

Perioperative Management for Emergency Surgery in Pediatric Patients with COVID-19: Retrospective Observational Study

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Background: The first wave of COVID-19 in 2020 created massive challenges in providing safe surgery for pediatric patients with COVID-19. Inevitably, emergency surgery and the unknown nature of the disease place a burden on the heavily challenged surgical services for pediatrics in a developing country. Lessons from the pandemic are important for future disaster planning.

Aim: To describe the characteristics of pediatric surgical patients with COVID-19 undergoing emergency surgery during the first wave and its perioperative narrative in a developing country.

Methods: The study was a multicenter retrospective descriptive study in eight Indonesian government-owned referral and teaching hospitals. The authors reviewed confirmed COVID-19 pediatric patients (≤ 18 years old) who underwent surgery. Institutional review board clearances were acquired, and data were evaluated in proportion and percentages. The writing of this paper follows the STROBE guidelines.

Results: About 7791 pediatric surgical cases were collected, 73 matched the study criteria and 24 confirmed cases were found. Cases were more common in females (58.3%), who were above 12 years old (37.5%) and who were asymptomatic (62.5%). Laparotomy (33.3%), general anesthesia (90.4%) and intubation (80.8%) were common, while use of video laryngoscopy (40%) and rapid sequence intubation (28.8%) were rare. The mean length of stay was 12 ± 13.3 days, and in-hospital mortality was 8.3%.

Discussions: Lockdown and school closure were successful in protecting children, hence the low incidence of pediatric surgical cases with COVID-19 during the first wave. Many hospitals were unprepared to perform surgery for a droplet or airborne infectious disease, and COVID-19 testing was not available nationally in the early pandemic, hence the use of protective protection equipment during these early pandemic times are often not efficient.

Conclusion: The incidence of COVID-19 in pediatric surgical patients is low. The rapidity and availability of preoperative testing for a new emerging disease are essential in a pandemic.

Keywords: COVID-19, emergency surgery, operating room, pandemic, pediatric anesthesia, pediatric surgery, perioperative

Introduction

The COVID-19 pandemic had emerged in Indonesia by January 2020; by the end of 2021, reports concluded four million cases with 150,000 deaths.^{1,2} The spread of the severe acute respiratory syndrome coronavirus type 2 (SARS-CoV-2) virus, the

pathogen behind COVID-19, affected the provision of emergency and elective pediatric surgery services globally. Official reports stated that children represented 1.8–14.5% of global cases – highest among older adolescents and young adults – with a case fatality of 0.1–0.4% or around 72,000–58,000 cases in Indonesia alone.^{3,4} Owing to the high number of pediatric patients during the COVID-19 pandemic, which had not been seen during previous flu pandemics, some pediatric surgical patients are highly likely to be infected with the virus during their preoperative period. Furthermore, pediatric patients are asymptomatic and may unknowingly transmit the virus to others, including health care workers.^{3,5–7}

Although pediatric surgeries were generally postponed at the beginning of the pandemic owing to lockdowns and the preservation of medical resources to manage the pandemic, emergency surgery continued.^{8,9} Alarming, multicenter studies reported that adult patients with COVID-19 had higher rates of mortality and morbidity than those without COVID-19.^{9–14} However, there is a dearth of studies on pediatric emergency surgery epidemiology or outcomes of COVID-19 in developing countries and its perioperative management. These outlooks and studies are essential in pediatric surgery as the pandemic moves to a chronic state globally in 2022, and there are predictions of another pandemic in the future. At the time of writing this paper, the World Health Organization (WHO) has declared monkeypox as a new pandemic, while COVID-19 is still present.¹ Hence, first-stage reports of reaction to a pandemic are essential for better disaster planning in the future, especially that related to the safety of patients and health care personnel.

Firstly, we aim to describe the characteristics of pediatric surgical patients with COVID-19 undergoing emergency surgery during the first wave of the pandemic. Second, we aim to provide a narrative of the perioperative management of emergency pediatric surgery for pediatric patients with COVID-19 in a developing country.

Methods

Study Setting, Study Design and Data Collection

This study was a multicenter retrospective descriptive study involving eight government-owned hospitals. Six centers were a national referral and teaching hospital, one was a provincial referral and teaching hospital, and one was a specialized provincial referral mother and child hospital. All of the centers were COVID-19 referral centers.

