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ORIGINAL ARTICLE

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Cardiac surgery practice during the COVID-19 outbreak: a multicentre national survey

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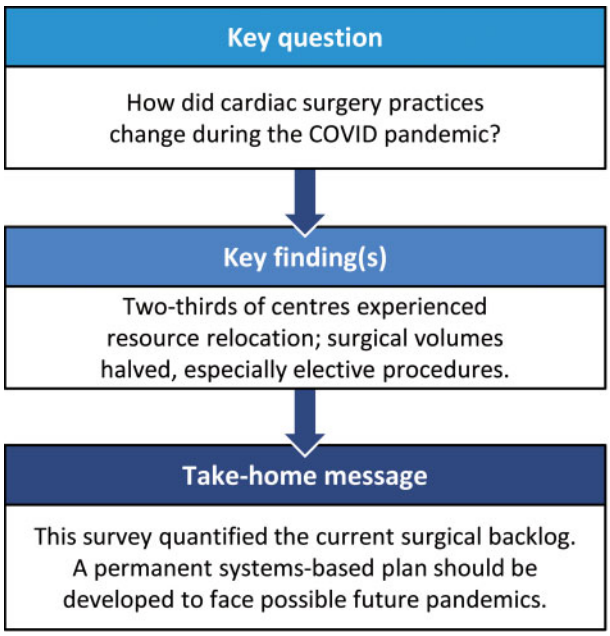

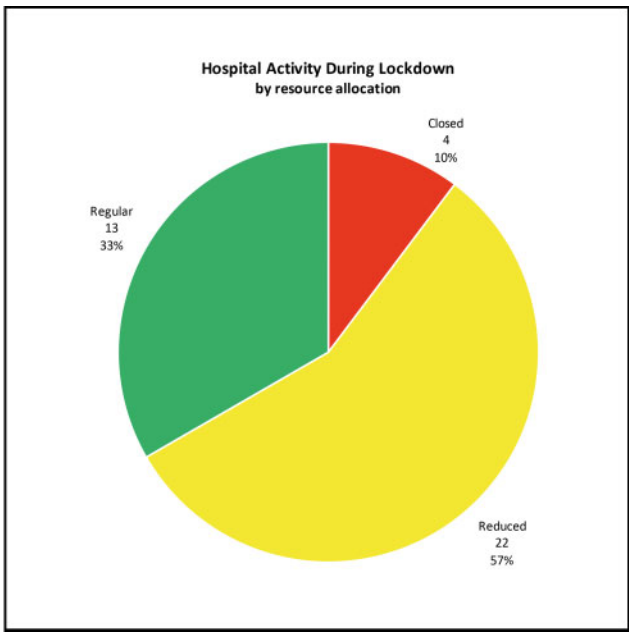

Abstract

OBJECTIVES: Healthcare systems worldwide have been overburdened by the coronavirus disease 2019 (COVID-19) outbreak. Accordingly, hospitals had to implement strategies to profoundly reshape both non-COVID-19 medical care and surgical activities. Knowledge about the impact of the COVID-19 pandemic on cardiac surgery practice is pivotal. The goal of the present study was to describe the changes in cardiac surgery practices during the health emergency at the national level.

METHODS: A 26-question web-enabled survey including all adult cardiac surgery units in Italy was conducted to assess how their clinical practice changed during the national lockdown. Data were compared to data from the corresponding period in 2019.

RESULTS: All but 2 centres (94.9%) adopted specific protocols to screen patients and personnel. A significant reduction in the number of dedicated cardiac intensive care unit beds (-35.4%) and operating rooms (-29.2%), along with healthcare personnel reallocation to COVID departments (nurses -15.4%, anaesthesiologists -7.7%), was noted. Overall adult cardiac surgery volumes were dramatically reduced (1734 procedures vs 3447; $P < 0.001$), with a significant drop in elective procedures [580 (33.4%) vs 2420 (70.2%)].

CONCLUSIONS: This national survey found major changes in cardiac surgery practice as a response to the COVID-19 pandemic. This experience should lead to the development of permanent systems-based plans to face possible future pandemics. These data may effectively help policy decision-making in prioritizing healthcare resource reallocation during the ongoing pandemic and once the healthcare emergency is over.

