increase the risk of postoperative pulmonary complications.<sup>16</sup> These complications were also linked to the patient's increased anxiety, decreased activity, and poor diet during this period.

One of the major concerns on elective surgery during the pandemic is the increased risk of postoperative SARS-CoV-2 exposure. Patients who undergo the procedure, especially major surgery, with ASA 3-4, and cancer are at risk of experiencing immune system disorders, which makes them vulnerable to the virus.<sup>5,10</sup> Baboudjian et al. showed that minor surgery with a COVID-19-free pathway is very safe.<sup>17</sup> The study also reported that one patient was infected with SARS-CoV-2 after a kidney transplant. A previous study involving more major and complex surgeries, which accounts for 56.8% of all surgical cases reported that among 291 inpatients who underwent the procedure, only six were infected with SARS-CoV-2 postoperatively.<sup>18</sup> This finding is consistent with the result obtained in this study, where no symptomatic patient was found among 277 who underwent the same procedure.

During the peak of the pandemic, Karayiannis et al. revealed that there was no 30-day postoperative mortality in traumatic and orthopedic cases with ASA 1 and 2, but four patients classified as ASA 3-4 were diagnosed with COVID-19 after the surgery.<sup>19</sup> The result showed that 2 died from the infection, while the remaining 2 died from seizure and congestive heart failure, respectively. However, it is still unclear whether the surgical procedure implemented a COVID-19-free pathway. Gammeri et al. reported no serious pulmonary complications or 30-day

postoperative mortality in 98 ASA 1, 181 ASA 2, 29 ASA 3, and 1 ASA 4 patients who underwent elective surgery in a hospital that was free from the virus.<sup>11</sup> All the participant underwent only minor and intermediate surgical procedures. In this study, three patients died, but were not associated with COVID-19. This finding is in line with Kane et al. where one-third of people with ASA 3 and 4, and more than half of patients who underwent major/complex surgical with a COVID-19-free pathway had low postoperative COVID-19 infection rate.<sup>18</sup> The pathway also exhibited a lower 30-day postoperative pulmonary complication rate among cancer sufferers.<sup>10</sup> These findings indicate that people at risk of immune system compromise due to major surgery, namely ASA 3 and 4, as well as cancer patients can still undergo the procedure safely.

Hospital-acquired SARS-CoV-2 infection can be defined as a patient contracting SARS-CoV-2 during hospitalization or within the first 14 days after discharge.<sup>20</sup> Several studies showed that the average incubation period of the virus is 5.1 days,<sup>21</sup> hence, monitoring patients with a length of stay longer than five days or 14 days after discharge is necessary to determine its possibility. Although more than one-third of participants in this study had a postoperative stay of more than eight days, none of them showed symptoms. However, 8 out of 253 patients developed fever or cough within 14 days of discharge. They also did not undergo the RT-PCR test, but recovered later. Although the incidence of nosocomial COVID-19 infection was reduced by implementing zone division and wearing PPE,<sup>22</sup> length of stay is still a risk factor.<sup>20,23</sup> A previous study reported that 12 patients (80%) with a length of stay of more than 14 days were infected.<sup>23</sup> Strategies to reduce the duration need to be developed to lower the risk of the condition. Implementing the Enhanced Recovery After Surgery (ERAS) protocol is an option during the pandemic<sup>6,24</sup> and previous studies revealed that it reduced the length of stay and postoperative complications by 20-50%.<sup>24</sup> Its application requires good cross-multidisciplinary collaboration to provide safety for patients undergoing surgery during the pandemic.

Patient compliance with health protocols, such as wearing masks, physical distancing, and hand hygiene after discharge have an essential role in reducing the risk of infection. Surgical procedures, especially major surgeries have impact on the immune system for more than 14 days, hence, patients are still susceptible to community-acquired COVID-19 after discharge. A systematic review and meta-analysis showed that self-protection by wearing masks, physical distancing, and washing hands effectively reduced the incidence of COVID-19 in the community.<sup>25</sup>

The majority of patients in this study had high adherence to health protocols. Awareness of implementing these protocols have a major role in preventing its transmission.

One of the limitations of this study is that RT-PCR tests were not carried out during postoperative care and at discharge. Based on the hospital's policy, it is only performed on people with symptoms of COVID-19. This indicates that the possibility of having asymptomatic patients cannot be ruled out. A simulation study using a model revealed that routine RT-PCR testing twice a week in high-risk healthcare facilities can reduce the risk of outbreaks, <sup>26</sup> but it requires many resources. Kobayashi et al., performed serial COVID-19 tests on inpatients, and the result showed that 19 of 1950 experienced a conversion from negative results on admission to positive results during hospitalization.<sup>27</sup> Furthermore, three of them were infected at the hospital. Others studies on routine RT-PCR testing of asymptomatic hospitalized patients during the early stage of COVID-19 showed a very low incidence of SARS-CoV-2 infection.<sup>28,29</sup> This indicates that performing the test when daily coronavirus cases are low has minimal benefit compared to symptom-based screening. Discretion in adopting policies regarding routine RT-PCR testing in inpatients is also needed to reduce the risk of hospital-acquired SARS-CoV-2 infection.