The study reviews subjects undergoing emergency surgery with a suspected or confirmed COVID-19 infection in the preoperative period. Data were collected from the Indonesian Pediatric Surgery (I-PASS) registry from May 1 2020 to December 31, 2020, with the age limit for the subjects being 18 years old. A confirmed or positive COVID-19 case was defined when a nasal or nasopharyngeal swab test was positive for severe acute respiratory syndrome coronavirus type 2 (SARS-CoV-2) using the real-time (RT) polymerase chain reaction (PCR) test.²

Mortality was defined as whether the patient was discharged alive or dead. Preoperative, intraoperative and postoperative data were collected. The preoperative data collected included the patient's origin, sex, age, contact history, symptoms, laboratory results, immunological results, coexisting disease, body mass index and vital signs. Intraoperative data collected were personal protective equipment, negative pressure operating room, intubation technique, type of surgery and type of anesthesia. Postoperative data collected were postoperative inpatient facility, length of stay and discharged condition. Patients were excluded if their RT-PCR results were unavailable.

Preliminary institutional board review (IRB) clearance was obtained first in the primary center (Dr. Hasan Sadikin National Referral and Teaching Hospital), number LB.02.01/X.6.5/14/2021, and each participating center completed its internal IRB clearance. The IRBs waived patient consent since data were taken from medical records and complied with the Declaration of Helsinki. Data were collected using a Microsoft Excel form in each center and pooled in a primary center database. The writing of this paper follows the STROBE guidelines. All subjects that matched the inclusion and exclusion criteria were included, and no minimal sample was measured; hence, a descriptive approach using simple proportions and percentages was used.

Results

Of the 7791 pediatric patients in the registry, 84 subjects matching the searched criteria of cases with suspected COVID-19 during the preoperative period were included. Eleven cases were excluded since nine did not have RT-PCR results, and two had incomplete anesthetic and surgical records (Figure 1).

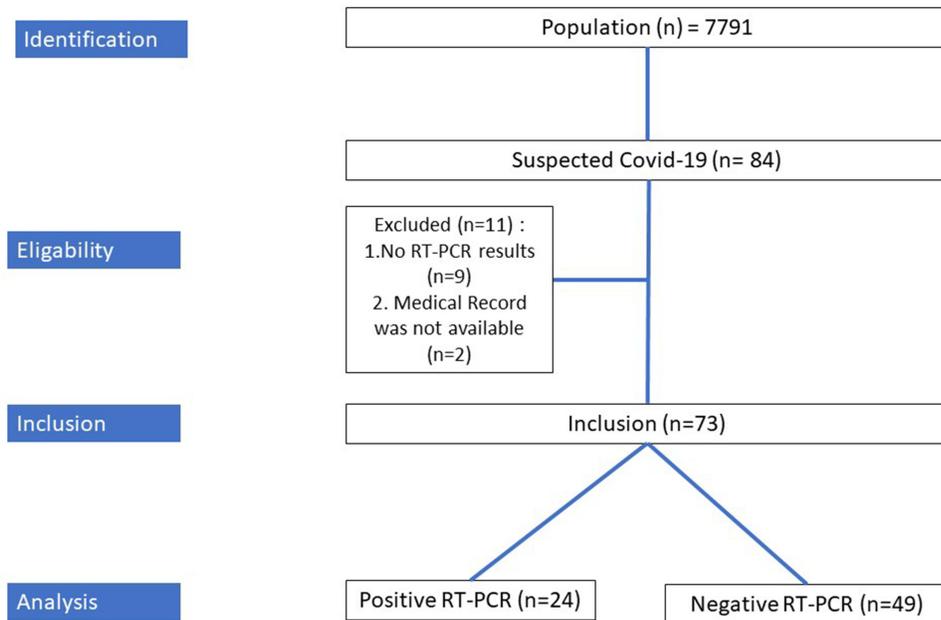


Figure 1 Strengthening the reporting of observational studies in epidemiology (STROBE) diagram. Adapted by permission from Springer Nature, Aging Clinical and Experimental Research Bolignano D, Mattace-Raso F, Torino C, et al. The quality of reporting in clinical research: the CONSORT and STROBE initiatives. Aging Clin Exp Res. 2013;25(1):9-15, COPYRIGHT 2013.²⁴

Most of the suspected cases came from Java Island (91.8%), with a center in East Java reporting the most cases (n=28 cases), and secondly the capital, Jakarta (Figure 2).

