

IMPACTS OF THE COVID-19 PANDEMIC ON PERFORMING CARDIOVASCULAR SURGICAL PROCEDURES: WHAT WERE THE ALTERNATIVES TO MINIMIZE THE DAMAGE?

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Abstract: This article aims to analyze the implications of the Covid-19 pandemic in carrying out cardiovascular surgical procedures and what alternatives were used by Health Systems to overcome the difficulties encountered. This is an integrative literature review, based on articles found in the MedLine database, through a pre-selection, using the descriptors “Cardiovascular Surgical Procedures” and “Covid-19”, joined by the Boolean operator. The selection of articles was based on a scientific question prepared by the PICO strategy and inclusion and exclusion criteria. Articles were classified by country of study, type of surgery, level of evidence by *Agency for Healthcare Research and Quality* classification, and by the implications and adaptations to the pandemic. A total of 112 articles were found, with 21 articles selected. The United States and United Kingdom prevailed, with a total of 10 articles. The most discussed procedures were heart valve replacement and implantation (23.81%) and congenital heart surgery (14.28%). As impacts of the pandemic were evidenced: the reduction in the number of procedures (85.71%) and the higher mortality (47.62%). As alternatives used to overcome these difficulties, the use of telemedicine (42.86%) and the advance of procedures for patients positive for Covid-19 (38.10%) stand out.

Keywords: COVID-19, Cardiovascular Surgical Procedures, Hospital Administration, Telemedicine, Access to Health Services.

INTRODUCTION

The Covid-19 (SARS-CoV-2) pandemic began at the end of 2019 and brought numerous negative consequences for various sectors of society, among which the health sector stood out ¹. In view of this situation, the establishment of social isolation, the fear of contamination on the part of patients and the prioritization of hospitalization for those

with the new respiratory syndrome affected, in different ways, the performance of other medical procedures^{1,2}.

This context forced global health to reinvent itself in different ways, using strategies such as greater emphasis on telemedicine to deal with social isolation³, the active search for patients who need medical care and the decrease in face-to-face consultations in health environments^{3,4}.

When looking at the scenario of cardiovascular surgeries, several complications were observed, since Covid-19 can trigger cardiac and thrombotic changes, in addition to the fact that patients with cardiovascular comorbidities have a higher risk of adverse outcomes related to infection^{5,6,7}.

Therefore, a reinvention in this scenario was necessary, through the development of strategies aimed at reducing contagion and maintaining or improving the quality of treatment throughout the perioperative period.^{3,5,8} Among these strategies, the protocols that gave preference to emergency and urgent cases reduced attention to the so-called elective frameworks⁹. In this scenario, many prophylactic and non-emergency surgeries were postponed, such as the postponement of elective surgical procedures for neonates with congenital cardiovascular diseases (CHD - acronym in English), in addition to the decrease in hospitalizations due to other cardiovascular conditions, as well as acute coronary syndromes and stroke^{2,9,10,11}.

Faced with the *Lockdown* periods, care for patients with chronic complications was suspended in person, which required the use of telemedicine for them to be attended to, as was done in Italy and planned in sub-Saharan countries, in order to deal with the new reality^{3,8,12}.

In addition, the efforts of cardiac surgery centers to modify the logistics of their departments were notable, from patient

admission to the postoperative period, to reduce the risk of contamination of the professional team¹³, as well as rationalizing the use of personal protective equipment (PPE)¹⁴.

According to Yong *et al.* (2021)¹⁵, there were significant decreases in the volume of cardiovascular procedures that occurred at the beginning of the Covid-19 pandemic, with disproportionate impacts by race, gender and age. Also, Perrin *et al.* (2020)¹⁶ pointed out the psychological aspect as one of the factors responsible for the delay of these patients in seeking medical services. This emotional pressure was also noticed in the medical team¹⁷.

Thus, this study aims to analyze the main challenges encountered in cardiovascular surgical practice, arising from the pandemic context, as well as to verify the procedures implemented and the strategies used to face this crisis in the Health System.

