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Francesco ONORATI, Patrick MYERS, Pietro BAJONA, Andrea PERROTTI, Carlos A
MESTRES, Eduard QUINTANA

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Effects of COVID-19 pandemic on cardiac surgery practice in 61 Hospitals worldwide: results of a survey

**Francesco Onorati¹, Patrick Myers², Pietro Bajona³, Andrea Perrotti⁴,
Carlos A. Mestres⁵, Eduard Quintana⁶.**

¹Division of Cardiac Surgery, University of Verona Medical School, Verona, Italy

²CHUV Cardiovascular Surgery, Lausanne, Switzerland

³Allegheny Health Network – Drexel University College of Medicine, Pittsburgh, PA, USA

⁴Department of Cardio-Thoracic Surgery, University Hospital Jean Minjoz, Besançon, France

⁵Department of Cardiovascular Surgery, University Hospital Zürich, Zürich, Switzerland

⁶Hospital Clínic de Barcelona, University of Barcelona Medical School, Barcelona, Spain

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Correspondence:

Francesco Onorati, MD PhD

Division of Cardiac Surgery

University of Verona Medical School

Piazzale A. Stefani n.1, 37126, Verona (Italy)

Tel. 0039 045 812 1945;

Fax: 0039 045 812 3308

E-mail: francesco.onorati@univr.it

ABSTRACT

Background: To investigate the impact of COVID-19 infection on cardiac surgery community and practice. **Methods:** A 43-question survey was sent to cardiac surgery Centres worldwide. The survey analysed the pre-pandemic organization of the Centre, the Centre's response to Covid-19 in terms of re-organization pathways, surveillance methods, personal-protective equipment (PPE), and allowed surgical practice with results. **Results:** Sixty-one out of 64 Centres (95.3%) fulfilled the survey. One third of ICUs were transformed into COVID-19 dedicated-ICUs and one-third moved to another location inside the hospital. Negative-pressure rooms were available in 60.6% Centres. Informative measures from hospital administration were received after the first COVID-19 admitted case in 36.1% and during the spread of the infection inside the hospital in 19.6%. Inadequate supply of PPE was common, with no COVID-surveillance of the medical personnel in 4.9% of Centres. COVID-19 infected 7.4% of staff surgeons, 8.3% of residents and 9.5% of anaesthetists. Cardiac surgery caseload declined in 93.4% Centres. COVID-19 infection in patients receiving cardiac surgery resulted in 41-50% mortality in 9.5% Centres, and 91-100% mortality in 4.7% Centres. Successful weaning with survival from V-V ECMO and V-A ECMO was <50% in 79.2% and 80.0% Centres respectively. COVID-19 infection in transplanted patients was rare, with a reported mortality of 0.5% and 1% in one Centre each. **Conclusions:** There is room for improvement in hospital surveillance, informative measures and PPE to the personnel. These measurements will reduce current spread of COVID-19 infection among medical personnel and patients, helping the rump up of cardiac surgical practice.

Words: 250

Keywords: COVID-19; Cardiac surgery; SARS-CoV-2; ECMO; transplant

Introduction

The new Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered coronavirus, the SARS-CoV-2 [1]. This disease has had a tremendous impact on the global Health Care System. In particular, several medical and surgical specialties have experienced a drop in their practice during pandemic, due to the need for a systematic resource allocation to the fight against the virus-related disease. Cardiac surgery was not spared by these unprecedented changes in hospital pathways [2], so that different Scientific Societies have recently suggested methods, safeguards to correctly reintroduce, and rump up safely cardiac surgical practice [3].

The aim of this study was to analyse the impact of COVID-19 infection on the cardiac surgery community and cardiac surgical practice in different Hospitals worldwide.

Materials and methods

Study design

A 43-question survey (Appendix I) was sent to cardiac surgery centres across the world. Participation was voluntary and anonymized.