Most cases were managed using general anesthesia (90.4%), and patients were intubated (80.8%). The use of video laryngoscope was at 40%, and 28.8% of intubation was done using the rapid sequence protocol. Most cases were done

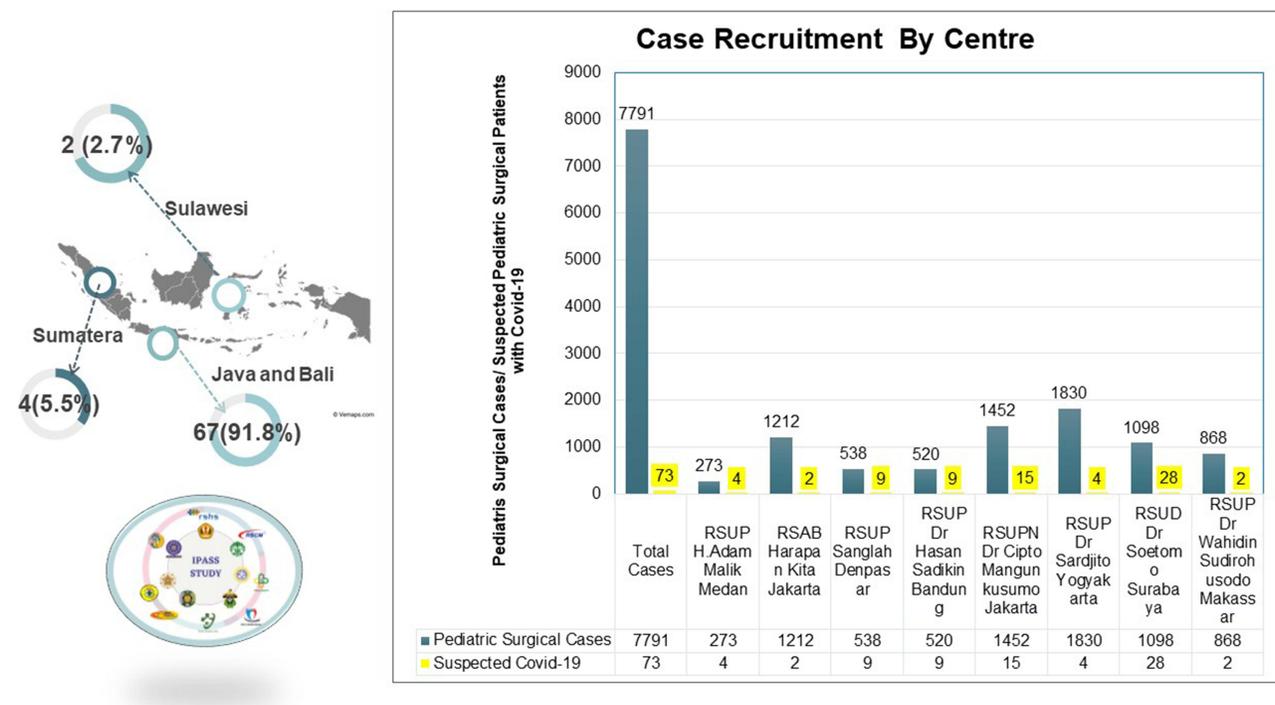


Figure 2 Indonesian area distribution of pediatric surgical cases with suspected COVID-19 infection. **Abbreviations:** RSUP, rumah sakit umum pusat (national referral and teaching hospital); RSUD, rumah sakit umum daerah (provincial referral and teaching hospital); RSAB, rumah sakit anak dan bunda (provincial mother and child referral hospital).

