Usefulness of PCR Screening in the Initial Triage of Trauma Patients During COVID-19 Pandemic

Juan A. Porcel-Vazquez, MD,[a] Jose V. Andres-Peiro, MD,[a] Yaiza Garcia-Sanchez, MS,[b] Ernesto Guerra-Farfan, MD,[a] Jaume Mestre-Torres, MD, PhD,[c] Joan Minguell-Monyart, MD, PhD,[a] Vicente Molero-Garcia, MD, PhD,[a] Jordi Selga Marsa, MD,[a] Jordi Tomas-Hernandez, MD,[a] Maria del Mar Villar-Casares, MD, PhD,[c] Mohit Bhandari, MD, PhD,[d] and Jordi Teixidor-Serra, MD[a]

Background: Hospitals worldwide have postponed all nonessential surgery during the COVID-19 pandemic, but non-COVID-19 patients are still in urgent need of care. Uncertainty about a patient's COVID-19 status risks infecting health care workers and non-COVID-19 inpatients. We evaluated the use of quantitative reverse transcription polymerase chain reaction (RT-qPCR) screening for COVID-19 on admission for all patients with fractures.

Methods: We conducted a retrospective cohort study of patients older than 18 years admitted with low-energy fractures who were tested by RT-qPCR for SARS-CoV-2 at any time during hospitalization. Two periods based on the applied testing protocol were defined. During the first period, patients were only tested because of epidemiological criteria or clinical suspicion based on fever, respiratory symptoms, or radiological findings. In the second period, all patients admitted for fracture treatment were screened by RT-qPCR.

Results: We identified 15 patients in the first period and 42 in the second. In total, 9 (15.8%) patients without clinical or radiological findings tested positive at any moment. Five (33.3%) patients tested positive postoperatively in the first period and 3 (7.1%) in the second period ($P = 0.02$). For clinically unsuspected patients, postoperative positive detection went from 3 of 15 (20%) during the first period to 2 of 42 (4.8%) in the second ($P = 0.11$). Clinical symptoms demonstrated high specificity (92.1%) but poor sensitivity (52.6%) for infection detection.

Conclusions: Symptom-based screening for COVID-19 has shown to be specific but not sensitive. Negative clinical symptoms do not rule out infection. Protocols and separated areas are necessary to treat infected patients. RT-qPCR testing on admission helps minimize the risk of nosocomial and occupational infection.

Key Words: COVID-19, pandemics, polymerase chain reaction, triage, fractures, trauma, hip fractures, hospital admission

Level of Evidence: Level IV, retrospective cohort study. See Instructions for Authors for a complete description of levels of evidence.

(*J Orthop Trauma* 2020;00:e1–e5)

INTRODUCTION

A new coronavirus disease, COVID-19, has been spreading from China since December 2019.[1] In Spain, the first COVID-19 case was reported on January 31, 2020. On March 2, Spain reached 100 confirmed cases. Shortly after, on March 11, the World Health Organization (WHO) declared COVID-19 as a pandemic disease.[2] During the pandemic, not only are critically ill patients affected by COVID-19 pneumonia in need of care but also emergent and urgent patients with common health problems, such as surgical fractures.[3] On March 14, the Spanish government declared a partial lockdown and increased to total lockdown on March 23.[4] This scenario reduced the overall number of admitted trauma patients but frail patients with fractures continued to be admitted to hospital.

In Spain, suspected cases of COVID-19 were initially defined according to the WHO guidelines.[5–7] Suspected cases included patients with any acute respiratory disease symptom (eg, fever, cough, or shortness of breath) and a history of travel to or residence in a location reporting community transmission of COVID-19 during the 14 days before symptom onset or having been in contact with a confirmed or probable COVID-19 case in the last 14 days before symptom onset.

The current coronavirus pandemic has been an unexpected challenge to the medical community. Unfortunately, a high proportion of COVID-19 patients (56%) present no or mild symptoms,[8] thus hindering their management. This situation leads to unknown and dynamic scenarios involving a high potential risk of contamination for staff and non-COVID-19 inpatients.

Initial triage to perform quantitative reverse transcription polymerase chain reaction (RT-qPCR) based on symptoms of respiratory disease and chest x-ray and/or based on epidemiological criteria in the emergency department (ED)

Accepted for publication July 9, 2020.

