ORIGINAL ARTICLE

THE RISK OF WAITING UP TO ONE YEAR FOR CARDIAC SURGERY

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Abstract

***Introduction**: Cardiac disease is associated with a risk of death, both by the cardiac condition and by comorbidities. The waiting time for surgery begins with the onset of symptoms and includes referral, completion of the diagnosis and surgical waiting list (SWL). This study was conducted during the COVID-19 pandemic, which affected surgical capacity and patients' morbidities.*

***Methods:** The cohort includes 1914 consecutive adult patients (36.6% women, mean age 67 ±11 years), prospectively registered in the official SWL from January 2019 to December 2021. We analyzed waiting times ranging from 4 days to one year to exclude urgencies and outliers. Priority was classified by the national criteria for non-oncologic or oncology surgery.*

***Results:** During the study period, 74% of patients underwent surgery, 19.2% were still waiting, and 4.3% dropped out. Most cases were valvular (41.2%) or isolated bypass procedures (34.2%). Patients were classified as non-priority in 29.7%, priority in 61.8%, and high priority in 8.6%, with significantly different SWL mean times between groups ($p<0.001$). The overall mean waiting time was 167 ± 135 days. Mortality on SWL was 2.5%, or 1.1 deaths per patient/weeks. There were two mortality independent predictors: age (HR 1.05) and the year 2021 versus 2019 (HR 2.07) and a trend toward higher mortality in priority patients versus non-priority ($p=0.065$). The overall risk increased with time with different slopes for each year. Using the time limits for SWL in oncology, there would have been a significant risk reduction ($p=0.011$).*

***Conclusion:** The increased risk observed in 2021 may be related to the pandemic, either by increasing waiting time or by direct mortality. Since risk stratification is not entirely accurate, waiting time emerges as the most crucial factor influencing mortality, and implementing stricter time limits could have led to lower mortality rates.*

***Keywords**: Surgery Waiting List, Heart Surgery; Valve Surgery, Coronary Artery Bypass, Patient Care Management, Health Services Accessibility, COVID-19*

INTRODUCTION

Cardiac disease is associated with a risk of death, not only due to the cardiac condition but also because of comorbidities. Cardiac surgery often involves life-saving interventions, and the timing of these procedures can significantly impact patient outcomes. However, the landscape of cardiac surgery has been further complicated by the emergence of the COVID-19 pandemic, adding an additional layer of challenges to the delivery of cardiovascular care (1). While the importance of timely intervention in cardiac cases is widely recognized, delays in receiving surgery remain a substantial concern. The reasons behind surgical delays are varied and can include the time taken for accurate diagnosis and assessment, the complexities of the referral processes, limited availability of operating rooms and surgical teams, as well as patient-specific factors (2). These delays may lead to the progression of heart diseases, causing irreversible damage, increased symptom burden, heightened mortality rates, perioperative complications, and additional resource utilization within the healthcare system (3).

When there is a surgical waiting list (SWL), risk stratification is paramount to ensure that those at the highest

risk receive the necessary interventions promptly, enhancing their chances of successful outcomes. However, even with a multidisciplinary approach in risk stratification, the hazards of waiting cannot be totally mitigated (3).

Our aim is to study the hazards of waiting, identify mortality predictors and develop recommendations regarding waiting times.

METHODS

This study is a single center study that includes 1914 consecutive adult patients (more than 18 years old), 36.6% women with a mean age of 67.3 ±11.2 years. Data was prospectively registered in the official Portuguese national SWL of cardiac surgery, from January 2018 to December 2021 (3 years in total) and retrospectively analyzed until April 2023. Only waiting times between 4 days and one year were analyzed, to exclude urgencies and outliers. Other exclusion criteria were isolated thoracic surgery, adult congenital surgery, non-index interventions and minor procedures.

The waiting time was evaluated as a continuous variable and when needed it was classified in four groups: 4-30 days; 31-90 days; 91-180 days; 271-365 days.

Mortality was evaluated as overall mortality (events divided by population) and deaths per 1000 patients.week (D/PW) to be compared with previous in literature reports.