Study variables

The survey analysed the pre-pandemic organization of the Centre, as well as the Centre's response to Covid-19 pandemic in terms of resource allocation, re-organization pathways, informative measures, personal-protective equipment (PPE) supply to health-care workers, allowed surgical practice with results, and surveillance methods.

Ethics

The study did not require Institutional Review Board (IRB) approval, as no patients were directly involved in data collection and analysis.

Timeline

The survey was closed on May 17th, 2020, at a time when COVID-19 affected 4,673,809 patients worldwide causing more than 312,000 deaths [4].

Results

Centres and staff

The survey was sent to 64 centres. Sixty-one (95.3%) fulfilled the survey, representing 499 staff cardiac surgeons (median 8 surgeons/Centre), 337 resident surgeons (median 10/University Centre) and 472 dedicated anaesthetists (median 7/Centre). Most of the responses came from cardiac surgeons holding an administrative and/or clinical leadership position at their Institution.

Institutional categorization and geographical distribution

There were 31 (50.8%) university centres, 23 (37.7%) public hospitals, and 7 (11.5%) private hospitals. There were 49 replies from Europe (80.3%; of these, 26.6% were from Italy and from Spain, 12.2% from Switzerland, 10.2% from U.K., 6.1% from France and Portugal, 4.2% from Germany, 2.0% from Ireland, Austria, Finland, and Russia), 4 (6.5%) from USA, 4 (6.5%) from Asia, 3 (5.0%) from Latin America, and 1 (1.7%) from Australia. Of respondents, 75.4% had adult cardiac practice, and 23% mixed adult and paediatric practice.

COVID-19 specific resources

Forty-nine (80.3%) of these Hospitals were locally identified as Regional SARS-CoV-2 Centres, although all admitted COVID-19 patients during the pandemic. From the range perspective, 12 (19.8%) admitted <50 patients and other 12 (19.8%) admitted >500 COVID-19 patients. The precise amount of admission of COVID-19 patients is reported in Figure 1 (panel A).

Post-cardiac surgery ICUs in pre-COVID-19 era were dedicated in 46 (75.4%) and mixed with other surgical specialties in 15 (24.6%). The sum of dedicated beds in post-surgical

ICUs was 834 (median 13), whereas the sum of dedicated beds in the wards was 1770 (median 29). Structural changes inside the Hospitals were reported in Table 1. Of note, almost one third of ICUs were transformed into exclusively dedicated COVID-19 ICUs. One-third of the dedicated post-surgery ICUs moved to another location inside the Hospital to leave their dedicated reanimation beds to COVID-19 patients; despite structural relocation, 31 Institutions (50.8%) still admitted >5 COVID-19 patients in their dedicated post-cardiac surgery ICU (Figure 1 panel B), as well as in the ward (Figure 1 panel C). Negative-pressure rooms inside the ICUs and in the Operating Room Suites were available only in 60.6% of Centres.

Staff information and protection

Fifty-two respondents (85.2%) considered that the Hospital Government provided the staff with adequate information about the biological risks related to the COVID-19 infection. Twenty-seven (44.2%) reported that the information was provided before the first admitted COVID-19 patient, 22 (36.1%) after the first admitted case but in time to limit in-hospital spread, and 12 (19.7%) late, during the spread of the infection inside the hospital. Forty-seven respondents (77%) confirmed that Hospitals supply adequate personal protection equipment (PPE) according to the Guidelines on SARS-CoV-2 from the European Centre for Disease Prevention and Control. The type and percentages of PPE provided in different areas are reported in Figure 2 panels A-C.

Surveillance of the personnel was mainly based on COVID-19 nasal swab, which was indicated in different scenarios according to individual Centres policy (Table 1); similarly, different policies were implemented to screen every newly admitted patient (Table 1).