Keywords: Cardiac surgery • COVID-19 pandemic • Waiting list • Healthcare resources • Prioritization •

ABBREVIATIONS

COVID-19	Coronavirus disease 2019
ICU	Intensive care unit
IQR	Interquartile range
LOS	Length of stay
PPE	Personal protective equipment
SARS-CoV-2	Severe acute respiratory syndrome coronavirus-2

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic is the world's largest infectious disease crisis in the last 100 years. Italy was the first European country affected and has the third highest number of casualties after the UK and Spain. Despite several attempts to control the spread of infection, the prevalence rose significantly and led to a nationwide lockdown on 9 March 2020 that ended only on 4 May 2020 [1]. The availability of inpatient beds in Italian hospitals is chronically lower than the European average (262.5 per 100 000 inhabitants vs 372.2 per 100 000, respectively) [2]. As the cases of acute respiratory failure requiring intensive care unit (ICU) admission surged, a dramatic imbalance between the healthcare needs of the population and the actual availability of acute/critical care resources became evident. In this 'disaster medicine' scenario, the principle of proportionality of care has driven resource allocation, leaving many patients, especially those with other diseases, without adequate care [3], and leading to a possible increase in non-COVID-19-related deaths as a further dramatic consequence of the pandemic [4, 5]. Remodelling of therapeutic algorithms for non-COVID-19 medical and surgical care has therefore become mandatory. Knowledge about the impact of the COVID-19 pandemic on cardiac surgery practice is pivotal to define potential improvement strategies in case of similar scenarios in the future.

In fact, the risk of overlooking severely ill patients and postponing life-saving treatments was high during the central phase of the epidemic. Moreover, quantifying the backlog of deferred cases might help estimate the need for increasing cardiac surgery volumes during the COVID-19 recovery period (phase 2 and over) [6]. The goal of the present study was to describe the changes in cardiac surgery practices during the health emergency at the national level.

MATERIALS AND METHODS

On 24 April 2020, a 26-question survey (Supplementary Material, File S1) was sent by e-mail to a total of 99 Italian adult cardiac surgery centres identified from the Italian Society for Cardiac Surgery mailing list. In view of the rapidly evolving situation and given the need for timely presentation of results, we predetermined to close the survey on 20 May 2020.

The topics investigated by the questionnaire included the redistribution of dedicated healthcare resources; the modalities for screening surgical candidates and for active surveillance of healthcare workers; the availability of adequate personal protective equipment (PPE); the number, urgency status, type of surgical procedure, patterns of referral and discharge and the length of hospital stay of all consecutive patients referred for surgery during the lockdown period. These data were compared with those from the equivalent period in 2019.

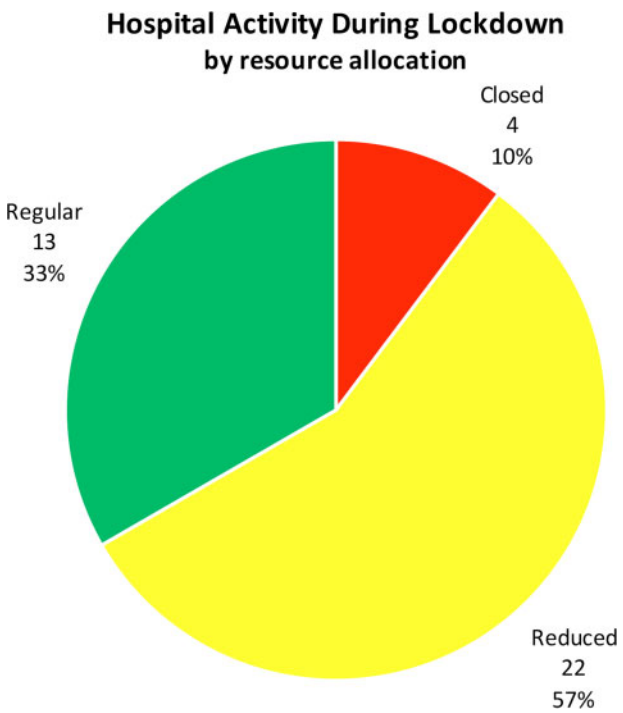

Figure 1: Proportion of centres stratified by resource reallocation to treat COVID-19.

Data collection

Each centre retrieved data from their internal records or from the Department of Management. The completed questionnaires were submitted to the coordinating unit at the Department of Translational Medical Sciences, University of Campania, Naples, which was in charge of data collection and analysis.

Statistical analyses

Categorical variables are presented as numbers and percentages, continuous data as median, interquartile range (IQR) and maximum value. Data were compared using the χ^2 test, the paired-sample *t*-test and the Kruskal–Wallis test. Statistical significance was set at an alpha level of 0.05. All statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC, USA).

