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COVID-19 pandemic implications in paediatric and congenital heart surgery in Brazil

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Abstract

Introduction: The Coronavirus Disease 2019 (COVID-19) pandemic negatively impacted global healthcare. Consequences in Pediatric and Congenital Heart Surgery programmes and mortality of congenital heart patients infected with severe acute respiratory syndrome coronavirus-2 (SARS-Cov-2) is still to be determined. *Objective:* To study the COVID-19 pandemic implications in Brazilian Pediatric and Congenital Heart Surgery programmes. *Methods:* We conducted a national online survey covering all states that perform Pediatric and Congenital Heart Surgery from 10 November to 22 November, 2020, using a Google forms questionnaire. We formulated questions related to impact on surgical volume, case-mix, and mortality. Then we asked about short-term post-operative COVID-19 infection and outcomes. *Results:* We received responses from 46 centres representing all states where there were a Pediatric and Congenital Heart Surgery programme and all high-volume centres across the country. All but one centre experienced a significant decrease in surgical volume, and 23.9% of the responders revealed less than one-quarter of volume decrement. On the other hand, in over 70% of the centres, there was a significant surgical volume reduction. In addition to this, there was a shift in case-mix in 41 centres (89.1%) towards more complex cases. More than one-third of the responders revealed increased mortality in 2020 compared to previous years, and 43.5% of the programmes (20 centres) had at least one patient contaminated by SARS-Cov-2, accounting for 48 patients. Mortality in post-operative infected patients was 45.8% (22 patients). *Conclusions:* In general, Brazilian Pediatric and Congenital Heart Surgery programmes were severely affected by decreased surgical volume, unbalanced case-mix towards more complex cases, and increased mortality. Almost half of the programmes related post-operative COVID-19 contamination with high mortality.

The Coronavirus Disease 2019 (COVID-19) is a respiratory disease caused by the new coronavirus (severe acute respiratory syndrome coronavirus-2 [SARS-Cov-2]) firstly described in December 2019, in the province of Wuhan, China, that rapidly spread worldwide with a high transmission rate leading to an escalating number of deaths and hospitalisations requiring intensive care and ventilation support, jeopardising every healthcare system in the world.[1-3]

On 30 January, 2020, the World Health Organization declared a COVID-19 outbreak.[4] The first imported case of COVID-19 in Brazil was confirmed in March 2020. Currently, Brazil is the third most affected country by the pandemic, with over 8 million cases and more than 220,000 deaths.[5]

Infection and hospitalisation among children and adolescents due to COVID-19 is less than 3% of the total of cases and less than 1% of mortality. Still, mortality has been reported in children less than 1 month of age.[6,7]

Despite the low rate of contamination, hospitalisation, and mortality in children, there was global concern and warning to cancel or postpone all elective surgeries, including paediatric, due to the risk of contamination, risk of resources'scarcity, and lack of disease knowledge.[8,9]

CHD is a public health issue. Nearby, 19% of the deaths in early childhood are caused by congenital malformations, and most of them are related to CHD.[10,11] In Brazil, out of 27 states, there are 22 states in which Pediatric and Congenital Heart Surgery is performed. Nevertheless, even before the pandemic, there was a national alarm about children dying because Pediatric and Congenital Heart Surgery surgical volume in Brazil was not enough, with a deficit in response to demand close to 50%.[11]

Pediatric and Congenital Heart Surgery programmes worldwide were concerned due to their patients' unique particularities.[12,8] A survey performed by the COVID-19 International Congenital Heart Surgery Taskforce identified a significant surgical volume impact in 52 countries.[12]

In many regions of Brazil, the Pediatric and Congenital Cardiac Surgery programmes have been pressured to decrease the surgical volume due to limited resources such as staff and supplies needed for adults, but this reduction has not yet been measured.

The present survey aimed to study the COVID-19 pandemic implications on Pediatric and Congenital Heart Surgery Brazilian programmes and estimate the number of post-operative SARS-Cov-2 contaminations and its mortality in Brazil.

Methods

This study represents a national Brazilian cross-sectional observational survey performed from 10 November to 22 November, 2020, using the Google forms platform. We managed to get responses from the most extensive programmes and all states that perform Pediatric and Congenital Heart Surgery in Brazil. The study was conducted by the Heart Institute of São Paulo University (InCor), São Paulo, Brazil, and the Pediatric and Congenital Cardiovascular Surgery Department from the Brazilian Society of Cardiovascular Surgery. The institutional review board and ethics committee approved the study.

Data source collection

The data were collected through an online survey with a simple questionnaire to reduce the chance of missing data and to engage more responders. We got a total of 46 responders from 22 states. The participants answered an identified questionnaire, so it was possible to exclude duplicates.