Implementing the tests can be carried out by considering the daily number of positive cases as well as the hospital's capabilities and resources.

## CONCLUSION

The COVID-19 pandemic has affected various

non-COVID-19 patient services, including elective surgery. In its earliest stage, several countries suspended elective operations to use the available resources for treatment of infected people. This was caused by the high morbidity and mortality of infected patients undergoing surgery as well as the risk of transmission. However, discontinuation of elective surgery can lead to a backlog of surgical cases and increased morbidity, especially among people with cancer. Restarting the surgical during the pandemic is an option to overcome this problem. Adopting a new strategy for the process is also needed to minimize the harmful effects on the patient and the risk of contracting the virus postoperatively. This study showed that implementing a COVID-19-free pathway and adherence to health protocols provides safety against the risk of hospital-acquired SARS-CoV-2 infection. This strategy is practical and can be applied in dealing with other potential pandemics in the future.

## REFERENCES

1. Nepogodiev D, Omar OM, Glasbey JC, Li E, Simoes JFF, Abbott TEF, et al. Elective surgery cancellations due to the COVID-19 pandemic: global predictive modelling to inform surgical recovery plans. *Br J Surg*. 2020;107(11):1440–9.
2. Stahel PF. How to risk-stratify elective surgery during the COVID-19 pandemic? *Patient Saf Surg*. 2020 Dec 31;14(1):8.
3. N. KN, H. PA, J. LM, H. SF, F. SW. The Effect of COVID-19 on Orthopedic Practices and Surgeons in Louisiana. *Orthopedics*. 2020 Nov 1;43(6):351–5.
4. Mouton C, Hirschmann MT, Ollivier M, Seil R, Menetrey J. COVID-19 - ESSKA guidelines and recommendations for resuming elective surgery. *J Exp Orthop*. 2020;7(1):28.
5. Chang JS, Wignadasan W, Pradhan R, Kontoghiorghis C, Kayani B, Haddad FS. Elective orthopedic surgery with a designated COVID-19-free pathway results in low perioperative viral transmission rates. *Bone Jt Open*. 2020;1(9):562–7.
6. Thomakos N, Pandrakis A, Bisch SP, Rodolakis A, Nelson G. ERAS protocols in gynecologic oncology during COVID-19 pandemic. *Vol. 30, International journal of gynecological cancer : official journal of the International Gynecological Cancer Society*. England; 2020. p. 728–9.
7. Nice.org.uk. Recommendation for specific surgery grades (minor, intermediate, and major or complex) and ASA grades [Internet]. 2016 [cited 2021 Aug 1]. Available from: <https://www.nice.org.uk/guidance/ng45/chapter/recommendations>
8. Asahq.org. ASA physical status classification system [Internet]. 2020 [cited 2021 Aug 1]. Available from: <https://www.asahq.org/standards-and-guidelines/asa-physical-status-classification-system>
9. PDPI, PERKI, PAPDI, PERDATIN, IDAI. Pedoman tatalaksana COVID-19. EDISI 3. Pedoman Tatalaksana COVID-19. Jakarta; 2020.
10. Glasbey JC, Nepogodiev D, Simoes JFF, Omar O, Li E, Venn ML, et al. Elective Cancer Surgery in COVID-19-Free Surgical Pathways During the SARS-CoV-2 Pandemic: An International, Multicenter, Comparative Cohort Study. *J Clin Oncol Off J Am Soc Clin Oncol*. 2021 Jan;39(1):66–78.
11. Gammeri E, Cillo GM, Sunthareswaran R, Magro T. Is a “COVID-19-free” hospital the answer to resuming elective surgery during the current pandemic? Results from the first available prospective study. *Surgery*. 2020 Oct;168(4):572–7.
12. Sutherland L, Hastie J, Takayama H, Furuya Y, Hochman B, Kelley N, et al. Low rate of health care-associated transmission of coronavirus disease 2019 (COVID-19) in the epicenter. *J Thorac Cardiovasc Surg*. 2020/08/15. 2021 Feb;161(2):e235–7.
13. Lei S, Jiang F, Su W, Chen C, Chen J, Mei W, et al. Clinical characteristics and outcomes of patients undergoing surgeries during the incubation period of COVID-19 infection. *EclinicalMedicine*. 2020 Apr 5;21:100331.
14. Nepogodiev D, Bhangu A, Glasbey JC, Li E, Omar OM, Simoes JF, et al. Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infection: an international cohort study. *Lancet*. 2020;396(10243):27–38.
15. COVIDSurg Collaborative, GlobalSurg Col-