Thirty-nine out of 499 (7.4%) staff surgeons contracted COVID-19, as well as 28/337 (8.3%) of resident surgeons, and 45/472 (9.5%) staff anaesthetists, the latter being the most hit medical personnel dedicated to cardiac surgery. Incidence varied significantly among

Centres, with 32 Centres (52.4%) having no cases of infected medical personnel, and Centres with a wide range of infection (from 6.6 to 66.6% for staff surgeons, from 8.6 to 50% for resident surgeons, and from 5.8 to 100% for staff anaesthetists).

Cardiac surgical activity

Cardiac surgery caseload declined compared to pre-COVID-19 era in 57 Centres (93.4%); the majority of these experienced a decline of surgical volume of more than 60%, with two Centres totally stopping their practice (Table 1). When priority was considered, almost all Centres were allowed to perform urgent cardiac surgery, and less than half of them continued elective cardiac surgery during the pandemic; interestingly, there were 8 Centres refusing emergent cardiac surgery and 12 Centres refusing salvage procedures (Table 1). Twenty-one Centres (34.4%) reported that COVID-19 disease was then diagnosed in patients receiving cardiac surgery during pandemic: 11 (52.3%) reported that none of these patients died for COVID-19 disease, whereas a mortality range between 1-10%, or 11-20%, or 21-30% or 41-50% was reported in 2 Centres (9.5%) each; finally, a mortality range between 31-40% and 91-100% was reported in one Centre (4.7%) each (Figure 3).

Extracorporeal life support in COVID-19 patients

In 34 Centres (55.7%) veno-venous (V-V) or veno-arterial (V-A) extracorporeal membrane oxygenation (ECMO) support because of COVID-19 disease was required. Of these, 29 only implanted V-V ECMO (85.3%); 24 out of these 29 (82.7%) implanted less than 10 patients; one Centre implanted 26 patients and another one Centre supported 46 patients (Table 1); fifteen Centres (44.1%) implanted V-A ECMO, all with less than 10 patients (Table 1). The need of V-V ECMO was reported in 203 patients (mean of 6 patient/Centre) and the need of V-A ECMO in 25 patients (0.7 patient/ Centre). Although the results of V-V ECMO and V-A ECMO differed significantly between Centres, successful V-V ECMO weaning with subsequent survival was reported to be less than 50% in most of implanting Centres (23/29,

79.2%). Weaning with survival rate <50% was also reported in most Centres implanting V-A ECMO (12/15, 80.0%). Details of the rates of successful weaning with survival after V-V ECMO or V-A ECMO are reported in Table 1.

Transplantation activity

An active cardiac transplant program was present in 30 Centres (49.2%), seven of which (23.3%) stopped it during pandemic. Twenty-one Centres (70.0%) did not experience any COVID-19 infection in cardiac transplanted patients; seven Centres (23.4%) reported infection in one transplant only, and one Centre each (3.3%) in 3 patients and 10 patients respectively. COVID-19-related mortality in these patients was 0.5% in one Centre and 1% in another; all the other participants reported no COVID-19-related mortality in transplanted patients.

Discussion

The COVID-19 pandemic has led to increased morbidity, mortality and reallocation of hospital resources. The disease had impact on every Health Care system worldwide. There have been significant restrictions and changes to common pre-pandemic pathways with an impact not only in cardiac surgery, obliged to defer most of its elective standard practice. A best estimate of 28,404,603 operations of all types cancelled or postponed during the peak 12 weeks of disruption due to COVID-19 was calculated, as per the COVIDSurg Collaborative led by Nepogodiev and Bhangu, who used a Bayesian meta-regression model to estimate cancellation rates for 190 countries [5].

The results of this survey confirm that significant structural changes occurred, from a complete transformation of cardiac surgery-dedicated ICUs into COVID-19-dedicated ICUs in one third of the cases, to a “physical” relocation of the surgery-dedicated ICUs to different areas inside the Hospitals in another third. Despite these changes, surgery-dedicated ICUs

still experienced some rate of admission of COVID-19 patients, either because of the need for cardiac surgery on these patients and of the rising tide of the pandemic in some countries [3].