We posed a series of questions: 1. Program name; 2. In what state is it located? 3. Was there a surgical volume reduction due to the pandemic? 4. When was your surgical volume mostly reduced? 5. When was the normalisation of surgical volume? 6. Was there a change in the demographic profile and case-mix of cases? 7. Was there an impact on the outcomes? 8. Were there cases diagnosed with COVID-19 in the post-operative period? 9. What was the outcome in COVID-19 infected patients in the post-operative period?

Any doubts about any specific data were clarified by direct contact with centres.

Statistical analysis

Standard descriptive statistics were calculated. Data are presented in absolute numbers and percentages. For statistical analysis, we used the software SPSS 21.0.

Results

We received a response from 46 programmes from 22 states. Most responses were from the southwest (21; 44.7%), reflecting the distribution of Pediatric and Congenital Heart Surgery in Brazil (Fig 1). Only one centre (2.2%) reported not experiencing an impact on surgical volume during the pandemic. In all other programmes, surgical volume was decreased from less than one-quarter (23.9%) till reaching up to more than 75% reduction in eight centres (17.4%) (Fig 2; panel A).

The majority of the programmes referred that the timespan between April and June was where the most substantial impact took place (Fig 2, panel B). In July, the Brazilian Pediatric and Congenital Heart Surgery centres began to observe a normalisation in surgical volume. Still, in November 2020, one-third of Brazilian centres have not had their programmes back to normal (Fig 2, panel C).

Figure 1. Illustration of Brazilian map showing the distribution of questionnaire responders.

There was a shift in the case-mix profile with 89.1% of the centres reporting more complex surgeries due to cancellation of elective surgeries. As a consequence, 37% of the centres reported increased mortality during the pandemic period.

Nearly half (43.5%) of the programmes had at least one patient with SARS-Cov-2 contamination in the post-operative period. Responders referred that the number of COVID-19 positive cases varied from one to five in each centre with positive cases. Overall there were 48 infected patients in the Pediatric and Congenital Heart Surgery post-operative period in the Brazilian Pediatric and Congenital Heart Surgery programmes from March 2020 to November 2020.

Due to the small number of cases in each centre, mortality among centres exhibited a wide variation from 0 to 100%. There was a 45.8% (22 patients) mortality rate in COVID-19 positive cases in the post-operative period of Pediatric and Congenital Heart Surgery in Brazil (Table 1). There was not a clear relation between pre-operative surgical risk and mortality due to COVID-19 post-operative infection.

Comment

Brazil ranks number 6 in the most populated countries according to the worldometer, and Brazilian citizens represents 2.73% of the global population.[13] The prevalence of CHD is estimated at 9:1.000 births, which accounts for approximately 25.000 new CHD cases per year in Brazil.[14] The biggest Latin American country is divided into five regions with 27 states, and there are 22 states in which Pediatric and Congenital Heart Surgery is performed. Nevertheless, there is a deficit in response to demand close to half.[11]

Brazil is the second most affected country by the pandemic, with more than 12 million cases.[5] As in the rest of the world, the Brazilian healthcare infrastructure is also facing a massive