When including a patient in official Portuguese national waiting list system, the surgeon classifies the priority as: non-priority; priority; high priority and urgency. This paper focus is on non-priority, priority, and high priority. The classification is made by surgeons when patient is registered and can be changed over time. There are official recommendations for maximum waiting times in each grade for non-oncologic and oncologic surgery (Table 1).

During the waiting time, patients can be operated, die, or be dropped out of the SWL for several reasons. After evaluating the drop-out causes, these patients were excluded from further analysis.

Patients were also classified into five groups of pathology: univalvular, multivalvular, isolated coronary artery disease (CAD), aorta surgery and others.

Sub-analyses were conducted in three subgroups: 1- Isolated CAD; 2- Isolated aortic valve 3- Isolated aortic valve plus isolated CAD.

Mortality was confirmed by our clinical registries and by consulting the Portuguese national database of death certificates, which was checked at least 15 months after registration at the SWL, thus allowing enough time (> 3 months) for registry update (100% complete).

STATISTICAL ANALYSIS

All data was analyzed with IBM SPSS Statistics for Windows, Version 22.0 Armonk, NY: IBM Corp. All mean values in the tables were expressed as the mean ± standard deviation. The χ^2 test or Fisher's exact test was used to compare categorical data. Comparisons between the two main groups were made using independent samples with Student's T test or Mann-Whitney test in the case of non-normal distribution. The normal distribution was assessed by Kolmogorov–Smirnov test.

Kaplan-Meier and log-rank test was used to compare long term survival and Cox regression was used for uni and multivariate mortality predictors during follow up.

Values of $p<0.05$ were considered statistically significant.

RESULTS

Analyzing the entire population, 74% (n=1416) patients were operated, 19.2% (n=368) were still waiting, 4.3% (n=83) dropped out and the mortality was 2.5% (n=47). The overall mortality was 1.1 deaths per 1000 patients.week (D/PW). The causes of dropping out the SWL were a very high risk on a second evaluation (13.3%), patient refusal (20.5%), surgery at another institution (21.7%), percutaneous treatment (25.3%), loss of surgical indication (18.1%) and others (1.2%).

After exclusion of the dropped-out cases, the remaining

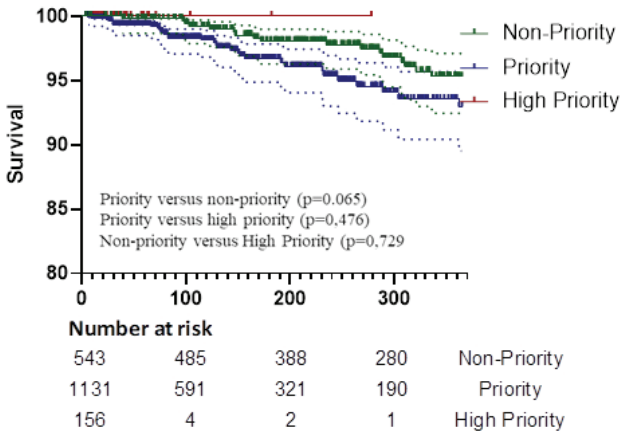

Figure 1 *Survival by priority group. Y axis origin does not start at 0 to enhance differences.*

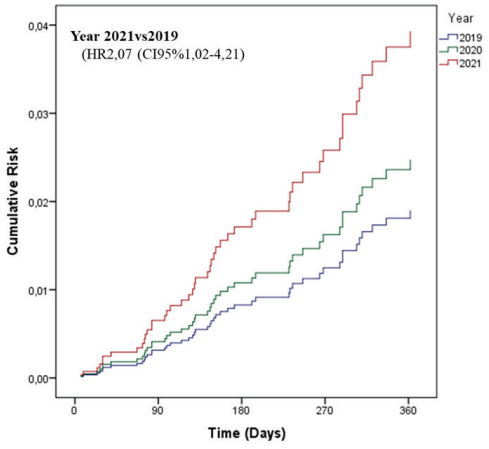

Figure 2 *Multivariate model cumulative risk by registration year for all population.*

Table 1 **National Portuguese recommendations for maximum waiting times in a surgical list published by public health entities. Observed waiting times and compliance with recommendations.**

Recommended maximum waiting time for			Observed*	Compliance with recommende maximum waiting time	
	Non-oncologic surgery (days)	Oncologic Surgery (days)	Mean waiting time (davs)	Non-oncologic surgery (%)	Oncologic Surgery (%)
High Priority	15	15	19.1+29.1	66.7	66.7
Priority	60	45	104.9+92.4	41.5	36.7
Non-priority	180	60	202.7+93 7	42	6.4

*Excluding patients still waiting.