Table 1 Pediatric Anesthesia Services for Suspected and Confirmed COVID-19 Patients in Indonesian Referral Hospitals

Variable	n=73
Anesthesia Procedure	
General anesthesia	66 (90.4%)
Regional anesthesia or blocks	6 (8.2%)
Monitored anesthesia care	1 (1.4%)
Intubation	
Intubated	59 (80.8%)
If intubated, use of video laryngoscope	24 (40%)
If intubated, use of rapid sequence intubation	17 (28.8%)
Not intubated	14 (19.2%)
Pandemic Infection Control	
Level 3 personnel protection equipment	
Yes	54 (74%)
No	19 (26%)
Timing of polymerase chain reaction testing	
24 hours	37 (50.6%)
1–3 days	26 (35.6%)
>3 days	10 (13.8%)
Use of negative pressure infectious operating room	
Yes	45 (61.6%)
No	28 (38.4%)
Cases	
Confirmed	24 (32.9%)
Discarded	49 (67.1%)

using level 3 personal protective equipment (PPE) (74%). RT-PCR results were available within 24 hours in 50.6% of the cases, and 61.6% of the patients were done in a negative chamber operating room (Table 1).

This study recorded 24 confirmed COVID-19 cases in the preoperative period with an incidence of 0.3% (24 patients/7791 pediatric surgical cases). Most cases were female (58.3%), over 12 years old (37.5%) and asymptomatic (62.5%). A positive antibody test for SARS-CoV-2 was found in 50% of the cases, and most radiological imaging was normal (70.8%). Clinically, 33.3% of the patients required oxygen supplementation, with the lowest saturation recorded (92–98%) at 58.3%, and 12.5% of the patients required mechanical ventilation. General pediatric laparotomy surgery was the most common type of surgical procedure (33.3%), and most procedures were emergency or urgent surgery (50%; 33.3%). Most patients were discharged to the COVID-19 inpatient ward, with a mean length of stay of 12 ±13.3 days. In-hospital mortality was 8.3% among COVID-19-positive pediatric patients undergoing surgery (Table 2).

A comparison was made between the two groups of patients: patients with positive SARS-CoV-2 results (confirmed) and patients with negative SARS-CoV-2 results (discarded). More patients in the negative group had more pneumonia in chest radiological examinations (29.2% vs 69.4%), more oxygen requirements (33.3% vs 61.2%), lower saturation (58.3% vs 85.7%), more admission to ICU (29.2% vs 57.1%) and higher mortality (8.3% vs 24.5%) (Table 3).

Discussion

Our multicenter study was the first to describe the prevalence of pediatric COVID-19 among general pediatric surgical patients in a low-middle-income country (LMIC), which would be relevant to surgeons and anesthesiologists in other LMICs, especially in regards to mitigating the possibility of another emerging disease in the future. There are some limitations in our study. Although this was a multicenter study, we did not include all 12 COVID-19 referral hospitals in Indonesia. Secondly, there is the possibility of bias in data entry; hence, not all pediatric surgical patients with or without suspected COVID-19 were included in the database. Thirdly, there is a possibility that there are patients who were

Table 2 Characteristics of Confirmed COVID-19 Pediatric Patients Undergoing Surgery in Indonesia

Variable	n=24
Confirmed Cases	24 (32.9%)
Incidence (24 confirmed/7791 cases)	0.3%
Sex	
Male	10 (41.7%)
Female	14 (58.3%)
Age (Years)	
0	3 (12.5%)
1–2	5 (20.8%)
2–4	1 (4.2%)
5–12	6 (25.0%)
>12	9 (37.5%)
Symptoms	
Symptomatic	9 (37.5%)
Asymptomatic	15 (62.5%)
Typical Symptoms	
Fever	5 (20.8%)
Cough	4 (16.7%)
Dyspnea	3 (12.5%)
Rapid SARS-CoV-2 Antibody Test Result	
Positive	12 (50.0%)
Negative	12 (50.0%)
Suspicious Chest X-Ray	
Yes	7 (29.2%)
No	17 (70.8%)
Positive Contact History	
Yes	6 (25.0%)
No	18 (75.0%)
Comorbidities	
Cancer	2 (8.3%)
Cardiac	1 (4.2%)
Prematurity	1 (4.2%)
Others	2 (8.3%)
Body Mass Index (kg/m²)	
<17.5	12 (50.0%)
17.5–25.0	1 (4.2%)
>25.0	11 (45.8%)
Oxygen Supplementation	
No	16 (66.7%)
Yes	8 (33.3%)
Mechanically Ventilated	
No	21 (87.5%)
Yes	3 (12.5%)
Lowest Oxygen Saturation Recorded (%)	
>98	10 (41.7%)
92–98	14 (58.3%)
Surgery	
General surgery	8 (33.3%)
Ear nose and throat	1 (4.2%)
Neurosurgery	9 (37.5%)
Cardiothoracic	0 (0.0%)

(Continued)

Table 2 (Continued).