From the [a]Department of Orthopaedic Surgery and Traumatology, Hospital Universitari Vall d'Hebron, Barcelona, Spain; [b]Department of Orthopaedic Surgery and Traumatology, Vall d'Hebron Institut de Recerca (VHIR), Barcelona, Spain; [c]Department of Internal Medicine, Hospital Universitari Vall d'Hebron, Barcelona, Spain; and [d]Department of Surgery, McMaster University, Hamilton, ON, Canada.

The authors report no conflict of interest.

Reprints: Jordi Teixidor-Serra, MD, Department of Orthopaedic Surgery and Traumatology, Hospital Universitari Vall d'Hebron, Vall d'Hebron Barcelona Hospital Campus, Passeig Vall d'Hebron, 119-129, 08035 Barcelona, Spain (e-mail: jteixidorserra@gmail.com).

DOI: 10.1097/BOT.0000000000001903

may be not enough to avoid nosocomial infection or unprotected hospitalization and surgery for health care workers due to the significant incidence of asymptomatic COVID-19 patients.[9,10]

We hypothesized that ED screening by symptoms and chest radiographs may lead to the underdiagnosis of active COVID-19 infection in patients admitted for fracture treatment. Therefore, we suggest universal screening in EDs with specific COVID-19 PCR testing to facilitate management throughout an entire hospital, establishing early isolation measures for infected patients, and the proper use of personal protective equipment (PPE), thus preventing nosocomial and occupational infections and the misallocation of resources.

The aim of this study was to evaluate the usefulness of RT-qPCR screening for COVID-19 in the ED for all admitted patients with fractures, and to identify the rate of trauma patients with an active COVID-19 infection initially underdiagnosed according to the definition of suspected cases. In addition, and in light of the results, we would like to propose some recommendations to optimize management for these patients that have arisen in relation to the results of this research.

MATERIAL AND METHODS

Study Design and Patients

This was a retrospective single-center cohort study. From March 11, 2020, (when WHO declared COVID-19 as a pandemic disease[2]) to April 11, 2020, all patients older than 18 years admitted to our hospital (Level III trauma center university public hospital) with the clinical and radiological diagnosis of a traumatic fracture due to a low-energy mechanism were included. Exclusion criteria were polytrauma and patients not tested for COVID-19 at any time during hospitalization.

The approval of the Institutional Review Board of Hospital Universitari Vall d'Hebron was obtained. The need for informed consent was waived by the institutional review board.

Data Collection

Demographic, epidemiologic, and clinical variables related to COVID-19, such as symptoms (cough, dyspnea, and body temperature) and abnormalities in the chest radiograph, were collected on admission.[11,12] Chest radiographs were evaluated by an expert radiologist. A diagnosis of COVID-19 was determined by in-house RT-qPCR following the protocol of the Centers for Disease Control and Prevention 2019-Novel Coronavirus (2019-nCoV) Real-Time Reverse Transcriptase (RT)-PCR Diagnostic Panel,[13] from nasopharyngeal swab samples. Variables related to fracture characteristics, therapeutic procedures, and follow-up during hospitalization were obtained for each patient.

Data were extracted from electronic medical records used for clinical management based on SAP software (SAP SE, Walldorf, Germany) and introduced on a costumed data collection form property of the research team and anonymized in accordance with the current Spanish data protection law.

Procedure

Two different periods of action based on the criteria for requesting an RT-qPCR diagnostic test for COVID-19 were defined. The first period, from March 11 to March 20, 2020, included all patients with a traumatic fracture who were tested for COVID-19 based on symptoms of respiratory disease and chest x-ray and/or epidemiological criteria on admission (history of travel to or residence in a location reporting community transmission of COVID-19 or having been in contact with a confirmed or probable COVID-19 case in the past 14 days before symptom onset). During the first period, patients were also tested after an onset of symptoms clinically suspicious of COVID-19 during their hospitalization. Only suspected cases according to the WHO definition were isolated in specific areas awaiting RT-qPCR results or once they were a confirmed case during that period. This strategy did not take into account either the incubation interval of the virus, the period of appearance of symptoms, or potentially infectious asymptomatic COVID-19 patients. A consecutive detection of positive cases of COVID-19 several days after admission and a gradual knowledge of the infection motivated the change of procedure. The second period was between March 21 and April 11, 2020. Universal screening of RT-qPCR on admission was established for all admitted patients with fractures regardless of clinical or radiological findings.