It is not then a surprise a global decrease in cardiac surgery volumes, experienced by 93.4% of the Centres responding to this survey. This drop in practice ranged between 60 and 100% compared to pre-pandemic practice in 68.8% of the Centres; 2 (3.2%) completely stopped their practice. Patient management differed significantly between countries, as 41% of Centres allowed to continue elective practice, whilst 13.1% and 19.7% of the Centres were not allowed to perform emergent and salvage procedures, respectively. One argument could be the anticipated higher mortality and major morbidity of emergent/salvage procedures requiring significant allocation of resources – in an era when massive hospital resource allocation to COVID-19 disease was implemented – responsible for a triage similar to that applied in medicine during war-time or in catastrophe-hit zones [4,6,7].

An interesting finding of this survey relates to the outcome of COVID-19 disease in patients receiving cardiac surgery before developing it, given that scanty data are reported in the literature. First, the disease was diagnosed in only one third of the Centres continuing to provide cardiac surgery, and half of these Centres reported no COVID-19-related mortality; on the opposite, about one third reported COVID-19-related mortality ranging from 11 to 50%, and 4.5% of Centres a 91-100% mortality. Despite these data have obvious limitations; literature still lacks data on COVID-19-related mortality after cardiac surgery. Our data seem to indicate now a significantly high mortality in operated patients if COVID-19 develops afterwards. Similarly, COVID-19 mortality in V-V ECMO and V-A ECMO seems to be high, confirming previous finding of SARS-related mortality on ECMO between 17 and 50%, with great inter-institutional differences and peaks of mortality as high as 100% [8, 9]. On the other hand, it is surprising that our data on COVID-19-related mortality seem lower in transplanted patients. Our data confirmed the only two published series at the moment,

reporting a 15% and 25% SARS-related mortality respectively in heart transplant recipients [10, 11]. Although it is still unknown how much COVID-19 will challenge this category of patients, it has been suggested that transplantation-related immunosuppression might help mitigate expression of SARS-CoV-2 disease in transplanted patients [12], and that immunosuppressive medications may inhibit in vitro viral replication [13].

There has been a common perception (85.2%) that Hospitals provided adequate information about pandemic and the related biological risks to the staff, although information was provided before the admission of the first COVID-19 patient in less than half of the Centres, and about 20% considered that information arrived late because it was provided only when the disease spread inside the Hospital. Similarly, 77% of respondents reported that Hospitals complied with the Guidelines of the European Centre for Disease Prevention and Control in terms of PPE supplied to the staff. The sub-analysis of PPE provided showed that crucial PPE such as FFP-2 masks were not supplied in about 2 out of 10 ICUs and 3 out of 10 surgical platforms and wards. Similarly, FFP-3 masks were not provided in about half of surgical platforms and ICUs, and in 2 out of 3 wards; again, face shields/goggles were not supplied in 2 out of 10 wards, and water-resistant gowns in about 1 out of 4 surgical platforms and ICUs, and in 2 out of 3 wards.

If these data merge with actual surveillance of the staff, it is not a surprise that 7% of staff surgeons, 8% of resident surgeons and 9.5% of staff anaesthetists had COVID-19 infection. This is because still 5% of Centres have no surveillance at all, and two-thirds of them with active surveillance by nasal swab only check if the staff reported symptoms suggesting COVID-19 or had a contact with a COVID-19 patient. Alternatively, if the staff had contact with newly admitted COVID-19 patients. In 14.8% of patients no swab before admission was done but questionable alternative methods. Forty percent of the Centres had no negative-pressure rooms in ICUs and operating rooms. The data suggest that an aggressive policy in

terms of safeguard of the medical and paramedical staff was not implemented in most Centres; the reason could probably be knowledge about COVID-19, at least at the beginning of the pandemic. All this should be kept in mind in those areas not experiencing yet the rising tide of the virus, as well as in areas where all medical and surgical specialties limited by the pandemic are resuming their practice.