METHODS

This is an integrative review of the literature produced from material available in the Medline database, using the descriptors “Cardiovascular Surgical Procedures” and “Covid-19”, from DeCS, using the Boolean operator “AND”. The searches were carried out between December 15, 2021 and January 15, 2022.

The article selection process consisted of two steps, of which the first, or pre-selection, involved searching the database with filters for complete, citable, national or international articles, with no language restriction, published between 1 January 2020 and December 31, 2021.

From this pre-selection, the articles were individually and carefully analyzed by the authors, who applied the inclusion and exclusion criteria to obtain the selected articles. Inclusion criteria include those that meet the

scientific question formulated through the “PICO” strategy, with the following question: “How did the Covid-19 pandemic impact the performance of cardiovascular surgical procedures and what were the strategies used to face it?”. According to this method, an acronym is formed that promotes the formulation of the scientific question that meets the authors’ demand. In this context, the “P” was defined as the population: “Patients requiring cardiovascular surgeries”; the “I” as the intervention: “Surgical procedures in the face of the pandemic”; the “C” as a comparison: “the performance of cardiovascular surgeries before the pandemic”; and the “O” as the outcome: “Implementations and modifications in cardiovascular surgical practices resulting from the pandemic”.

Articles that have the Covid-19 pandemic as the main complication was another inclusion criterion used. Based on these discriminants, the articles selected in the second stage - the process of inclusion and exclusion of pre-selected articles-, the primary studies were submitted to classification according to the type of cardiovascular surgery they addressed, the target country of study, the implications and adaptations used in procedures as a result of the pandemic.

Finally, the articles were classified into levels of evidence that were proposed, in 1998, by the *Agency for Healthcare Research and Quality* (AHRQ), which divides the articles into 6 levels of evidence: Level 1, meta-analyses of multiple randomized controlled clinical trials; level 2, evidence derived from at least one well-designed randomized controlled clinical trial; level 3, well-designed clinical studies, but without group randomization; level 4, well-designed cohort and case-control studies; level 5, systematic review of descriptive and qualitative studies; level 6, evidence based on only one descriptive or qualitative study; and level 7, opinions of authorities or report of

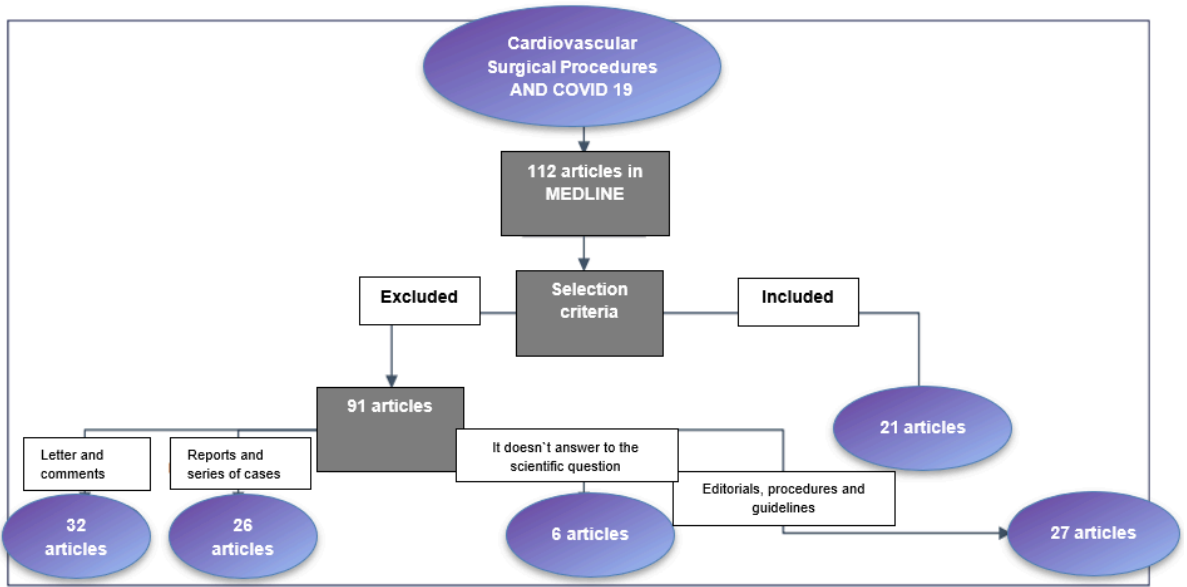
expert committees.