During the second period, all patients were isolated in specific areas of the ED until the RT-qPCR result was available. Meanwhile, nursing and medical teams protected themselves according to the internal protocol.[7] Then, patients were admitted to COVID-19 and non-COVID-19 areas according to the RT-qPCR result. Furthermore, patients who developed COVID-19 symptoms or who were in close contact with a COVID-19 confirmed case during hospitalization were immediately tested and isolated, even if asymptomatic, until the result was obtained. If positive, appropriate isolation and protection measures were taken. This modification in the protocol allowed the early isolation and proper management of symptomatic and asymptomatic patients with positive RT-qPCR test results on admission.

In both periods, additional RT-qPCR tests for COVID-19 were performed if COVID-19 symptoms or radiological findings seemed de novo during hospitalization, or if the patient had been in contact with confirmed infected patients, even if previous RT-qPCR results were negative.

Statistical Analysis

Descriptive and inferential statistics were calculated. Continuous variables were displayed as means and SD or medians and interquartile ranges (IQRs), as appropriate. Categorical variables were reported as counts and percentages. The Pearson χ^2 test was used to test differences in categorical variables between the 2 groups. For comparisons with a small number of observations, the nonparametric Fisher exact test was applied. Differences in quantitative variables were analyzed by the Student t test or the Mann–Whitney U test, according to the variable distribution. A P value ≤ 0.05 was considered statistically significant. Multiple

testing corrections were not performed. Statistical analysis was performed using Stata/IC 14.2 software (StataCorp, College Station, TX).

RESULTS

From March 11 to April 11, 2020, 70 fracture patients were admitted to our hospital. Thirteen patients did not meet the inclusion criteria and were excluded. There were 3 polytrauma patients and 10 patients without any RT-qPCR results admitted in the first period of the pandemic. The remaining 57 cases were available for analysis. The cohort comprised 15 men and 42 women, with a median age of 86 years (IQR: 82–90). Patients ranged in age from 45 to 100 years. This was an asymmetric sample with a strong predominance of older patients sustaining fragile hip fractures. We attribute the low incidence of young patients to the lockdown established by the public health authorities. In total, 50 of 57 patients were surgically treated (89.3%). The mean time from admission to surgery was 4.6 days (SD 4.1). This long delay was probably related to the initial confusion at the start of the pandemic and the lack of standardized protocols (Table 1).

On admission, only 13 (22.8%) patients had either COVID-19 symptoms (cough, shortness of breath, or fever) or the distinctive radiological pattern. Overall, 19 (33.3%) patients tested positive for COVID-19 but there was a clinical suspicion in only 10 (52.6%) of them. Statistically significant relations were found between patients testing positive by RT-qPCR and having previous contact with COVID-19 patients ($P = 0.01$), living in a nursing home ($P = 0.01$), and the presence of compatible symptoms ($P = 0.01$) and/or radiological findings ($P < 0.01$).

TABLE 1. Sample Description

Sample Variable	Descriptive Statistics
Median age (IQR), y	86 (82–90)
Mean ASAPS (±SD)	2.70 (0.46)
Living in nursing home—no. (%)	12 (21.05)
Contact with COVID-19 patients—no. (%)	15 (26.3)
Fracture location/type:	
Hip (proximal femur)—no. (%)	47 (82.46)
Tibia (proximal to distal)—no. (%)	4 (7.02)
Periprosthetic femur fracture—no. (%)	2 (3.5)
Others (radius, pelvic ring, distal femur, and ankle)—no. (%)	4 (7.02)
Surgical treatment—no. (%)	50 (89.29)
Mean surgery delay* (±SD), d	4.64 (4.07)
Fragility hip fracture patients†—no. (%)	47 (80.7)
Fixation surgery—no. (%)	28 (66.67)
Replacement surgery—no. (%)	14 (33.33)

*Time in days from admission to surgery.
†Patients aged 65 years or older sustaining proximal femur fractures.
ASAPS, American Society of Anesthesiologists physical status classification.