Limitations

The main limitation is that this survey is a snapshot of an evolving worldwide emergency with different responses in different regions. Another limitation stems from the subjectivity in responses, some of which were intentionally based on the replier perceptions. Furthermore, most respondents came from countries well advanced in the spread of the pandemic and most of them from Centres with cumulative large series.

This survey has some strength as it is one of the scanty available reports that focus on current data on cardiac surgery, ECMO support and transplant activity during the pandemic.

Conclusions

Our data underline the profound impact of COVID-19 spread on cardiac surgery practice in terms of resource allocation, healthcare staff infection, surveillance policies and surgical outcomes during the pandemic. These data can help to guide future decision-making and health policies for the next phases of the pandemic.

Author's Contribution:

Francesco Onorati: conception and design, acquisition, analysis and interpretation of data; drafting and revising the work; final approval of the version to be published; agreement to be accountable for all aspects of the work

Patrick Myers: conception and design, acquisition, analysis and interpretation of data; drafting and revising the work; final approval of the version to be published; agreement to be accountable for all aspects of the work

Pietro Bajona: conception and design, acquisition, analysis and interpretation of data; drafting and revising the work; final approval of the version to be published; agreement to be accountable for all aspects of the work

Andrea Perrotti: conception and design, acquisition, analysis and interpretation of data; drafting and revising the work; final approval of the version to be published; agreement to be accountable for all aspects of the work

Carlos Mestres: conception and design, acquisition, analysis and interpretation of data; drafting and revising the work; final approval of the version to be published; agreement to be accountable for all aspects of the work

Eduard Quintana: conception and design, acquisition, analysis and interpretation of data; drafting and revising the work; final approval of the version to be published; agreement to be accountable for all aspects of the work

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Table 1.

Query	Item	N° of Centres (%)
<i>Traditional post-cardiac surgery ICU transformed into dedicated COVID-19 ICU</i>		
	Yes	22 (36.1)
	No	39 (63.9)
<i>Traditional post-cardiac surgery ICU moved to another location</i>		
	Yes	22 (36.1)
	No	39 (63.9)
<i>Negative-pressure rooms in the ICU</i>		
	Yes	37 (60.6)
	No	24 (39.4)
<i>Negative-pressure Operating Room Suites</i>		
	Yes	37 (60.6)
	No	24 (39.4)
<i>Surveillance of Cardiac Surgery personnel</i>		
	COVID-19 nasal swab	14 (22.9)
	Immunological serum test	1 (1.6)
	COVID-19 nasal swab only if symptoms of SARS-CoV-2	2 (3.3)

	COVID-19 nasal swab if symptoms and/or contact with COVID-19 patients	41 (67.3)
	No surveillance	3 (4.9)
<i>Surveillance of newly admitted patients</i>		
	COVID-19 nasal swab	52 (85.2)
	Immunological serum test	4 (6.6)
	CT scan	4 (6.6)
	None	1 (1.6)
<i>Decline of surgical practice vs. pre-Covid19 era:</i>		
	15%	1 (1.7)
	25%	1 (1.7)
	30%	1 (1.7)
	37.5%	1 (1.7)
	50%	11 (19.4)
	60%	7 (12.3)
	65%	4 (7.0)
	70%	7 (12.3)
	75%	4 (7.0)
	80%	9 (15.8)
	85%	2 (3.5)
	90%	5 (8.9)

	95%	2 (3.5)
	100%	2 (3.5)
<i>Allowed procedures (priority)</i>		
	Elective	25 (41)
	Urgent	55 (90.2)
	Emergent	53 (86.9)
	Salvage	49 (80.3)
<i>V-V ECMO implanted</i>		
	1	4 (13.8)
	2	5 (17.2)
	3	4 (13.8)
	4	3 (10.2)
	5	1 (3.5)
	6	3 (10.2)
	7	4 (13.8)
	12	1 (3.5)
	13	1 (3.5)
	17	1 (3.5)
	26	1 (3.5)
	46	1 (3.5)
<i>A-V ECMO implanted</i>		
	1	11 (73.3)
	2	2 (13.3)
	3	1 (6.7)