- laborative. Timing of surgery following SARS-CoV-2 infection: an international prospective cohort study. *Anesthesia*. 2021;76(6):748–58.
16. COVIDSurg Collaborative, GlobalSurg Collaborative. Effects of pre-operative isolation on postoperative pulmonary complications after elective surgery: an international prospective cohort study. *Anesthesia*. 2021;76(11):1454–64.
  17. Baboudjian M, Mhatli M, Bourouina A, Gondran-Tellier B, Anastay V, Perez L, et al. Is minor surgery safe during the COVID-19 pandemic? A multi-disciplinary study. *PLoS One*. 2021;16(5):e0251122–e0251122.
  18. Kane AD, Paterson J, Pokhrel S, Berry SK, Monkhouse D, Brand JW, et al. Peri-operative COVID-19 infection in urgent elective surgery during a pandemic surge period: a retrospective observational cohort study. *Anesthesia*. 2020;75(12):1596–604.
  19. Karayiannis PN, Roberts V, Cassidy R, Mayne AIW, McAuley D, Milligan DJ, et al. 30-day mortality following trauma and orthopedic surgery during the peak of the COVID-19 pandemic: a multicentre regional analysis of 484 patients. *Bone Jt open*. 2020;1(7):392–7.
  20. Lakhani K, Minguell J, Guerra-Farfán E, Lara Y, Jambrina U, Pijoan J, et al. Nosocomial infection with SARS-CoV-2 and main outcomes after surgery within an orthopedic surgery department in a tertiary trauma centre in Spain. *Int Orthop*. 2020;44(12):2505–13.
  21. Lauer SA, Grantz KH, Bi Q, Jones FK, Zheng Q, Meredith HR, et al. The incubation period of coronavirus disease 2019 (CoVID-19) from publicly reported confirmed cases: Estimation and application. *Ann Intern Med*. 2020;172(9):577–82.
  22. Ogawa F, Kato H, Sakai K, Nakamura K, Ogawa M, Uchiyama M, et al. Environmental maintenance with effective and useful zoning to protect patients and medical staff from COVID-19 infection. *Acute Med Surg*. 2020;7(1):1–5.
  23. Luong-Nguyen M, Hermand H, Abdalla S, Cabrit N, Hobeika C, Brouquet A, et al. Nosocomial infection with SARS-Cov-2 within Departments of Digestive Surgery. *J Visc Surg*. 2020 Jun;157(3S1):S13–8.
  24. Ljungqvist O, Nelson G, Demartines N. The Post COVID-19 Surgical Backlog: Now is the Time to Implement Enhanced Recovery After Surgery (ERAS). *World J Surg*. 2020;44(10):3197–8.
  25. Talic S, Shah S, Wild H, Gasevic D, Maharaj A, Ademi Z, et al. Effectiveness of public health measures in reducing the incidence of covid-19, SARS-CoV-2 transmission, and covid-19 mortality: systematic review and meta-analysis. *BMJ*. 2021;375:e068302.
  26. Chin ET, Huynh BQ, Chapman LAC, Murrill M, Basu S, Lo NC. Frequency of Routine Testing for Coronavirus Disease 2019 (COVID-19) in High-risk Healthcare Environments to Reduce Outbreaks. *Clin Infect Dis*. 2021;73(9):e3127–9.
  27. Kobayashi T, Trannel A, Holley SA, Alshaihani MA, Abosi OJ, Jenn KE, et al. Coronavirus Disease 2019 Serial Testing Among Hospitalized Patients in a Midwest Tertiary Medical Center, July-September 2020. *Clin Infect Dis an Off Publ Infect Dis Soc Am*. 2021;73(9):e3116–9.
  28. Bai AD, Li XX, Alsalem M, Khan S, Smieja M, Mertz D, et al. Utility of asymptomatic inpatient testing for COVID-19 in a low-prevalence setting: A multicenter point-prevalence study. *Infect Control Hosp Epidemiol*. 2020;41(10):1233–5.
  29. Kessler T, Wiebe J, Graf T, Schunkert H, Kasrati A, Sager HB. SARS-CoV-2 Infection in Asymptomatic Patients Hospitalized for Cardiac Emergencies: Implications for Patient Management. *Front Cardiovasc Med*. 2020;7:1–4.