Fifteen patients were admitted before the universal implementation of RT-qPCR screening from March 11 to March 20. In this period, the need for RT-qPCR was decided according to clinical features and records of exposure to COVID-19 inpatient contacts or epidemiologic criteria. Forty-two patients were admitted between March 21 and April 11, when RT-qPCR testing was performed on admission for all patients. There was a higher proportion of symptomatic patients and patients testing positive in the first period. This is attributable to the criteria applied to indicate the test. These differences were not statistically significant (Table 2).

Overall, 9 (15.8%) patients without clinical or radiological findings of COVID-19 tested positive by RT-qPCR. Before the implementation of universal RT-qPCR, 5 (33.3%) patients tested positive postoperatively. By changing the protocol, this decreased to 3 (7.1%) patients. The relative reduction of risk was 78.57%, which meant a great improvement in hospital management and in controlling exposure of health care workers and non-COVID-19 inpatients to uncontrolled COVID-19 patients. This difference was statistically significant ($P = 0.02$). For unsuspected patients (without clinical or radiological findings), the postoperative positive RT-qPCR detection went from 3 of the 15 (20%) patients in the first period to 2 of the 42 (4.8%) patients in the second. The relative reduction of risk was 76.19%. This difference was not statistically significant ($P = 0.11$) (Table 2). The presence of clinical symptoms demonstrated high specificity (92.1%) but poor sensitivity (52.6%) for infection (Table 3).

Four of 15 (26.7%) patients tested positive after one or more negative RT-qPCR results in the first period compared with 4 of 42 (9.5%) patients in the second period. Overall, 6 patients had only one negative previous result, and 2 patients tested negative twice before a positive result. Four of these patients were in close contact with other asymptomatic COVID-19 inpatients. Three patients tested positive more than 10 days after their admission, and 5 patients tested positive during the first week of hospitalization, with a mean of 5.8 days of hospitalization.

Testing all admitted patients with fractures for COVID-19 also reduced the delay in knowing the infection status of patients from just over a week to 24 hours on average ($P = 0.01$) (Table 2).

DISCUSSION

During the pandemic, not only are critically ill patients affected by COVID-19 pneumonia in need of care but emergent and urgent patients with common health problems, such as surgical fractures, are as well.

Since the declaration of the pandemic, patients with fractures have been continuously admitted through our ED,[7] even during the total lockdown. Most of them are in need of urgent hospital treatment regardless of their COVID-19 status, as has happened with other surgical specialties.[14]

Taking into account that 9 of the 19 (47.4%) admitted patients tested positive by RT-qPCR but without clinical suspicion of COVID-19, infection control strategies should be widely applied. An important point in the recommendations for hospital admission and treatment of patients with COVID-

TABLE 2. Inferential Statistics

	Total	RT-qPCR on Admission		*P*
		First Period*	Second Period†	
Sample size	57	15	42	—
Patients testing positive in COVID-19 RT-qPCR test	19 (33.33%)	8 (53.33%)	11 (26.19%)	0.06
Patients with clinical or radiological features of COVID-19	13 (22.81%)	6 (40%)	7 (16.67%)	0.06
Previous contact with suspected or confirmed COVID-19 cases	12 (21.05%)	5 (33.33%)	7 (16.67%)	0.17
Nursing home patients	15 (26.32%)	4 (26.67%)	11 (26.19%)	1.00
Unsuspected‡ patients with positive RT-qPCR test	9 (15.79%)	4 (26.67%)	5 (11.90%)	0.22
Patients testing positive after surgery	8 (14.04%)	5 (33.33%)	3 (7.14%)	0.02
Unsuspected patients testing positive after surgery	5 (8.78%)	3 (20%)	2 (4.76%)	0.11
Mean delay of positive RT-qPCR results from admission in days (SD)	2.60 (5.14)	7.60 (7.31)	0.81 (2.32)	0.01

*First Period: patients with fractures tested for COVID-19 because of epidemiological criteria or after an onset of clinical suspicion of COVID-19 during their hospitalization.
†Second Period: universal screening by RT-qPCR on admission to all admitted patients with fractures.
‡Unsuspected patients: admitted patients without clinical or radiological features of COVID-19.

