European Journal of Cardio-Thoracic Surgery 61 (2022) 225–232
doi:10.1093/ejcts/ezab246 Advance Access publication 21 May 2021

**ORIGINAL ARTICLE**

Cite this article as: Scheenstra B, Princée AMA, Imkamp MSV, Kietselaer B, Ganushchak YM, van't Hof AWJ *et al.* Last-minute cancellation of adult patients scheduled for cardiothoracic surgery in a large Dutch tertiary care centre. Eur J Cardiothorac Surg 2022;61:225–32.

# Last-minute cancellation of adult patients scheduled for cardiothoracic surgery in a large Dutch tertiary care centre

Bart Scheenstra [a,b,*,†], Anouk M.A. Princée[a,†], Maike S.V. Imkamp[c,†], Bas Kietselaer[d], Yuri M. Ganushchak [a], Arnoud W.J. van't Hof[b,d,e] and Jos G. Maessen[a,b]

[a] Department of Cardiothoracic Surgery, Heart and Vascular Centre, Maastricht University Medical Centre, Maastricht, Netherlands
[b] Cardiovascular Research Institute Maastricht, Maastricht University, Maastricht, Netherlands
[c] Department of Data Science and Knowledge Engineering, Maastricht University, Maastricht, Netherlands
[d] Department of Cardiology, Zuyderland Medical Centre, Heerlen, Netherlands
[e] Department of Cardiology, Heart and Vascular Centre, Maastricht University Medical Centre, Maastricht, Netherlands

* Corresponding author. Department of Cardiothoracic Surgery, Heart and Vascular Centre, Maastricht University Medical Centre, P. Debyelaan 25, 6229 HX Maastricht, Netherlands. Tel: +31-043-3876543; e-mail: bart.scheenstra@mumc.nl (B. Scheenstra).

Received 17 January 2021; received in revised form 9 March 2021; accepted 16 April 2021

**Key question**

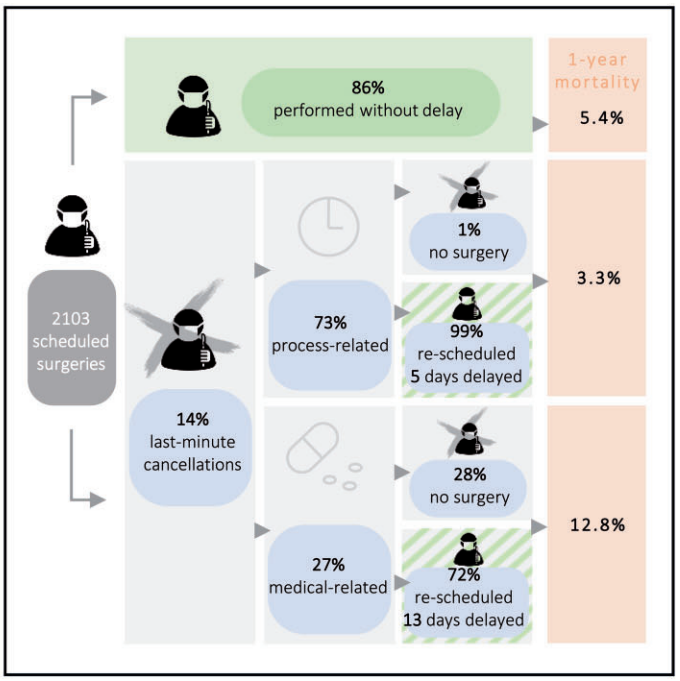
Is the reason for a last-minute cancellation related to patient outcomes in patients scheduled for cardiothoracic surgery?

**Key finding(s)**

Medically related cancellations are associated with significantly higher 1-year mortality.

**Take-home message**

Systematic screening for common medical reasons for last-minute cancellations might reduce these cancellations and mitigate poor outcomes in patients scheduled for cardiothoracic surgery.




## Abstract

**OBJECTIVES:** Unanticipated cancellation of a surgical procedure is a common problem, causing distress to the patient and increases in healthcare costs. However, limited evidence exists on the effects of last-minute cancellations of cardiothoracic surgical procedures in particular. The goal of this study was to gain insight into the prevalence of and the reasons for last-minute cancellations and to examine whether cancellation is associated with adverse medical outcomes.