RESULTS

The pre-selection, carried out using the descriptors “Cardiovascular Surgical Procedures” and “Covid-19”, joined by the Boolean operator “AND”, together with the highlighted filters, was contemplated with 112 articles from the Medline database. Then, the article selection process was carried out based on the inclusion and exclusion criteria and the formulated scientific question. This process was responsible for excluding a total of 91 articles. Of the excluded articles, those with a low level of evidence stand out, that is, letters and comments, which covered 32 articles (35.16%); followed by reports and case series, with 26 articles excluded (28.57%) and by those that do not answer the scientific question, with 6 articles excluded (6.59%). The rest was composed mainly of editorials, procedures and guidelines. These steps can be seen in Flowchart 1.

In the analysis of the levels of evidence in the AHRQ standard, no evaluated article had evidence level 1 (0%); 3 had evidence level 2 (14.28%); 1 had evidence level 3 (4.76%); 10 had evidence level 4 (47.62%); 1 had evidence level 5 (4.76%) and 6 articles had evidence level 6 (28.57%). No articles with level of evidence 7 were accepted, since they had very low scientific evidence, thus complying with one of the adopted exclusion criteria.

Thus, 21 articles that met the scientific question and the inclusion and exclusion criteria were selected. These publications were located based on the region where the studies were carried out and data were collected, which are sequenced in descending order of the number of articles included: 5 in the United States (23.81%); 5 in the United Kingdom (23.81%); 3 in Italy (14.28%); 2 in Germany (9.52%); and China, Spain, Switzerland, Turkey and Israel, with 1 article each (4.76%),



Flowchart 1: Schematic representation of the pre-selection and selection of articles from the descriptors and selection criteria.

as well as 1 article that addressed the world situation of these surgical procedures. The absence of studies of this nature in Brazil makes clear the need for discussion on the topic addressed in the present study.

Regarding the type of surgery highlighted in the selected articles, 8 articles are not limited to a specific type of heart surgery (38.10%), 5 are replacement and implantation of the aortic valve (23.81%), 3 of congenital heart surgery (14.28%), as well as heart transplantation (14.28%) and 1 of implantation of a left ventricular assist device (4.76%), the same observed with 1 article, which treated myocardial reperfusion (4.76%).

Among the main negative impacts observed in hospitals as a result of the pandemic, there are: reduction in the number of cardiovascular surgical procedures, highlighted by 18 articles (85.71%); higher patient mortality, reported by 10 articles (47.62%), the prevalence of urgent or emergency procedures mentioned in 10 articles (47.62%), higher spending on PPE and tests *polymerase chain reaction* (PCR) for viral RNA (47.62%), as well as the redeployment of health professionals (47.62%). These data and other impacts are shown in Figure 1.



Figure 1: Negative implications of the COVID-19 pandemic on cardiovascular surgical procedures

Implications

A –Reduction in the number of elective cardiovascular surgical procedures

B –Increased patient mortality in the COVID era

C –Increase in urgent and emergency surgeries

D –Increased expenses with PPE and RT-PCR tests

E –Less training

F –Increased fear and anxiety of physicians and patients

G –Redirecting professionals to treat COVID-19 patients

H –Reduction in the number of beds

Regarding the strategies used to circumvent the negative implications of the pandemic, the following points were highlighted: screening of patients by PCR, as well as the use of telemedicine in screening, monitoring and directing patients, reported in 9 articles (42.86%) each, and the advance of procedures for positive patients for Covid-19, present in 8 studies (38.10%). The shorter hospital stays and the increase or preference for minimally invasive procedures and bed adaptations for urgent or emergency surgeries were described in 7 articles (33.33%) each, while the reduction in the number or time of consultations and returns to the hospital, as well as guidance on pre- or post-surgical self-isolation and team reduction during surgical procedures was discussed in 6 articles (28.57%) each. These data and other implemented measures are shown in Figure 2.