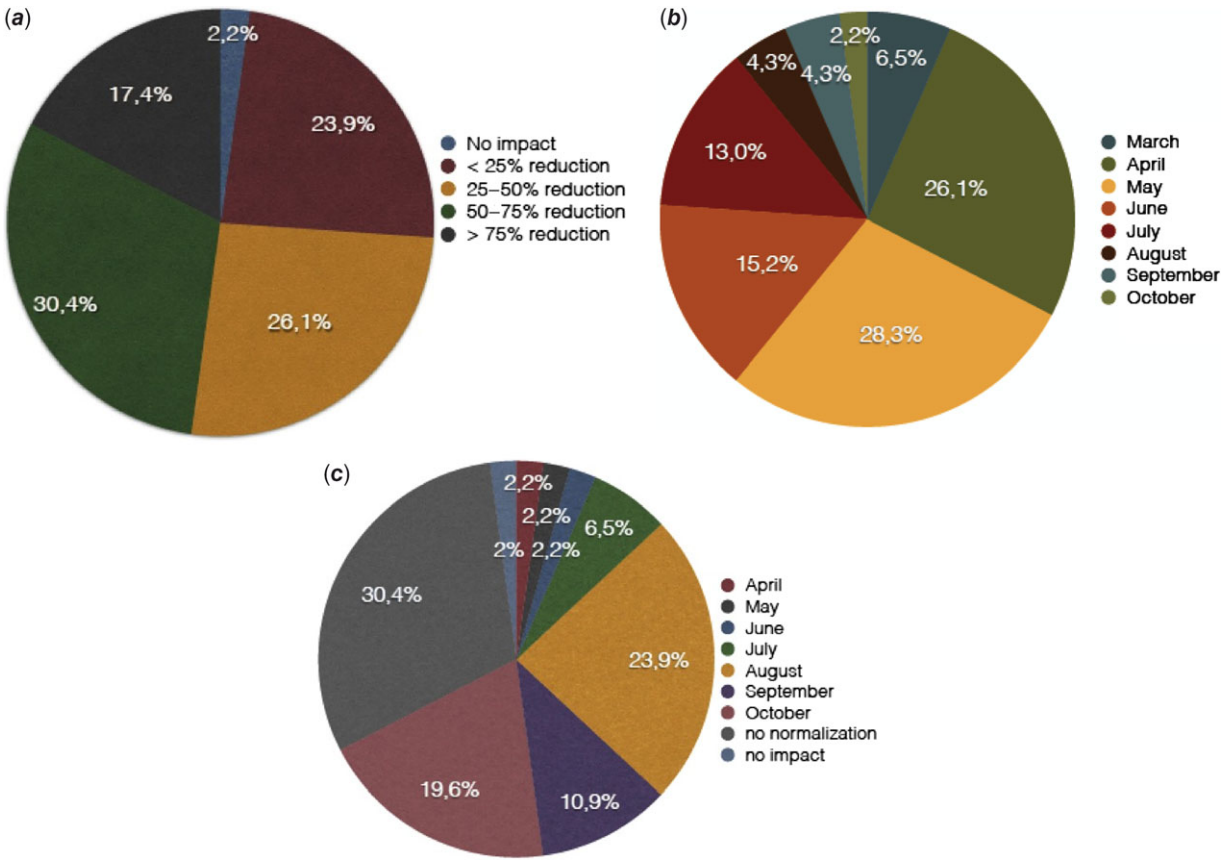

Figure 2. Questionnaire answers: panel A – Did you notice any change in Pediatric and Congenital Heart Surgery surgical volume? B – When did you notice the greatest impact regarding surgical volume? C – When did you manage to return your surgical volume to full capacity?

challenge with the COVID-19 pandemic, and CHD patients were no exception. Patients avoided going to medical facilities due to fear of catching the deadly condition or as an unintended consequence of "*stay-at-home*" orders.

This delay in seeking medical care has drastically decreased emergency room visits for non-COVID-19 conditions such as appendicitis, heart attack, stroke, and other diseases, including CHD decompensations. Elective surgeries were postponed or cancelled, including those for CHD. Due to limited resources as staff and supplies needed for adults, the Health Ministry and the Brazilian Society of Cardiovascular Surgery recommended cancelling elective surgery that was the major surgical volume.[9] It was not just a local recommendation, but it was a global advice.[8]

In the present scenario, it is essential to understand the pandemic's impact on the national Pediatric and Congenital Heart Surgery programmes that are known to be insufficient to meet CHD demand.

Almost all Brazilian centres were affected in some way by the pandemic, both in terms of the volume and complexity of the cases treated. In 17.4% of the centres, less than one-quarter of the staff caring CHD remained active.

At the beginning of the pandemic, there were no screening protocols for two reasons: 1 – unknown disease; and 2 – logistical issue, low availability of tests.[15]

Institutional protocols have been established to prevent infection of patients both in the pre- and post-operative periods. In the most extensive Brazilin Pediatric and Congenital Heart Surgery programme, the protocol suffered constant improvements as the pandemic evolved, but a significant impact on surgical volume and case-mix could not be avoided.[15]

Many protocols and guidelines have been proposed worldwide to establish a perioperative management issue for patients with CHD.[12,16,17] The similarity of the protocols is pre-operative screening for COVID-19, separation of wards between COVID-19-free patients, and suspects avoiding contamination risks. Nevertheless, contamination risks apparently came from all over the places, like patients relatives, healthcare workers, and other patients.

During the peak of the pandemic's first wave between April and June 2020, the most significant impact was observed. There was a need to offset the expense of supplements, and hospital beds were saved for potential COVID-19 patients that could be useful at a time when little was known about the new disease.[4]

Accordingly, we observed that Brazilian centres were mostly impacted between April and June 2020. Although there was a declined number of cases and deaths since July 2020, one-third of Brazilian programmes have not had their volume back to normal as of November 2020.

Reduction in surgical volume and post-operative contamination risks apparently had nothing to do with the centres size or volume. It seemed that the higher the contamination rate in the community, the worse the situation inside the hospital. Said that, most post-operative contaminations occurred in the north of Brazil (Amazon area) and in São Paulo, respectively, the lowest and higher income areas in Brazil.