†These authors contributed equally to this study.

**METHODS:** Patients who were scheduled for elective cardiothoracic surgical procedures between January 2017 and June 2019 were evaluated. The reasons for the cancellations were assigned to the categories medically related or process related. We examined the differences in patient characteristics between those designated as no cancellation, medically related cancellations and process-related cancellations. Lastly, we examined the outcomes of patients who experienced a last-minute cancellation of a scheduled operation.

**RESULTS:** A total of 2111 patients were included; of these, 301 (14.3%) had last-minute cancellations. In 78 (26%) cases, the cancellations were attributable to medical reasons (e.g. infection, comorbidities); 215 (71%) of the cancellations were process related (e.g. another patient in more urgent need of surgery, lack of staff). Almost 99% of the operations with a process-related cancellation were rescheduled compared to only 71.8% of the medically related cancelled operations ($P < 0.001$). Patients with a medically related cancellation had significantly higher 1-year mortality than patients who had no cancellation (unadjusted hazard ratio 2.50; 95% confidence interval, 1.30–4.78; $P = 0.006$); after adjustment for the EuroSCORE II, this effect remained significant.

**CONCLUSIONS:** Last-minute cancellations were commonly seen in our cohort, and the reasons for cancellation were significantly related to adverse medical outcomes.

**Keywords:** Last-minute cancellation • Same day cancellation • Postponed surgery

**ABBREVIATIONS**

| | |
|---|---|
| AVR | Aortic valve replacement |
| CABG | Coronary artery bypass grafting |
| CI | Confidence interval |
| CRP | C-reactive protein |
| HR | Hazard ratio |
| ICU | Intensive care unit |

## INTRODUCTION

Unanticipated cancellation of scheduled surgery often has a negative impact on patient experience, outcomes and healthcare costs [1, 2]. When scheduled surgery is cancelled within 24 h before the intended start (in this article defined as a last-minute cancellation), this event can lead to inefficient use of operating room capacity and other resources. Therefore, last-minute cancellations can lead to increase of patient waiting time and further increase of healthcare costs [3]. Also of importance, a last-minute cancellation causes distress to patients and their relatives [4] and has been associated with an increased risk of adverse medical outcomes [5].

Although cancellation of scheduled surgery is common—a recent study by Wong *et al.* [6] showed a 13.9% cancellation rate for scheduled surgery in the UK—limited evidence exists on last-minute cancellations of cardiothoracic procedures specifically. Consequently, knowledge is limited about the incidence of last-minute cancellations in cardiothoracic surgery and the correlation between causes for cancellation and patient outcomes.

Commonly reported reasons for cancellation are infections, change of health status and an unanticipated long preceding case or occupation of the operating room for a more urgent operation. Categories for the concept of 'reasons for cancellation' differ greatly in the literature [6–11]. A common theme is who initiated the cancellation, for example, the surgeon, the patient or the organization. Another common theme is whether it was possibly foreseeable or not or whether the cancellation was medically related or process related. A medical reason for cancellation is related to the patient's condition and treatment plan. Process-related reasons can make it impossible to perform an operation due to lack of staff or capacity.

The purpose of this study was to examine last-minute cancellations of scheduled cardiothoracic operations. Our goal was to identify the incidence of and reasons for cancellations; to construct 2 categories of cancellations: medically and process related; and to evaluate the impact of the last-minute cancellation on medical outcome measures.

## PATIENTS AND METHODS

### Study design

The study was a retrospective, single-centre, observational cohort study.

### Ethical statement

The medical ethics committee of the Maastricht University Medical Centre confirmed on 9 September 2019 that the Medical Research Involving Human Subjects Act (WMO) did not apply to our study (METC 2019-1081). Patient written informed consent was waived.