1831 patients were classified as non-priority in 29.7% (n=543), priority in 61.8% (n=1131) and high priority in 8.6% (n=157). The overall mean waiting time was 167±135 days, with different (p<0.001) SWL mean times between groups: non-priority patients waited 267±107 days, priority 139±123 days and high priority 21±40 days.

The proposed procedures were valvular (41.2%), isolated coronary (34.4%), combined valvular and coronary (9.7%), aorta (5.4%) and others (1.9%). The pathology distribution among priority groups was significantly different (p<0,001).

By univariate analysis there was a trend to higher mortality on priority patients versus non-priority (p=0.065) (Figure 1) and the year 2021 versus 2019 (p=0.074). There was no significant difference among the types of procedures. On multivariate analysis model including priority classification, age, registration year and procedure group there were two independent predictors for mortality: age (HR1,05 CI95%1,01-1,08; p=0,009) and the year 2021vs2019 (HR2,07 CI95%1,02-4,21; p=0,044). There was a mortality risk increase with time during the overall SWT with different slopes for each year (Figure 2)

Considering only the patients that reached surgery or died waiting for it (n=1463) we compared results for each priority group and waiting times recommendation. Patients operated during the recommended time for non-oncologic surgeries (Table 1), had a trend towards a lower risk (p=0.11) compared to those that exceeded it, in each priority group. Moreover, if complying instead with the more restrictive waiting time limits for oncology surgery, there would have been a significant risk reduction (p=0.011). Procedures performed within the recommended limits for oncologic surgery have a significant mortality reduction when compared to those done under non-oncologic surgery criteria (p<0,001) (Figure 3).

Further sub-analysis of the 1268 patients with aortic valve pathology (n=486, 38.3%), CAD (n=630, 49.7%) or combination (n=152, 12%), showed no significant difference in SWL survival between groups, nor independent mortality predictors on univariate and multivariate analysis.

Isolated CAD patients (n=630) were classified as non-priority in 23.3% (n=147), priority in 62.7% (n=395), and high priority in 14% (n=88). On univariate analysis there was a trend to higher mortality on priority group versus non priority (p=0.051) and the year 2021 versus 2019 (p=0.066). Using the multivariate model there was a higher mortality on priority patients versus non-priority (HR3.36 (CI95% 1.04-10.84) and a trend on year 2021 versus 2019 (HR4.52 (CI95% 0.95-21.4).

As for the of aortic valve disease group (n=486) we didn't find any mortality predictor.

The effect of the COVID-19 pandemic is apparent during the study period, with a moderate decrease of the surgical activity in 2020, a steady increase in numbers and SWL mean waiting time and finally a delayed recover with increasing surgical and normalization of referral's load in 2023 (Figure 4).

DISCUSSION

This is a real-world analysis of all commers on an adult cardiac surgery waiting list regarding their risk of death before surgery. The study yielded three main findings: firstly, waiting for cardiac surgery carries a high risk, secondly, the prioritization system is not effective. Lastly, if the more strict limits recommended for oncologic procedures were followed, the mortality rate would have been significantly lower.

The overall mortality was 2.5% or 1.1 deaths per 1000

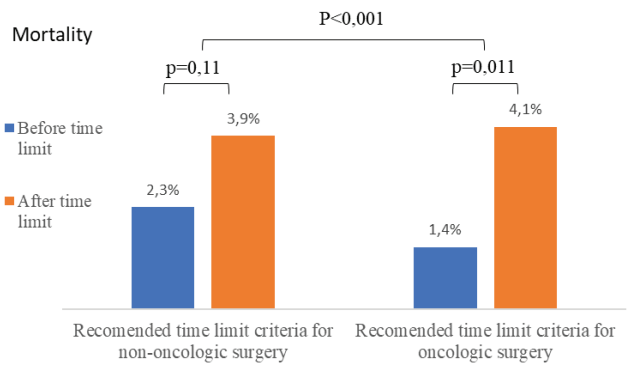

Figure 3 *Mortality observed when applying recommended times limit criteria for non-oncologic and oncologic procedures*

patients.week (D/PW); this compares with published risks of 0.4 to 11% (1-13) and 0.8 to 1.21 D/PW) (2, 14, 15)..