RESULTS

Thirty-nine national cardiac surgery centres out of 99 (39.4%) agreed to participate in the survey and returned the completed questionnaire. Of these, 15 were academic hospitals (38.5%), 15 were public hospitals (38.5%) and 9 were private clinics (23.1%). Fourteen centres (35.9%) were in northern Italy, 10 (25.6%) in

Table 1: Reallocation of healthcare resources in the 3 macro areas

Beds	Northern Italy ($n = 12$)[a]	Central Italy ($n = 8$)[a]	Southern Italy ($n = 10$)[a]	*P*-value
ICU	-45.1% (20.0–81.0%; max 100%)	-30.0% (0–71.3%; max 100%)	-21.2% (0–56.9%; max 100%)	0.50
Operating room	-41.7% (0–74.3%; max 100%)	-12.5% (0–50.0%; max 100%)	-16.7% (0–50.0%; max 50.0%)	0.60
Ward	-35.4% (2.3–84.9%; max 100%)	-41.7% (6.3–55.4%; max 66.7%)	-8.3% (0–35.8%; max 50.0%)	0.18
Healthcare professionals	**Northern Italy ($n = 10$)[a]**	**Central Italy ($n = 5$)[a]**	**Southern Italy ($n = 6$)[a]**	***P*-value**
Nurses	-25.7% (4.6–67.9%; max 100%)	-28.6% (7.7–40.8%; max 41.7%)	-1.8% (0–15.0%; max 40.0%)	0.18
Anaesthesiologists	-23.8% (0–63.8%; max 100%)	0% (0–36.9%; max 37.5%)	-3.8% (0–16.7%; max 33.3%)	0.43
Cardiac surgeons	0% (0–37.5%; max 77.8%)	0% (0–3.8%; max 7.7%)	0% (0–5.0%; max 20.0%)	0.39
Cardiologists	0% (0–51.6%; max 87.5%)	0	0% (0–7.1%; max 28.6%)	0.20
Perfusionists	0% (0–25.0%; max 50.0%)	0	0% (0–12.5%; max 50.0%)	0.42

Results are expressed as median (interquartile range; maximum) percentage reduction, comparing availability of resources during lockdown to the corresponding period in 2019.

[a]The number of centres experiencing resource reallocation.

ICU: intensive care unit.

central Italy and 15 (38.6%) in southern Italy. Thirty out of 39 (76.9%) were hub hospitals for COVID-19 patients.

Screening protocols and availability of personal protective equipment

All but 2 centres (94.9%) adopted specific protocols for screening patients admitted to the hospital. Naso- and oropharyngeal swabs for the detection of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection were the most frequently performed preoperative screening tests for surgical candidates: 34 out of 39 centres (87.2%) performed swabs alone (30 centres) or in combination with serum tests (4 centres). The rapid test was the preferred screening test in 2 centres (5.1%), whereas titration of serum antibodies against SARS-CoV-2 was used in 1 centre (2.6%).

Surveillance protocols for healthcare professionals, including self-assessment, recording body temperature, rapid tests, swabs, antibody titre or various combinations of these, were implemented in all but 2 centres.

Use of PPE was mandatory in all centres and was perceived as sufficiently provided in 27 centres (69.2%), temporarily inadequate in 10 (25.6%) and chronically inadequate in 2 (5.1%).

Resource allocation

Hospital resources were rationed to cope with the national outbreak and to provide adequate regional support. Figure 1 shows the proportion of centres stratified based on whether their hospital resources were reallocated during the lockdown.

The ICUs normally admitting patients after cardiac surgical procedures were the facilities mostly involved, with a median bed reduction of -35.4% compared to 2019 standards (IQR 0–68.8%, maximum 100%, 106 unit reduction out of 189), followed by operating rooms (-29.2%, IQR 0–50%, maximum 100%, 35-unit reduction out of 64) and wards (-28.1%, IQR 0–50%, maximum 100%, 250 unit reduction out of 524). Twenty-one centres (53.8%) experienced a reduction in personnel. In particular, the largest reallocation involved nurses (-15.4%, IQR 0–40.0%, maximum 100%, 149 unit reduction out of 543), followed by anaesthesiologists (-7.7%, IQR 0–36.9%, maximum 100%, 39 unit reduction out of 101), cardiac surgeons (0%, IQR 0–13.8%, maximum 77.8%, 17 unit reduction out of 50), cardiologists (0%, IQR 0–6.7%, maximum 87.5%, 71 unit reduction out of 145) and perfusionists (0%, IQR 0–0%, maximum 50%, 6 unit reduction out of 23), which were reallocated to the emergency departments dealing with COVID-19 patients. Such redistribution, although not statistically significant, was most evident in northern Italy (Table 1).