	7	1 (6.7)
<i>Weaning with survival rate after V-V ECMO</i>		
	0%	7 (24.1)
	1-10%	4 (13.8)
	11-20%	2 (6.9)
	21-30%	2 (6.9)
	31-40%	2 (6.9)
	41-50%	6 (20.6)
	51-60%	0 (-)
	61-70%	1 (3.5)
	71-80%	1 (3.5)
	81-90%	0 (-)
	91-100%	4 (13.8)
<i>Weaning with survival rate after V-A ECMO</i>		
	0%	9 (60.0)
	1-10%	2 (13.3)
	11-20%	0 (-)
	21-30%	0 (-)
	31-40%	1 (6.7)
	41-50%	0 (-)
	51-60%	0 (-)
	61-70%	1 (6.7)

	71-80%	0 (-)
	81-90%	0 (-)
	91-100%	2 (13.3)

Data on hospital resources, surveillance, allowed practice, and results of ECMO

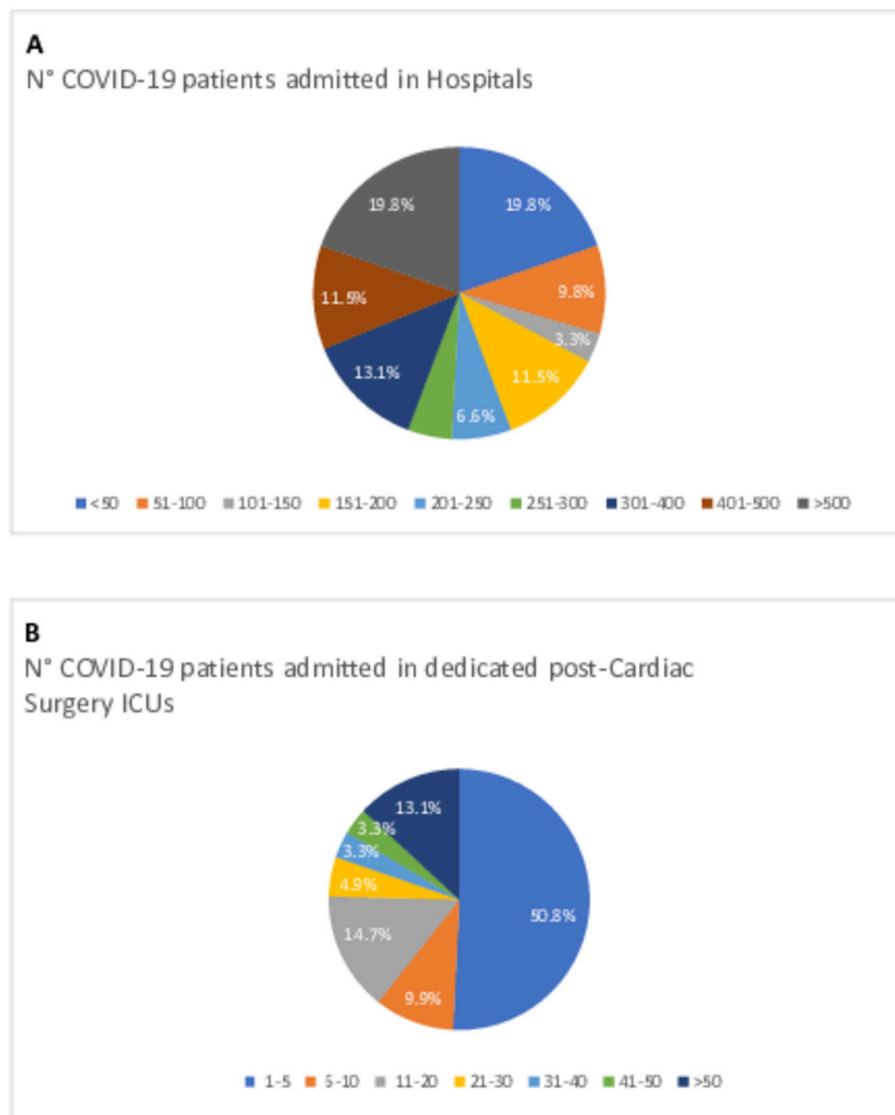
CT: Computer Tomography; ECMO: Extracorporeal Membrane Oxygenation; ICU: Intensive Care Unit