19 is the creation of safe corridors to avoid infecting health personnel or non-COVID-19 inpatients and the preparation of stable surgical circuits to treat patients with COVID-19 infection, achieving protection for treating personnel, rational use of hospitalization resources (isolation beds and PPE), and a reduction in uncertainty about a patient's condition.[15]

Since the beginning of the COVID-19 pandemic, we noticed a large proportion of patients (33.3%) testing positive by RT-qPCR after orthopedic surgery, corresponding to the first period of our study. More than half of these patients (3 of 5) had no distinctive clinical or radiological alterations, as previously determined in nursing home facilities.[8] Because of the lack of knowledge of the disease and the uncertainty generated regarding the availability of material resources, RT-qPCR tests were only requested from patients with symptoms or radiological findings compatible with COVID-19 infection or based on epidemiological criteria during the first study period.[11,12] The failure to detect these cases created several episodes of uncontrolled exposure for staff members and other non-COVID-19 inpatients, infecting some staff members and forcing the isolation of others.

Given this situation, the performance of RT-qPCR screening at the ED, with the corresponding isolation of positive patients in COVID-19 wards and surgically treated in differentiated operating rooms, has reduced the risk of uncontrolled exposure by 78.57%, which greatly improved the management of contaminated areas and protection of human resources with proper PPE. It is also important to repeat testing when new symptoms or radiological findings suggestive of COVID-19 appear during a patient's hospitalization or a new contact with confirmed infected patients is known, even if previous RT-qPCR results were negative. Our study reported that 4 of the 15 (26.67%) patients tested positive after 1 or more negative RT-qPCR results during the first period, as did 4 of the 42 (9.52%) patients in the second. This can be explained by false negative results or nosocomial infection. The test could have a lack of capacity to detect infections only a few days old due to the low viral load, being more successful several days after.[16] Moreover, the incubation period is highly variable, reaching 24 days in some cases but on average 2–7 days.[17] We hypothesize that, if a patient tested positive after a negative test in the first week of hospitalization, it was likely a false negative result. However, if patient tested positive a week later, it was likely a case of nosocomial infection. In our study, 3 patients tested positive more than 10 days after their admission, and 5 patients tested positive during the first week of hospitalization, with a mean of 5.8 days.

TABLE 3. Sensitivity and Specificity

	RT-qPCR Positive	RT-qPCR Negative	
Clinical risk factors*	10	3	Likelihood ratio for a positive test 6.67
No clinical risk factors	9	35	Likelihood ratio for a negative test 0.57
	Sensitivity: 52.6%	Specificity: 92.1%	

*Clinical risk factors include symptoms (cough, dyspnea, and body temperature) and abnormalities in the chest radiograph related to COVID-19.

Unfortunately, Spain is one of the countries where the infection of health personnel has been high (20%).[18] Symptom-based screening has shown to be ineffective, as demonstrated by 33.3% of patients treated surgically tested positive after surgery during the first period of study. Symptom-based screening for COVID-19 has also shown to be specific but not sensitive, denoting that negative clinical symptoms do not necessarily rule out infection. Overall, there has been a difficulty in obtaining adequate PPE. We believe that initial screening with RT-qPCR testing at the ED level for all admitted patients allows a more rational management of equipment and also allows the division of treatment areas into COVID-19 and non-COVID-19 areas while maintaining health care continuity, as has been suggested.[19]

Our hospital has adopted a policy of testing any patient being admitted, including ED admission and patients admitted for elective surgery during the de-escalation. In these cases, a formal interview regarding epidemiological criteria, chest radiography, and an RT-qPCR test 48 hours before admission are mandatory. Moreover, health care workers are tested by RT-qPCR and serologic tests. There is still much unknown regarding the effectiveness of screening methods during the asymptomatic phase, and further investigation is needed to evaluate how long this protocol should be applied beyond the current unprecedented time.

This study has several limitations, namely due to nonrandomization, the retrospective analysis, short and irregular follow-up, small sample sizes, and possible selection bias due to the inclusion of only those patients with RT-qPCR results. We consider that the value of this study lies in the description of this screening strategy of RT-qPCR testing in EDs, which was found to be effective for the care of surgical patients with fractures, decreasing the risk of nosocomial infection to health care workers and non-COVID-19 inpatients. This was possible due to the implementation of isolation measures, defined COVID-19 and non-COVID-19 areas, and to the proper use of PPE. Moreover, it can be effective in the new stages of de-escalation in preventing infection of or by health care personnel, patient management, and for the re-initiation of non-COVID-19 hospital activity.