Hospital pathways were differentiated to account for suspected or confirmed SARS-CoV-2-positive patients. Thirty-seven centres (94.9%) had a dedicated area for triage (22 outside the ward and 15 inside). Twenty-three centres (59.0%) also had an operating room dedicated to suspected/confirmed COVID-19 patients (15 inside the operating block, 8 outside). Thirty-four centres (87.2%) had dedicated ICU beds available for patients with positive or ongoing screening tests (18 centres in the general ICU, 16 centres inside the cardiac surgery ICU).

The admittance of relatives was forbidden in 27 centres (69.2%) and limited in 11 (28.2%). When relatives were not allowed to visit patients, updates were provided by telephone in 21 cases, whereas the remaining centres allowed a consultation in dedicated spaces. When admittance was limited, consultations with the referring physician were available in dedicated spaces preoperatively, at the end of the operation or during the entire hospital stay until discharge.

Referral, operative volumes and surgical procedures

Patterns of referral during the pandemic significantly changed compared to those during the equivalent period in 2019 (Table 2). In particular, we observed a significant reduction in patients' admittance from the waiting lists (22.5% during lockdown vs 43.3% during the same time period in 2019) in favour of increased referral by the emergency contact (12.0% vs 9.1%), in-hospital consultations (32.7% vs 25.4%) or from peripheral hospitals (20.5% vs 16.5%).

All centres experienced a significant drop in operative procedures during the lockdown compared to 2019 (1734 procedures vs 3447; $P < 0.001$), with a median reduction in cardiac surgery case volume of 53.5% (IQR 23.7–81.4%). Notably, the percentage

Table 2: Details of patterns of referrals and surgical volumes recorded during the lockdown compared to the same period in 2019 (absolute numbers and percentage)

	Lockdown 2020	2019	*P*-value
Referral, *n* (%)			<0.001
Emergency contact	161 (12.0)	221 (9.1)	
Internal to the hospital	438 (32.7)	619 (25.4)	
Peripheral hospitals	275 (20.5)	402 (16.5)	
Waiting list	301 (22.5)	1057 (43.3)	
Other	63 (4.7)	39 (1.6)	
Unknown	102 (7.6)	102 (4.2)	
Procedural volume, *n* (%)	1734	3447	<0.001
Elective	580 (33.4)	2420 (70.2)	
Urgent	955 (55.1)	832 (24.1)	
Emergency	166 (9.6)	155 (4.5)	
Salvage	33 (1.9)	40 (1.2)	

of elective surgery cases fell significantly in favour of urgent and emergency interventions, with 22 centres (56.4%) having stopped elective scheduling.

The distribution of aetiologies (Table 3) and the types of surgical procedures (Table 4) were different between the 2 study periods. During lockdown, we observed a percentage increase in admissions for acute coronary and aortic syndromes and for heart failure, with a consequent relative increase in coronary artery bypass graft surgery and either open or endovascular aortic procedures, whereas the percentage of valve procedures decreased significantly. Conversely, the occurrences of endocarditis or of complications of acute myocardial infarction and the number of transcatheter aortic valve implant procedures were similar.

Length of hospital stay and patterns of discharge

Twelve centres (30.8%) reported an increase in the average postoperative length of stay (LOS) compared to the same period in 2019 (13.6 ± 3.8 vs 8.8 ± 2.9 days; $P < 0.001$). During the lockdown, 19 centres (48.7%) did not change their pattern of discharge, maintaining the usual standard of care. On the other hand, 16 centres (41.0%) preferably discharged home and 3 centres (7.7%) continued to send patients directly to a rehabilitation facility.

DISCUSSION

This multicentre national survey clearly shows the unprecedented impact on cardiac surgery practice of the current COVID-19 pandemic. Excluding those few countries (such as China, Vietnam, Singapore and Canada), which faced the 2003 severe acute respiratory syndrome outbreak, most Western countries were found woefully unprepared both culturally and in terms of facilities and equipment [7, 8]. As mentioned previously, the number of hospital beds in Italy is chronically lower than the European average and has been further reduced by healthcare cost reduction policies since 2012 [2].