Figure 2: Strategies adopted by hospitals in carrying out cardiovascular surgical

procedures due to the negative implications of the COVID-19 pandemic.

Strategies

- A – Screening of patients by RT-PCR
- B – Postponement of procedures for patients positive for Sars-Cov-2
- C – Shorter hospital stay / Early discharge
- D – Adaptation of beds for urgent and emergency surgeons
- E – Reduction of number or time
- F – Allocation of exclusive rooms for cardiovascular procedures
- G – Use of telemedicine in screening, monitoring and directing patients
- H – Team reduction during the surgical procedure
- I – Prohibition / decrease in follow-up in consultations and during hospitalization
- J – PPE reuse
- K – Pre- and/or post-surgical guidance or self-isolation
- L – Increase or preference for minimally invasive procedures

Finally, regarding the classification of the articles in the topics of negative implications of the pandemic and adaptations to this crisis, it is necessary to point out that the articles presented intersections between the different impacts and adaptations resulting from the pandemic state, that is, the consequences are not limited to specific cases among the demand for cardiac surgical procedures, with many times there being overlap between different types of impacts and adaptations. This explains the higher number of articles observed, if the numbers in each of these topics are added together (Figures 1 and 2).

DISCUSSION

When listing the number of articles that deal with the impacts of the Covid-19 pandemic on the performance of cardiovascular surgeries, as well as the strategies used to mitigate the

situation, it is observed, at the international level, the most used adaptations, as well as the results obtained when dealing with the target audiences of both pathologies - patients with heart diseases or Covid-19 - in times of maximum capacity of intensive beds.

HIGH RISK OF MORTALITY IN CARDIOVASCULAR PATIENTS

Initially, it is important to emphasize that the target audience of our study is considered a risk group for Covid-19, since, in addition to the cardiovascular disorder itself, they tend to have other associated risk factors, such as advanced age and other comorbidities.^{6,7,13,18} For example, Bottio *et al.* (2021)⁶ demonstrated, in a cohort study with patients undergoing heart transplantation, that the prevalence of infection and lethality in this type of procedure corresponded to twice that of the general Italian population, considering only symptomatic patients tested.

The finding of Bottio *et al.* (2021)⁶ can be explained, in part, by the pathological mechanism of the SARS-CoV-2 virus, which leads to an inflammatory and procoagulant condition⁷. Besides, Cormican *et al.* (2021)⁷, demonstrated that patients with heart disease related to the coronavirus or with pre-existing cardiovascular disorders are more likely to have severe manifestations of Covid-19 and an increased risk of mortality.

In the same way, Bottio *et al.* (2021)⁶ observed, in their study with patients positive for Covid-19 undergoing heart transplantation, an intimate relationship between mortality and the severity of the disease, suggesting that the feasibility of performing the surgical procedure must be evaluated individually, taking into consideration, the previous conditions of the patient and the type of procedure to be performed.

IMPLICATIONS AND ADAPTATIONS REGARDING PPE (PERSONAL PROTECTIVE EQUIPMENT)

According to the classification established in Ordinance S.I.T. (WORK INSPECTION DEPARTMENT) number 877, of October 24, 2018, "Personal Protective Equipment - PPE is considered to be any device or product, for individual use, used by the worker to protect him against risks likely to threaten safety and health at work".

For the protection of the safety and health of health service workers, as well as those who carry out health promotion and assistance activities in general, the PPE, disposable or not, must be available in sufficient numbers at work stations, so that immediate supply is guaranteed (Ordinance SEPRT number 915, of July 30, 2019, in Brazil)., However, during the Covid-19 outbreak, these essential materials became scarce, while the values underwent significant changes, often above the resources available for this purpose in various parts of the world, requiring the optimization of available equipment¹.