Our results give information to the body of knowledge to improve health care to rearrange assistance to our patients and to decrease the risk of nosocomial infection to health care workers and non-COVID-19 inpatients. We recommend this protocol not only for orthopaedic and trauma services but also, in line with previous studies, to all specialties working in urgent care.

REFERENCES

1. Paules CI, Marston HD, Fauci AS. Coronavirus infections—more than just the common cold. *JAMA.* 2020;323:707–708.
2. World Health Organization. *Director-General's Opening Remarks at the Media Briefing on COVID19-11 March 2020*. Available at: https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19—11-march-2020. Accessed May 11, 2020.
3. Stahel PF. How to risk-stratify elective surgery during the COVID-19 pandemic? *Patient Saf Surg.* 2020;14:8.
4. Ministerio de la Presidencia, Relaciones con las Cortes y Memoria Democrática. Gobierno de España. Boletín Oficial del Estado (BOE). Real Decreto 463/2020, de 14 de marzo, por el que se declara el estado de alarma para la gestión de la situación de crisis sanitaria ocasionada por el COVID-19. Spanish. Available at: https://www.boe.es/diario_boe/txt.php?id=BOE-A-2020-3692. Accessed May 11, 2020.
5. World Health Organization. *Global Surveillance for COVID-19 Caused by Human Infection with COVID-19 Virus: Interim Guidance, 20 March, 2020*. Available at: https://apps.who.int/iris/handle/10665/331506. Accessed June 2, 2020.
6. European Centre for Disease prevention and Control (ECDC). *Infection Prevention and Control for the Care of Patients with 2019-nCoV in Healthcare Settings*. 2020. Available at: https://www.ecdc.europa.eu/sites/default/files/documents/nove-coronavirus-infection-prevention-control-patients-healthcare-settings.pdf. Accessed June 6, 2020.
7. Generalitat de Catalunya. *Servei Català de la Salut. Guia d'actuació enfront de casos d'infecció pel nou coronavirus SARS-CoV-2*. 2020. Available at: https://sem.gencat.cat/web/.content/coronavirus/guia-actuacio-clinica-casos-sars-cov-2.pdf. Accessed June 6, 2020.
8. Arons MM, Hatfield KM, Reddy SC, et al. Presymptomatic SARS-CoV-2 infections and transmission in a skilled nursing facility. *N Engl J Med.* 2020;382:2081–2090.
9. Chan JF, Yuan S, Kok KH, et al. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. *Lancet.* 2020;395:514–523.
10. Li Q, Guan X, Wu P, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *N Engl J Med.* 2020;382:1199–1207.
11. Chen N, Zhou M, Dong X, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet.* 2020;395:507–513.
12. Wang D, Hu B, Hu C, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA.* 2020;323:1061–1069.
13. Centers for Disease Control and Prevention (CDC). *CDC 2019-Novel Coronavirus (2019-nCoV) Real-Time RT-PCR Diagnostic Panel. Instructions for Use*. Available at: https://www.fda.gov/media/134922/download. Accessed June 4, 2020.
14. Sutton D, Fuchs K, D'Alton M, et al. Universal screening for SARS-CoV-2 in women admitted for delivery. *N Engl J Med.* 2020 [epub ahead of print].
15. Coccolini F, Perrone G, Chiarugi M, et al. Surgery in COVID-19 patients: operational directives. *World J Emerg Surg.* 2020;15:25.
16. Peiris JSM, Chu CM, Cheng VCC, et al. Clinical progression and viral load in a community outbreak of coronavirus-associated SARS pneumonia: a prospective study. *Lancet.* 2003;361:1767–1772.
17. Guan W, Ni Z, Hu Y, et al. Clinical characteristics of coronavirus disease 2019 in China. *N Engl J Med.* 2020;382:1708–1720.
18. European Centre for Disease Prevention and Control. *Coronavirus Disease 2019 (COVID-19) in the EU/EEA and the UK—Ninth Update, 23 April 2020*. Stockholm, Sweden: ECDC; 2020. Available at: https://www.ecdc.europa.eu/sites/default/files/documents/covid-19-rapid-risk-assessment-coronavirus-disease-2019-ninth-update-23-april-2020.pdf. Accessed May 11, 2020.
19. Wong J, Goh QY, Tan Z, et al. Preparing for a COVID-19 pandemic: a review of operating room outbreak response measures in a large tertiary hospital in Singapore. *Can J Anaesth.* 2020;67:732–745.