Figure Legends

Figure 1 Impact of COVID-19 infection on Hospital admissions (Panel A), ICU admissions (Panel B) and Ward admissions (Panel C)

Figure 2 Supply of Personal Protective Equipment (PPE) in different hospital areas of cardiac surgery practice

Figure 3. COVID-19 related mortality after cardiac surgery, as reported by 21 Centres

Figure 1

C

N° COVID-19 patients admitted in dedicated cardiac surgery wards

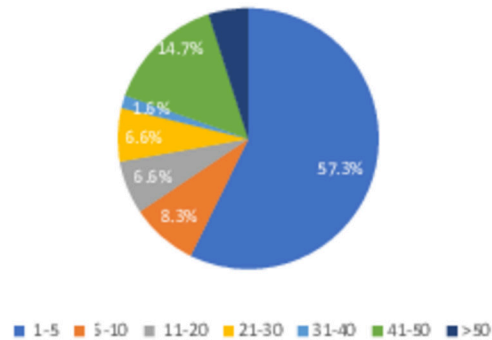
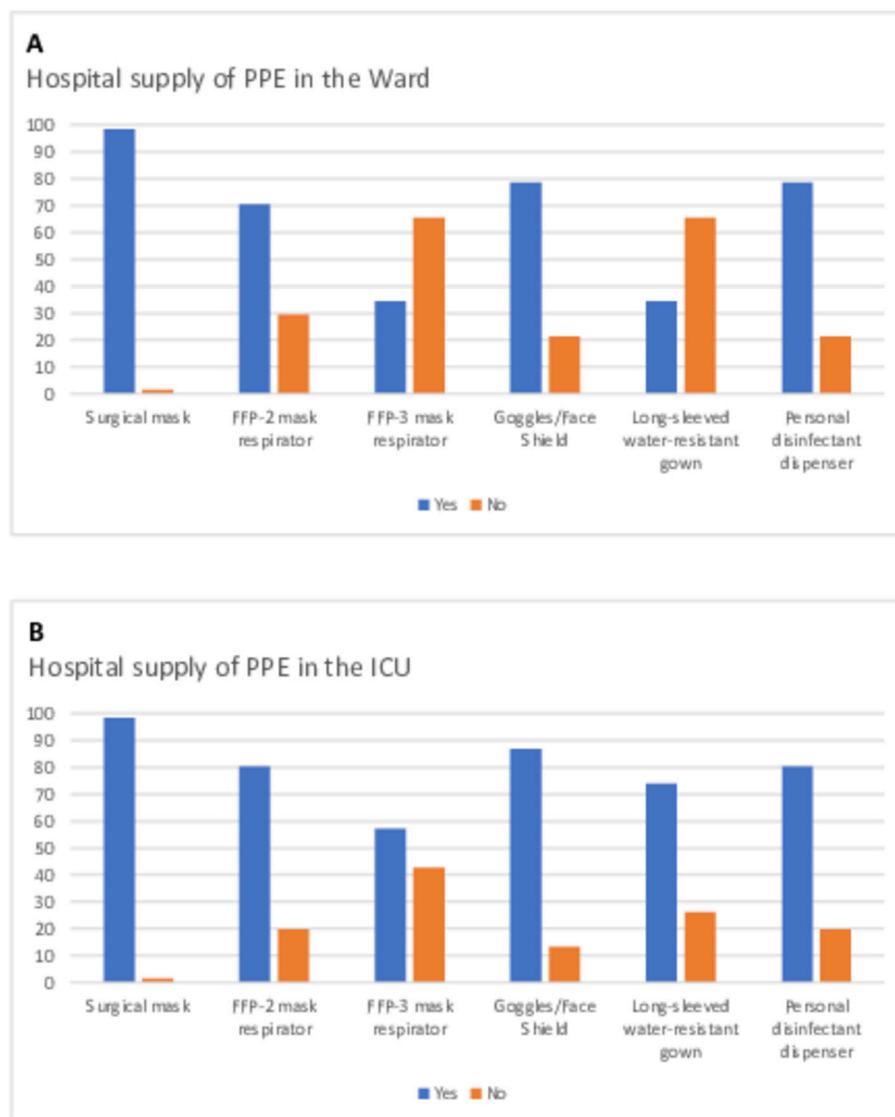