In this sense, it was observed that the rapid spread of the pandemic prevented health services from being able to adequately prepare to meet the increased demand for PPE^{17,19}. This fact, associated with the lack of adequate instructions for the care of Covid-19 cases¹⁷, justifies the shortage of beds, reported in 28.57% of the articles and an increase in speeding on PPE and PCR tests (47.62% of the articles).

Faced with this resource limitation, strategies have been devised to minimize the expense and waste of PPE¹. In this regard, the proposal to use the "Lean" methodology as a way to generate financial savings and less environmental impact becomes relevant. This methodology was adopted at the Department of Congenital Heart Surgery at *Children's Health Ireland*, through the centralization

of the distribution of PPE in order to better manage its use.. This measure reduced from 13 to 1 set of PPE used per patient¹⁴. Besides, the *American Society of Anesthesiologists* (ASA) allowed anesthesiologists to purchase, on their own, masks N95²⁰. Finally, Latz et al. (2021)¹⁹ reported that 71.4% and 86.4% of the vascular surgeons interviewed reused, respectively, PPE and N95 masks on patients.

In search of better management of beds and equipment and aiming to reduce possible contamination by the virus, cases were prioritized according to criteria established for the screening process, postponing elective cases and anticipating urgent cases, given that the absence of pre-existing guidelines in the management of patients in the period of Covid-19 led to uncertainty about the routes and mechanisms of treatment and consolidation of selection criteria^{8,10}.

REDUCTION IN THE NUMBER OF SURGICAL PROCEDURES

It is necessary to emphasize the importance of professional qualification during the pandemic, when more complex services and a greater number of cases were assigned to more qualified employees, which accelerated care¹², and at the same time protected patients and employees in procedures with a high risk of contagion, like those aerosol generators^{7,12}.

Coyan et al. (2020)²¹ e Latz et al. (2021)¹⁹ stated that there was a significant impairment in the learning of residents in cardiovascular surgery during this period. After stating this, Coyan et al. (2020)²¹ observed that, of the 23 health institutions surveyed, 91% began to carry out their teaching and consultations with cardiovascular surgical residents via telemedicine, while Latz et al. (2020)¹⁹ found that, of the 121 surgeons evaluated, 56% drastically limited their residents' contact with surgical patients.

However, Giamberti et al. (2020)¹⁷ found

a 52% reduction in the number of surgical procedures performed in Italian hospitals specializing in congenital heart surgery. This reveals the adequacy of hospitals to the pandemic situation, where there are greater restrictions on performing elective surgical procedures and an increase in the prioritization of Urgent and Emergency patients^{5,13}.

Another important point to be observed is about surgical procedures performed abroad, which have drastically reduced in the face of the border blockade adopted by some countries. Giamberti *et al.* (2020)¹⁷ reported an 85% reduction in these procedures, which mainly impacts underdeveloped countries, which often do not have the appropriate technological level to care for more complex cardiovascular patients¹².

However, it was observed by Martin *et al.* (2021)⁹ that, after the peak phases of the pandemic, the search for treatment tends to increase significantly, in view of the accumulated cases during this period. This is due, for other reasons, to the higher risk of mortality in this group, due to the delay of procedures, making necessary measures that satisfactorily combat the damage to patients who had their procedures canceled or postponed, aimed at unburdening health services⁹.

FEAR AND ANXIETY IN DOCTORS AND PATIENTS

This scenario of risk of contagion and overload in health services promotes the spread of fear, anxiety and depression, both in patients^{5,16} and in health professionals, since they constitute a relevant portion of the World's cases¹⁹. This emotional impact results in evasion or delay of the patient's contact with medical services, which starts to appear in more advanced conditions in the pathological condition^{3,5}. For example, as reported in the study of Perrin *et al.* (2020)¹⁶, the number of

heart attacks outside the hospital environment tripled, as well as the delay from the first symptom to seeking medical care was twice as high. In both cases, 42% of these effects were attributed to the patient's fear.¹⁶

In this scenario, the emotional impact was a determinant of resilience for the work to be carried out, since the stress caused to health professionals promoted negative impacts on the mental and, consequently, physical health of those involved^{17,22,23}. As an example of this problem, we have the abuse of licit drugs pointed out in the study by Dantas (2020)²² and the growing rate of anguish, depression, anxiety and insomnia evidenced in De Moraes' text (2021)²³.