### Patients

Data were collected by searching the database of the cardiothoracic surgery department of the Maastricht University Medical Centre in the Netherlands between 1 January 2017 and 1 June 2019. Surgical procedures other than cardiac (e.g. pulmonary, thymus and chest wall) were excluded from the study cohort. Patients with life-threatening conditions and in need of emergency surgery (need for surgery within 24 h) were not included in the cohort. If patients were scheduled multiple times within the described period, only the first scheduled surgery was included. Information on last-minute cancellations was found in the archives of printed timetables. These timetables are printed on the day before the scheduled surgery. When a surgical procedure is cancelled, the secretary marks this on the printed timetable with a short note explaining the reason for the cancellation. Cancellations were included only for patients already admitted to the hospital and with a cancellation within 24 h before the scheduled surgery. Remaining data were collected by the business

information management team using the identification number of the patient. Data that could not be subtracted automatically from the database were obtained manually from the digital patient records by 2 physicians (B.S. and A.M.A.P.).

## Procedures

We categorized the operations into 'coronary surgery' [coronary artery bypass grafting (CABG) and off-pump coronary artery bypass], 'valve surgery' [aortic valve replacement (AVR), mini-AVR, mitral valve replacement and tricuspid valve replacement], 'minimally invasive surgery' (minimally invasive mitral valve plasty, robot-assisted minimally invasive direct coronary artery bypass, transcatheter aortic valve implantation and hybrid atrial fibrillation ablation) and 'multiple procedures' (different combined operations, e.g. AVR and CABG or AVR and mitral valve replacement; this group also includes highly complex surgical procedures like thoracic aorta reconstructions). We constructed these categories based on the logistic aspect, i.e. the duration of the operation, the operating room capacity and the availability of the surgeon.

## Categories of cancellation

Notes about reasons for cancellation were inductively labelled by a physician (A.M.A.P.) using a descriptive coding method. Ambiguities were discussed with another physician (B.S.) to reach consensus. Each note was assigned to a category of alike coded reasons for cancellation. For all categories it was decided whether the assigned reasons were medically related or process related. A reason for cancellation was labelled as a medical cancellation when the event was related to the patient or the treatment plan and when it could, theoretically, be identified and modified in advance during the preoperative work-up.

## Variables and outcomes

The following variables were available to characterize the patients: age, gender (male/female), operation category (see above), American Society of Anesthesiology score [12], EuroSCORE II [13], diabetes mellitus (yes/no), chronic obstructive pulmonary disease (yes/no), C-reactive protein (CRP), serum creatinine, haemoglobin level, referred with urgency (need for surgery within 7 days) (yes/no) and referred from a secondary care centre (yes/no).

For every cancelled procedure it was assessed whether the procedure was rescheduled. For every rescheduled procedure, the waiting time between cancellation and rescheduling was evaluated.

One-year mortality was defined as death 1 year after the performed procedure; the initially scheduled date was the starting point for follow-up only for patients who were not rescheduled.

## Statistical analyses

First, the incidence of last-minute cancellations was reported. The frequency of the different reasons for cancellation was shown together with the incidence of medically and process-related cancellations. Then, the difference in patient characteristics was examined between no cancellation, medically related cancellation and process-related cancellation. Next, the implications of last-minute cancellations were examined by looking at several outcome measures. The percentage of rescheduled patients and the days between the cancellation and the rescheduled operation were compared for the medically and process-related cancellations. The difference in mortality was assessed among the 3 groups. Also, the correlation of 30-day and 1-year mortality with the different reasons for cancellation was examined. In addition, this relation was assessed with an adjustment for EuroSCORE II.

Categorical variables are shown as number (percentage) of patients, and continuous variables are shown as median (25th–75th percentile) or mean (standard deviation), as appropriate. Differences in continuous variables between the normally distributed groups was analysed by the one-way analysis of variance technique. The difference between 2 non-normally distributed groups was analysed by the Mann–Whitney *U*-test and the Kruskal–Wallis test for multiple groups. To compare differences in categorical variables between groups when 1 or more of the expected values was <5, the Fisher's exact test was used; otherwise, we used the $\chi^2$ test. Survival analysis was conducted using Kaplan–Meier methods and the log-rank test. A Cox proportional hazard model was designed to identify independent factors affecting mortality. Statistical analyses were performed using SPSS V.26 (IBM-SPSS Inc., Armonk, NY, USA). The significance level was set at 0.05.

# RESULTS

Between 1 January 2017 and 1 June 2019, a total of 2646 cardiac procedures were identified. After exclusions, 2111 unique patients were available for analysis. For 1810 patients (85.7%), the surgery was performed without delay. For 301 patients (14.3%), the scheduled procedure was cancelled; for 31 patients, the procedure was cancelled more than once. For 276 patients (13.1%) the procedure was rescheduled. A flow chart of the selection process is shown in Fig. 1.