Variable	n=24
Obstetric	3 (12.5%)
Urologic	2 (8.3%)
Orthopedic	0 (0.0%)
Other	1 (4.2%)
Type of Anesthesia	
General	20 (83.3%)
Regional	3 (12.5%)
Monitored anesthesia care	0 (0.0%)
Others	1 (4.2%)
Post-op Discharge	
COVID-19 ward	17 (70.8%)
Intensive care	7 (29.2%)
Hospital Discharge	
Mean±Std	12±13.3 Days
Discharged Conditions	
Alive	22 (91.7%)
Dead	2 (8.3%)

Table 3 Comparison of Pediatric Patients with Positive SARS-CoV-2 Results (Confirmed) and Patients with Negative SARS-CoV-2 Results (Discarded) Undergoing Surgery

Variable	PCR	
	Positive Group (n=24)	Negative Group (n=49)
General Characteristics		
Sex		
Male	10(41.7%)	26(53.1%)
Female	14(58.3%)	23(46.9%)
Age (years)		
0	3(12.5%)	2(4.1%)
1–2	5(20.8%)	14(28.6%)
2–4	1(4.2%)	4(8.2%)
5–12	6(25.0%)	8(16.3%)
>12	9(37.5%)	21(42.9%)
Comorbidity		
Hypertension	0(0.0%)	1(2.0%)
Diabetes	0(0.0%)	0(0.0%)
Asthma	0(0.0%)	0(0.0%)
Cancer	2(8.3%)	1(2.0%)
Chronic kidney disease	0(0.0%)	0(0.0%)
Cardiac	1(4.2%)	0(0.0%)
Immune-related diseases	0(0.0%)	0(0.0%)
Prematurity	1(4.2%)	0(0.0%)
Others	2(8.3%)	10(20.4%)

(Continued)

Table 3 (Continued).

Variable	PCR	
	Positive Group (n=24)	Negative Group (n=49)
Body Mass Index (kg/m²)		
<17.5	12(50.0%)	19(38.8%)
17.5–25.0	1(4.2%)	7(14.3%)
>25.0	11(45.8%)	23(46.9%)
Rapid Antibody Testing		
Positive	12(50.0%)	26(53.1%)
Negative	12(50.0%)	23(46.9%)
Pneumonia on Chest Imaging		
Yes	7(29.2%)	34(69.4%)
No	17(70.8%)	15(30.6%)
Positive Contact History		
Yes	6(25.0%)	37(75.5%)
No	18(75.0%)	12(24.5%)
Case Severity		
ASA Class		
I–II	12(50.0%)	16(32.7%)
III	8(33.3%)	30(61.2%)
>IV	3(12.5%)	2(4.1%)
Not available	1(4.2%)	1(2.0%)
Oxygen Supplementation		
No	16(66.7%)	28(57.1%)
Yes	8(33.3%)	21(42.9%)
Mechanically Intubated		
No	21(87.5%)	47(95.9%)
Yes	3(12.5%)	1(2.0%)
Not available	0(0.0%)	1(2.0%)
Lowest Recorded Oxygen Saturation (%)		
>98	10(41.7%)	7(14.3%)
92–98	14(58.3%)	42(85.7%)
Leucocyte, /mm³	10,672±5000	15,923±8090
Outcome		
Post-op Discharge		
COVID-19 ward	17(70.8%)	19(38.8%)
Intensive care	7(29.2%)	28(57.1%)
Not available	0(0.0%)	2(4.1%)
Length of Stay		
Mean±Std	11.90±13.357	10.83±10.261
Discharged		
Alive	22(91.7%)	37(75.5%)
Dead	2(8.3%)	12(24.5%)

operated in private hospitals, which is beyond the scope of this paper. Hence, this study's 0.3% incidence of pediatric surgical patients with COVID-19 cannot be generalized.