Figure 2

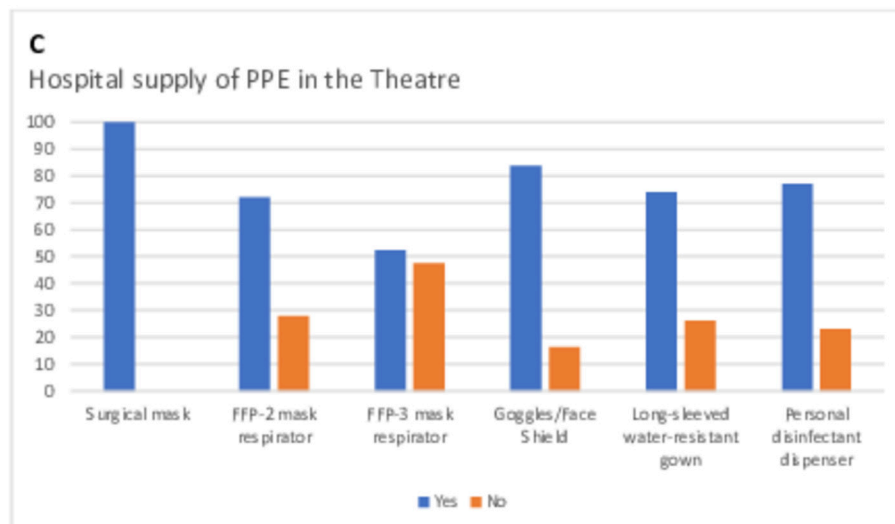
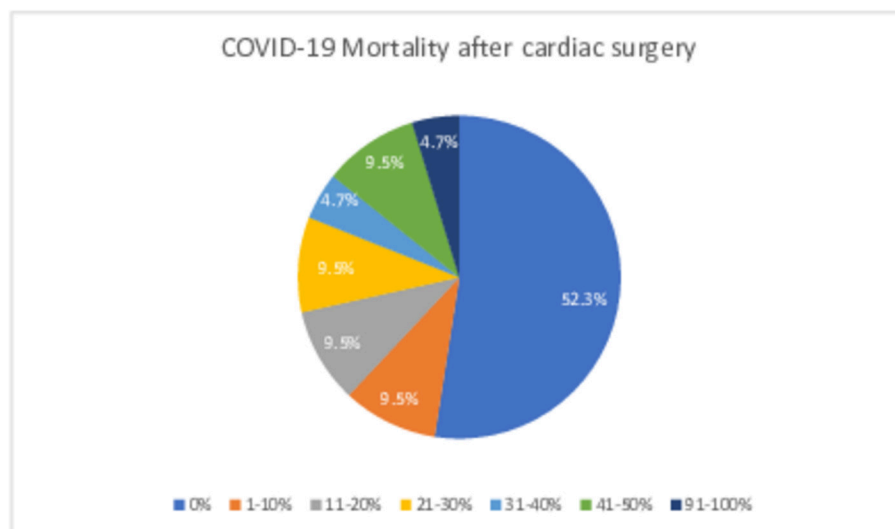


Figure 3

Supplementary Digital Material

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