With four classes of priority, various referral origins, and multiple pathologies, the department's official SWL comprises a mixture of several waiting lists. When there are short waiting times, it is easy to schedule patients with different priority levels and monitor those still awaiting surgery. However, in our study, characterized by a lengthy SWL and significant disruption to the health system due to the COVID-19 pandemic, patients are at risk of worsening heart conditions, developing additional health issues, or facing mortality. The duration and delay for surgery depends significantly on the healthcare organization in each country, a subject thoroughly examined by certain National Health Systems (1).

The definition of the beginning of the waiting time is debatable because the dates of completion of the diagnosis, acceptance for surgery and registration in SWL may differ in time and in order. Most papers use the registration at the SWL as their starting day (3-5, 7, 10, 14). The mortality risk is eventually the same for patients who are still waiting for the completion of diagnosis, for surgical assessment, or have not entered the waiting list at the appropriate time. In our study, it was decided to use the SWL registration date because we have a complete internal and national database starting from that date.

We did not compare the clinical status at the beginning and end of the waiting time, nor did we assess the complications that patients might have encountered. Nevertheless, a noteworthy number of patients were removed from the SWL during a late second evaluation. Some underwent surgery elsewhere or percutaneous interventions, while others declined the operation. Similar outcomes have been documented in other publications (1). Nineteen percent of patients remained on the SWL after one year, for various reasons such as extreme delays, surgery postponed due to a medical condition, or by patient preference. Comparable delays are reported in the range of 17 to 28% in other studies (1, 7, 12). Additionally, certain publications highlight very high median waiting times (6, 12) or censor the data if the waiting time exceeds one year (2, 11, 12).

An important proportion of deaths occurs early, as reported by several authors (3, 7-11, 14), with up to 54% occurring at home (14) and up to 65% before the planned waiting time limit (3, 10, 12). Others argue that scores used to predict preoperative death and prioritize patients are not useful, and the most effective measure is the reduction of all waiting times (9, 10, 12). In systems with a very long Surgical Waiting List (SWL) (1, 7, 12, 16, 17), all waiting time limits should be reduced because even with intricate prioritization criteria, SWL mortality remains high and is time-dependent. One hypothesis is that the appropriate selection of the high-risk patients tends to equalize the waiting risk in each subgroup. However, the challenge arises as postponing low-risk cases may increase their overall risk and contribute to leveling the risk. Our study yielded similar findings, as higher priority groups exhibited a trend towards higher risk, although this trend was not statistically significant.

The Portuguese National Health Service faces constraints in providing timely treatment for various types of pathologies, not limited to cardiac conditions. These constraints were significantly exacerbated during the pandemic. In our experience we had a moderate but significant reduction in surgical activity during the COVID-19 pandemic in 2020, followed by a steady increase. However, we also observed an increase in the referrals and waiting list with some delay in time until the recovery of the surgical activity in our center and others.

Patients registered in 2019 were operated in 2019 and 2020. On hundred and seventeen were affected by the pandemic, those who waited a period of time after February of 2020. It is a relatively small number (15%) compared with 100% of patients registered in SWL in 2021. These patients endured the challenges of a healthcare system in disarray from the onset of the pandemic, both before and after their registration. This dysfunction encompassed delays in diagnosis, insufficient monitoring or treatment by Cardiology, suboptimal responses from surgical departments, and inevitably, an escalation in patient numbers and wait times for necessary surgeries. These were likely the causes of a significantly higher SWL mortality in the year 2021 when compared to 2019 in our multivariate model.

The rise in our surgical activity was our hospital strategy to deal with the SWL substantial increase from 2020 to 2022.