Resource allocation

Usually, cardiac surgery is the single largest user of ICU beds. Contingent policy responses to the COVID-19 outbreak had to be organized along 3 key priorities: staff, supplies and facilities.

Table 3: Details of aetiologies at hospital admittance during lockdown compared to the same period of 2019 (absolute numbers and percentage)

Aetiologies	Lockdown 2020, *n* (%)	2019, *n* (%)
Valvulopathies	391 (22.2)	1094 (30.9)
Acute coronary syndromes	348 (19.8)	602 (17)
Chronic coronary artery disease	360 (20.4)	802 (22.7)
Myocardial infarction complications	13 (0.7)	19 (0.5)
Endocarditis	76 (4.3)	158 (4.5)
Acute aortic syndromes	91 (5.2)	100 (2.8)
Prosthetic failure	30 (1.7)	40 (1.1)
Heart failure	84 (4.8)	110 (3.1)
Rescue	45 (2.6)	46 (1.3)
Other	324 (18.4)	567 (16.0)

Table 4: Details of surgical procedures performed during lockdown compared to the same period in 2019 (absolute numbers and percentages)

Surgical procedures	Lockdown 2020, *n* (%)	2019, *n* (%)
CABG	598 (35.4)	1178 (32.8)
Valve replacement	289 (17.1)	649 (18.1)
Valve repair	126 (7.5)	399 (11.1)
Aortic/arch	149 (8.8)	212 (5.9)
Combined	207 (12.2)	522 (14.5)
GUCH	2 (0.1)	15 (0.4)
Heart transplant	19 (1.1)	16 (0.4)
VAD	14 (0.8)	66 (1.8)
ECMO-post-cardiotomy	10 (0.6)	7 (0.2)
ECMO-HF	14 (0.8)	13 (0.4)
ECMO-respiratory	32 (1.9)	6 (0.2)
TAVI	128 (7.6)	271 (7.5)
Endovascular	19 (1.1)	20 (0.6)
Infected device	10 (0.6)	38 (1.1)
Tumours	13 (0.8)	25 (0.7)
Tamponade	40 (2.0)	81 (2.3)
Miscellaneous	20 (1.2)	74 (2.1)

CABG: coronary artery bypass graft; ECMO: extracorporeal membrane oxygenation; GUCH: grown-up congenital heart disease; HF: heart failure; TAVI: transcatheter aortic valve implantation; VAD: ventricular assist device.

Accordingly, this survey showed a significant reduction in the number of dedicated cardiac operating rooms and ICU beds along with personnel reallocation to other departments, with peaks mostly confined to northern Italy, whose regions were the first to cope with the COVID-19 outbreak. The observed reallocation is consistent with that described by a recent UK nationwide survey [9]. The effects of these rationalization strategies and the response of the cardiac surgery system are authoritatively described in a recent paper by Belluschi *et al.* [10] about the Lombardy reorganization model. As these systems-based changes were evolving, guidelines with adequate specificity to address the complexity of decision-making for safely and effectively performing and/or deferring cardiac surgery were unavailable or, at best, under development [9, 11–13]. Nevertheless, the response of the Italian cardiac surgery community was prompt, and all centres developed programme-specific policies [14].

Screening protocols

As shown in this survey, preoperative screening for SARS-CoV-2 infection and algorithms for active surveillance of healthcare providers significantly differed from one institution to another. PPE has been an important and emotive subject during the current pandemic: Appropriate use in some clinical settings is mandatory to reduce the risk of viral transmission, but a critical shortage has been reported worldwide [15]. Limited availability of PPE has been experienced in variable degrees in Italian surgical centres, with up to 30% experiencing a critical scarcity at some time during the outbreak. A similar situation has been reported in other countries [9, 16, 17]. Modalities for access of patients' relatives to surgical wards and triage algorithms for suspected COVID-19 cardiac surgical candidates were modelled on local resource availability and varied widely. Notably, hospital LOS and the patterns of discharge were also affected by the COVID-19 pandemic. The competition for diagnostics, the scarcity of blood products, the need to maximize patient health status before discharge in times of limited access to cardiac surgery outpatient clinics, along with the scarcity of rehabilitation facilities, are among the factors that synergistically contributed to these practice changes. Usually, resource availability is not factored in the decision-making process and the choices of an individual clinical or surgical case [18].