In addition, misinformation is identified as one of the main causes of discomfort regarding the pandemic, especially in socioeconomically vulnerable populations, who have had worsening access to health¹⁵. This mistrust resulting from the lack of information promoted the fear of patients regarding the hospital environment, being one of the main factors associated with the decrease in demand for cardiovascular care and procedures²⁴.

RESTRUCTURING OF SERVICES AND REALLOCATION OF PROFESSIONALS

The pandemic also led to a reorganization of human resources, in which health professionals had to be reallocated to other services, causing a significant reduction in the number of professionals per team, and preventing, in many contexts, the correct execution and fulfillment of the workday normally scheduled by the service teams¹¹. Taking as an example the analysis of Latz *et al.* (2021)¹⁹, it was noted that 23.7% of vascular surgeons were reassigned to a vascular access service and 18.6% to another service outside the area of vascular surgery. On the other hand,

Giamberti *et al.* (2020)¹⁷ shows that the main groups of professionals deployed to care for patients with Covid-19 were anesthesiologists (57%), nurses (50%), perfusionists (28%) and congenital heart surgeons (7%).

Of the total number of articles evaluated, 33.33% reported that cardiovascular surgical beds were redirected to urgent and emergency surgeries, which was only possible thanks to the reduction in the number of elective surgical procedures and the prioritization of performing surgeries in more serious conditions of health^{9,17}. This alternative had telemedicine as an ally, which began to track emergency cases by monitoring patients at home³.

TELEMEDICINE

Implementing telemedicine for triage¹³, direction¹⁴ and patient monitoring^{6,13,19} was reported in 42.86% of the evaluated articles. Telemedicine, applied both by phone calls and videoconferences, was also used for health education^{12,17,19}, besides contributing to the rationalization of resources¹³.

The adoption of this medical modality was aimed at reducing the probability of admitting positive patients for Covid-19, seeing that not all health institutions have the resources to apply the PCR test to all patients and employees^{13,17,19}. In addition, this alternative reduced the physical contact of patients with each other and with health professionals, preventing the worsening of the pandemic^{3,25}. By reason of this issue, Moreira *et al.* (2021)³ stated that telemedicine had significant use as a patient triage and monitoring tool, enabling the tracking of priority cases.

COMPANIONS AND EXCESSIVE SPENDING

With regard to the strategies used to prevent the admission of people with Covid-19, some

institutions have chosen to prohibit the presence of companions during consultations and hospitalization periods^{17,19}. Such measure, according to Shi *et al.* (2021)²⁶, was intended to systematize the flow of companions for patients hospitalized in Covid-19 areas, ensuring the safety of the patient, companion and health professionals, in addition to being a way to reduce expenses in a pandemic environment. On the other hand, it was reported by Giamberti *et al.* (2020)¹⁷ that 7 of the 15 congenital heart surgery centers in Italy chose to test companions even in the absence of symptoms, which consequently increased hospital costs.

Another alternative for adapting to the pandemic situation, reported in 6 articles (28.57%), was the reduction in the number and duration of consultations. Data from the study of Joseph *et al.* (2021)¹³ showed a significant reduction in the average number of pre-admission hospital visits, in the average time for admission and in the average time from admission to the clinic until the percutaneous transcatheter aortic valve implantation procedure was performed. (TAVI).