In December 2020, many countries around the globe, including Brazil, were struck by a devastating pandemic second wave with an

Table 1. Distribution of the mortality according to performed procedures prior to COVID-19 confirmation

SURGERY	Number of cases	Mortality, n (%)
Bidirectional cavopulmonary anastomosis	9	4 (44.4%)
Ventricular septal defect repair	7	3 (42.9%)
Fontan	3	0 (0%)
Norwood	3	0 (0%)
Blalock–Taussig shunt	2	2 (100%)
Total anomalous pulmonary venous connection repair	2	2 (100%)
Complete atrioventricular septal defect repair	2	1 (50%)
Right ventricle to pulmonary artery conduit replacement	2	1 (50%)
Tetralogy of Fallot repair	2	1 (50%)
Mitral valve repair	2	1 (50%)
Atrial septal defect repair	1	1 (100%)
Partial atrioventricular septal defect repair	1	1 (100%)
Partial anomalous pulmonary venous connection repair	1	0 (0%)
Pulmonary artery banding	2	1 (50%)
Aortic coarctation repair	1	0 (0%)
Pulmonary valve replacement + mitral valve repair	1	1 (100%)
Heart transplant	1	1 (100%)
Arterial switch operation	1	0 (0%)
Interrupted aortic arch repair	1	0 (0%)
Pulmonary artery + ventricular septal defect repair	1	0 (0%)
Hypoplastic left heart syndrome hybrid approach	1	1 (100%)
Endocarditis	1	1 (100%)
Pacemaker implant	1	0 (0%)
Total	48	22 (45.8%)

increased number of cases and deaths and its impact is still to be understood.[18]

As expected, the present study demonstrated a significant COVID-19 pandemic impact on Brazilian Pediatric and Congenital Heart Surgery programmes such as surgical volume reduction and increasing complexity of the surgical case-mix. Along with all these implications, a considerable increment in mortality was observed in over one-third (37%) of the centres. Elevated mortality associated with the pandemic period may cause moral distress and anxiety in healthcare workers.[19]

Patients with CHD are known to be at increased risk of complications with COVID-19.[20] In our study, we observed a high number of infected patients in the post-operative period (48 patients) with a significant mortality rate of 45.8%. There were all sorts of presentations, from positive and asymptomatic patients to hypoxemic and respiratory insufficiency due to COVID-19.

It is hard to give a precise information regarding the cause of death in these patients, because autopsies are not being performed in Brazil since the pandemic beginning. However, as far as we could collect from the data, post-operative contaminated patients who survived had mild or asymptomatic presentations.

It is reported that inflammation adds an additional risk of complications in patients infected by SARS-CoV-2. Obese and diabetic patients are exhibiting higher mortality rates.[20] Surgical trauma associated with cardiopulmonary bypass enhances the inflammatory response[21] and may explain these high mortality rates observed in COVID-19-infected patients in Pediatric and Congenital Heart Surgery post-operative.

At the beginning of the pandemic, Nepogodiev et al. demonstrated 34% mortality rate in cardiac surgery patients infected by SARS-COV-2 in the perioperative period. When pulmonary complications occurred, 30-day mortality went up to above 90%.[22]

COVID-19 infections in the post-operative period of congenital cardiac surgery is poorly documented in the literature.[23] In the Global Multi-Societal Consortium, which analysed the pandemic's initial impact on several Pediatric and Congenital Heart Surgery in 176 centres in 52 countries on 6 continents, infection in the post-operative period was reported in only 3 centres.[12]

With increasingly safer protocols and guidelines (pre- and post-operative), surgical outcomes for CHD can be nearly close to those of the pre-COVID-19 era, as demonstrated in some centres.[24]

Pediatric and Congenital Heart Surgery will face the challenge of dealing with late referrals and patients with cancelled and postponed surgeries. New studies will be welcome to demonstrate the real impact on morbidity and mortality among CHD patients with delayed surgical repair.

In conclusion, the COVID-19 pandemic impacted the Brazilian Pediatric and Congenital Heart Surgery programmes with a significant decrease in surgical volume, increased complexity of surgical cases, and, consequently, increased mortality. Post-operative COVID-19 infection occurred in 48 cases, and mortality in infected patients in the post-operative period was much higher than in infected children in other conditions.

The most significant take-home message is that post-operative contamination may add significant risk. Pre-operative testing all surgical cases are of paramount importance, and separate flows in hospitals with COVID-19 patients are mandatory.

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Conflicts of interest. None declared.

Ethical standards. This work complies with the ethical standards of the relevant national guidelines and with the Helsinki Declaration of 1975, as revised in 2008.

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