Surgical activity

As elegantly shown in the few available surveys, indications for cardiac surgical procedures varied widely from one country to another and even within the same nation according to local resource availability, severity of viral outbreak and local expertise [9, 16, 17]. Although no official consensus statements were published by either academic or professional cardiac surgical societies, our survey reveals an almost uniform approach to indications for surgical procedures in Italy. It largely complies with that forwarded by the reorganization statement published by the Lombardy region [10]. When looking at the nationwide case mix during the lockdown, 4 points are worthy of a comment. First, although coronary artery bypass graft surgery for acute coronary syndrome accounted for more than 30% of all performed procedures, its absolute number significantly and worryingly dropped (by nearly 50%). This unexpected finding mirrors that reported by an Italian nationwide cardiologists' survey showing a dramatic reduction in hospital admissions for acute myocardial infarction during the lockdown and an increase in inherent mortality and complication rates [19]. Second, the number of transcatheter aortic valve implant procedures appeared to be less affected by the COVID-19 outbreak. Again, this pattern is consistent with that reported by recently published surveys and probably reflects a change in the treatment algorithm for severe aortic stenosis in times of limited healthcare resources [4, 9, 16, 17]. Third, surprisingly, the number of heart transplants appeared to be substantially unaffected by the pandemic. Recent data from the Italian Ministry of Health show that, by May 2020, despite a 4.5% decrease in available donors due to the reduced number of ICU beds, the number of oppositions to organ donations during the COVID-19 outbreak dropped from 33.1% to 25.3%, and the total number of solid organ transplants is currently 1.45% lower than that observed in 2019 [20]. Notably, as reported by the Italian National Organ Transplant Centre, the number of organ transplants in Italy was significantly higher than those in the USA, Spain and France during the most critical phase of the surge [20]. Fourth, as expected, the number of extracorporeal membrane oxygenation systems implanted for respiratory failure significantly increased 10-fold (in percentages of procedures performed), which corroborates the commitment of the cardiac surgical programmes to supporting the care of critically ill COVID-19 patients [21].

The dramatic reduction in the total adult cardiac surgery case load also deserves a comment. This finding is consistent with the findings of recently published international surveys [16, 17]. Most centres restricted cardiac surgery activity to urgent/emergency cases, and 10.2% cancelled all cases including emergencies. Such a decrease has led to obvious positive effects. Indeed, it contributed to spare the limited hospital resources, prevented the in-hospital spread of SARS-CoV-2 infection and limited the risk of performing surgery on patients with asymptomatic infection during the incubation period. The drawbacks of such practice patterns are less clear now, but the outlook is not optimistic. In fact, the current mortality rate while waiting for elective cardiac surgical procedures is still relevant [22, 23]. Moreover, an increase in the number of deaths has previously been reported by healthcare systems in the aftermath of natural disasters [24, 25]. In fact, the clearance of the backlog of cardiac surgical cases is complicated by the exhaustion of supplies and resources from the pandemic and the competition with similar needs by other medical and surgical subspecialties [6]. In this respect, our findings may effectively help policy decision-making in prioritizing healthcare resource reallocation once the healthcare emergency is over [26].

Limitations

This study has several limitations. First, only 39.4% out 99 centres participated in the survey, which might imply an issue of representativeness. Nevertheless, participating units were evenly distributed over the nation to account for possible differences pertaining to the spread of infection and regional availability of healthcare resources. Besides, the response rate is comparable to those reported in contemporary cardiological and surgical surveys on the practice pattern during the pandemic [9, 16, 17, 19]. Second, this survey is a snapshot of a rapidly evolving situation, focused on a restricted time span, within a context of limited resources and unsettled practice guidelines during an unprecedented pandemic. The descriptive nature of the study prevents us from making any inferences from the observed results. Third, the survey design implies an inherent potential for subjectivity. Fourth, we have assumed that historical rates of surgical procedures might provide a valuable benchmark to quantify the surgical backlog and thus intensify the need for a post-pandemic increase in the volume of cardiac surgical procedures.

CONCLUSIONS

This nationwide survey describes the major changes in adult cardiac surgery practice imposed by the COVID-19 pandemic. The cardiac surgical network responded promptly and effectively despite the severe shortage of healthcare resources in terms of facilities, staff and PPE and despite the absence of specific guidelines. In this respect, this experience should lead to the development of

permanent systems-based plans to face possible future pandemics and may effectively help policy decision-making in prioritizing healthcare resource reallocation once this healthcare emergency is over.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *EJCTS* online.

Conflict of interest: none declared.

Author contributions

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