Our results are compared with a similar multicenter registry in a similar time frame in early 2020 in several countries. This study included three United children's hospitals that resulted in 12 COVID-19-positive patients from 1295 pediatric surgical patients with an incidence of 0.22%.¹⁶ Another single-center study in Texas from April to August 2020 found

one of the highest records of 66 confirmed pediatric surgical patients with COVID-19. However, this study did not provide the total of pediatric surgical performed during that period, so the incidence was not calculated.¹⁷ Although WHO data show that during early 2020 infection rates in the US were three times higher than in Indonesia during the same period, our comparison shows that the incidence is somewhat similar.^{1,2} It is to be noted that the incidence of cases in our study and other comparative studies was small. There are several possible reasons why the incidence is low. One is that COVID-19 is more commonly found in adults, there are higher false-negative results owing to technical difficulties in performing swab tests, and a more deficient expression enzyme angiotensin-converting enzyme (ACE2) cell surface serves as the SARS-CoV-2 entry point in the nasal epithelium of children.^{4-6,15-17} Another possibility is the success of the lockdown protocols worldwide during the early phase of the pandemic, where schools were closed quickly so that infection transmissions were stopped. Hence, lockdowns in pandemic are essential to protect high-risk populations such as children and to slow down infection rates, in order to provide a timeframe for health services to start disaster protocols including surgery disaster protocols and planning.^{3-6,16-18}

Another finding in our study was that most COVID-19-positive patients were asymptomatic, and negative COVID-19 patients had more symptoms and higher severity and had worse outcomes. This description should be interpreted carefully since our study has some limitations. First, there were insufficient data to perform a statistical analysis of the differences in symptoms and outcomes. Since there were fewer pediatric patients in general in early 2020, a future study should include a multinational study to gather more patients. Second, although there were changes in workflow in each hospital to face the pandemic, the Indonesian Ministry of Health has issued guidelines on the management of COVID-19.¹⁵ However, each participating center in our study used different sets of clinical criteria to triage patients during the first wave of the pandemic. This triage generally consisted of a standardized triage questionnaire and assessment by a specific infection assessment team appointed by each hospital and known nationally as the *tim penyakit infeksi new-emerging dan reemerging* (Pinere).

Screening consisted mainly of positive contact history, presence of symptoms such as fever and cough, suspicious laboratory results, suspicious chest radiological examination, or a positive SARS-CoV-2 antibody or antigen test. In the early stages of the pandemic, COVID-19 patients were symptomatic, and those with respiratory symptoms that appeared during admission to the emergency room were quickly triaged as suspected COVID-19 patients. Only recent studies and understanding show that most pediatric patients were asymptomatic and that the sensitivity and specificity of many questionnaire-based triages are weak compared to RT-PCR.^{5,6,10,16,17} Further study is needed on whether asymptomatic children transmit COVID-19; hence, preoperative SARS-CoV-2 PCR testing is still deemed necessary for the time being.^{10,18}

The general impression of emergency surgery for pediatric patients with COVID-19, during the first wave of the pandemic, was alarming. Many surgeries were not performed in the recommended negative pressure operating room, guided intubation using the recommended video laryngoscope and rapid sequence was not common, and some surgeries were done without the recommended level 3 PPE.¹⁹⁻²¹ Possible reasons for this finding could primarily relate to the preparedness of a country's general healthcare system to face a pandemic. Studies have shown that national and hospital preparedness in many countries around the world, including Indonesia, is inadequate, with general issues such as the provision of onsite testing for SARS-CoV-2, availability of PPE, regulations in protection for health care workers, availability of isolation facilities and conflicting roles of agencies.^{22,23}

Since symptoms, radiological and laboratory results are not adequate to screen for COVID-19 in the perioperative period, there is an urgent requirement for general and rapid sensitive and specific testing for hospitals that provide emergency screening in the preoperative period if another emerging disease appears. When rapid point-of-care antigen testing with high specificity and sensitivity is not available, it is inevitable that PPE and infectious disease operating rooms will be overused owing to false-positive screening. If such a pandemic should happen again in the future, a strategy that seems to protect children is an early lockdown. However, as the pandemic continues to evolve through 2022, with new variants of the SARS-CoV-2 virus emerging and vaccinations in children being carried out, it will be interesting to continue observing the dynamics between the COVID-19 pandemic and pediatric surgery.

Conclusion

The incidence of COVID-19 in pediatric surgical patients is below, and most patients are asymptomatic. Provision of rapid point-of-care antigen testing with high specificity and sensitivity for perioperative screening for emergency surgery is critical during a pandemic.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflict of interest.

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