ADJUSTMENTS THAT AVOID POST-ADMISSION CONTAGIUM

Due to the needs imposed by the Covid-19 pandemic, strategies aimed at substantially reducing exposure rates to the SARS-CoV-2 virus stand out. Replacing surgeries with minimally invasive procedures, such as percutaneous coronary intervention (PCI) and TAVI^{5,13} was reported in 7 articles (33.33%). These alternatives also help to reduce the likelihood of contamination in the hospital environment, as they require less hospitalization time and less intensive care. Good results were obtained in a comparison between patients undergoing TAVI and patients undergoing surgical replacement.⁵. This strategy also increased bed turnover,

reducing costs and allowing new patients to be received.¹⁶

In this context, Reddavid *et al.* (2022)²⁷ reported an optimization model for TAVI procedures, where patient assessment and TAVI performance occur in the same hospitalization, which makes the procedure faster and optimizes the use of resources. These factors, in a pandemic context, are considered indispensable, since during the perioperative period there is potential for contamination by Covid-19, in addition to the possible aggravation of the patients case.

In addition, 4 articles (19.05%) cited the separation of exclusive places to perform cardiovascular procedures during the pandemic as an alternative to reduce contagion. Although it required a structural reorganization, this was a way to separate this public from environments that received positive patients for Covid-19, in addition to freeing up beds for the most serious patients. Joseph *et al.*, (2021)¹³ reported relocating the TAVI team to a new location as a safe strategy. Giamberti *et al.* (2020)¹⁷ cited the implementation of the model: *hub-and-spoke* in the Lombardy region, and the creation of routes dedicated to patients free of Covid-19 in other Italian units.

PRE- AND POST-OPERATIVE GUIDANCE

Government guidelines were instituted, implementing a national quarantine, especially in Italy, one of the countries most affected by the pandemic¹⁷. This request was reinforced, above all, in the pre-surgical period, to avoid the admission of patients positive for Covid-19, which would result in risks of contagion for professionals and other patients, as well as a waste of time, given the possibility of postponement¹³.

Finally, regarding post-surgical self-isolation guidance, although little reported,

it is addressed in the study of Bottio *et al.* (2021)⁶, in which 15 of the patients who received a heart transplant tested positive for Covid-19 because they were asymptomatic or had mild symptoms. These patients were discharged, and telephone monitoring was maintained for 30 days, with no reduction in the immunosuppressive regimen, managing to present resolution of symptoms without the need for additional treatments.

LIMITATIONS

The predominance of articles with level of evidence 4 and 6, associated with the absence of articles with level of evidence 1, as well as the prevalence of articles from the United States and Europe for the descriptors used, reinforce the need for further studies on the subject. This is possibly due to the fact that the pandemic is relatively recent and the difficulties in developing more complex studies during this period.

CONCLUSION

We observed that the rapid spread of the pandemic brought difficulties in carrying out cardiovascular surgeries, evidenced mainly by the large number of canceled elective surgical procedures, the increase in mortality during the period and adaptations in the use and management of PPE. Thus, the importance of careful screening was noted, using the PCR test, as well as the expansion of the use of telemedicine, in order to reduce the risk of contagion, given the overload in Health Services and the consequent scarcity of beds.

This scenario proved to be challenging, due to the increased pressure on the service of health professionals, who had to quickly adapt to safety protocols and reorganize their services, when there were still no specific Guidelines, or these did not suit the local reality. Besides, many professionals were reassigned to meet the demand for the period.

This context also affected the population, who, like the professionals, had to deal with fear, anxiety and the delay of procedures.

In addition, we noted the tendency to perform less invasive procedures, which require a shorter hospitalization time and less intensive care, reducing potential contagions during the intra-hospital period, increasing bed turnover, and rationalizing resources, cooperating to combat to the reality faced.

In view of this, the information shown here is of paramount importance for hospital managers and the Public Administration,

as they present the main needs of Health Services and possible strategies to mitigate them, with greater efficiency, and may be useful for the remainder of the coronavirus pandemic Covid-19 and future crises in the Health System.

CONFLICTS OF INTEREST

We declared that we don't have any financial, commercial, political, academic or personal conflict of interest.

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