When a patient is included in the Portuguese national waiting list system, it gets assigned a priority status, which can be changed over time: non-priority, priority, high priority, and urgency (less than 4 days). The classification is the responsibility of surgeons, who follow various criteria and recommendations. In 2015, the Portuguese Society of Cardiothoracic and Vascular Surgery and the Portuguese Society of Cardiology jointly published recommendations, primarily clinically based on symptoms and anatomical characteristics (16). The proposed maximum waiting times are similar to those implemented for oncologic surgery and were published by the Ministry of Health in 2017. There are also regulations to transfer patients that exceed the time limits on SWL to other public or private

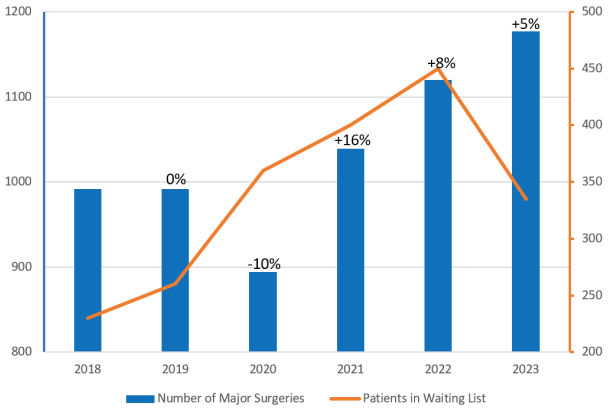

Figure 4 *Major cardiac surgery interventions (on the left side) with variation in percentage and the number of patients in surgical waiting list (on the right side). Y axis does not start at zero.*

hospitals under specific conditions of payments. However, the implementation of these regulations varies among hospitals, regions and throughout the years. In our experienced with long waiting times, very few patients were transferred to other hospitals.

In this study, we observed a significant reduction in surgical waiting list mortality in patients operated during the recommended times for oncologic surgeries. Therefore, in accordance with the 2015 recommendations, these maximum waiting times should serve as a reference for designing and enforcing the system response for cardiac surgery waiting list.

LIMITATIONS

This study is a single center retrospective study and have all the limitations inherent to this type of study. As a single center my not reflect the national reality. In a public health system, a rise in the waiting list at one center may signal a broader issue or even highlight deficiencies across multiple centers, given their interconnected nature and tendency to offset each other's burdens.

The potential deterioration of clinical status, surgical risk, poor postoperative outcomes, or effects on the quality of life has been reported but was not specifically studied in our analysis. The cause of death remains unknown in most cases, particularly during the pandemic. However, existing reports indicate that 84% to 100% of deaths have a cardiac origin (2, 3, 5, 6, 11, 12, 14).

Due to limitations in our data, we did not analyze whether the criteria for prioritization were correctly applied to each patient or if the initial classification was modified and when. Information on left ventricular function and symptomatic status was not available for most patients.

Statistical analysis of events occurring during a time frame with multiple important competing events is challenging to perform and interpret. Kaplan-Meier analysis has limited value compared to the cumulative incidence function. A series of patients with a low risk of death on a SWL can be attributed to patient selection, low-risk patients, or a high frequency of surgeries with low resolution time (22).

CONCLUSION

The overall mortality rate is high, underscoring the risk patients face during their entire time on SWL. Another pressing concern is the accurate classification of patients by physicians and their subsequent monitoring throughout this waiting period, both of which demand significant enhancements. The existing dysfunction within the entire healthcare system, which in this study was further exacerbated by the pandemic, amplified these challenges. Hence, we believe that the time spent on the SWL is a crucial determinant of mortality and must be significantly reduced.

The system should provide better follow-up for patients who are waiting for surgery- to identify a worsening condition or to upgrade the priority for those who surpass the waiting time recommendation. Additionally, the system should be adaptable to handle an extra influx of referrals, particularly urgent and emergency cases, which otherwise, would automatically negatively impact waiting times for elective cases. To enhance outcomes during the early and high-risk periods, proper prioritization and adherence to the schedule plan are essential. The potential extra cost for ensuring a prompt response will likely be compensated by improved outcomes and a reduction in health costs associated with the SWL.

The Portuguese National Health Service should implement stricter waiting time limits for cardiac surgery. The oncology maximum waiting times should serve as a reference for designing and enforcing the system response for cardiac surgery waiting list.

We believe our findings clearly differentiate cardiac surgery from other types of surgery with a lower risk of waiting and should trigger appropriate resource allocation to prevent avoidable adverse outcomes.

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