## Reasons for cancellation

After categorizing the reasons for cancellation, 78 (25.9%) patients were identified with a medical reason for cancellation. Process-related cancellations were responsible for 215 (71.4%) of cases; in 8 patients the reason for the cancellation was unknown.

The medical reasons for cancellation included 6 clusters: 'infection' (e.g. high CRP level, pneumonia or fever), 'change of treatment plan' (e.g. percutaneous coronary intervention instead of bypass surgery), 'comorbidities' (e.g. pressure ulcers, poorly controlled diabetes, delirium, anaemia or cancer), 'erroneous continuation of anticoagulation', 'incomplete work-up' (e.g. incomplete cardiac imaging or waiting for collegial consultation) and 'other' (e.g. no show or admission to another hospital). Five process-related reasons were identified: 'more urgent surgery of another patient, delay of a preceding scheduled surgery, lack of an intensive care unit (ICU) bed, lack of staff' and 'other' (Fig. 2).

## Patient characteristics

The differences in patient characteristics between no cancellation, medically related cancellation and process-related

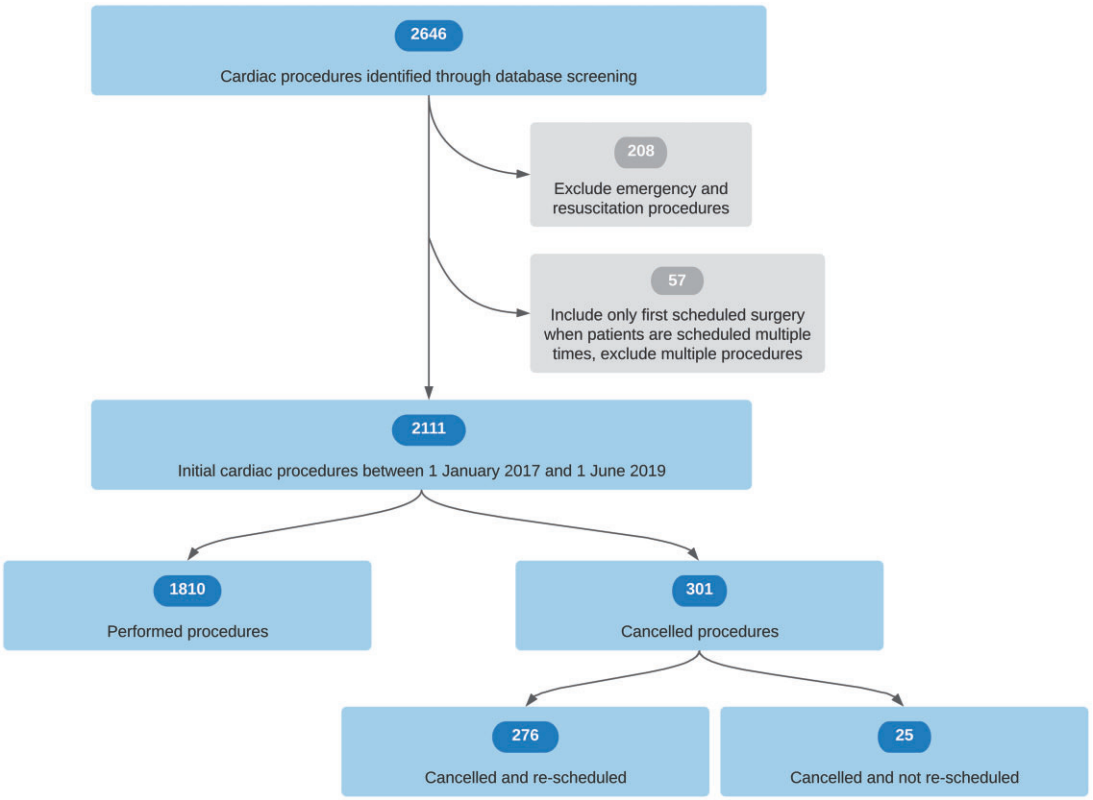



**Figure 1:** Flowchart of selection process.

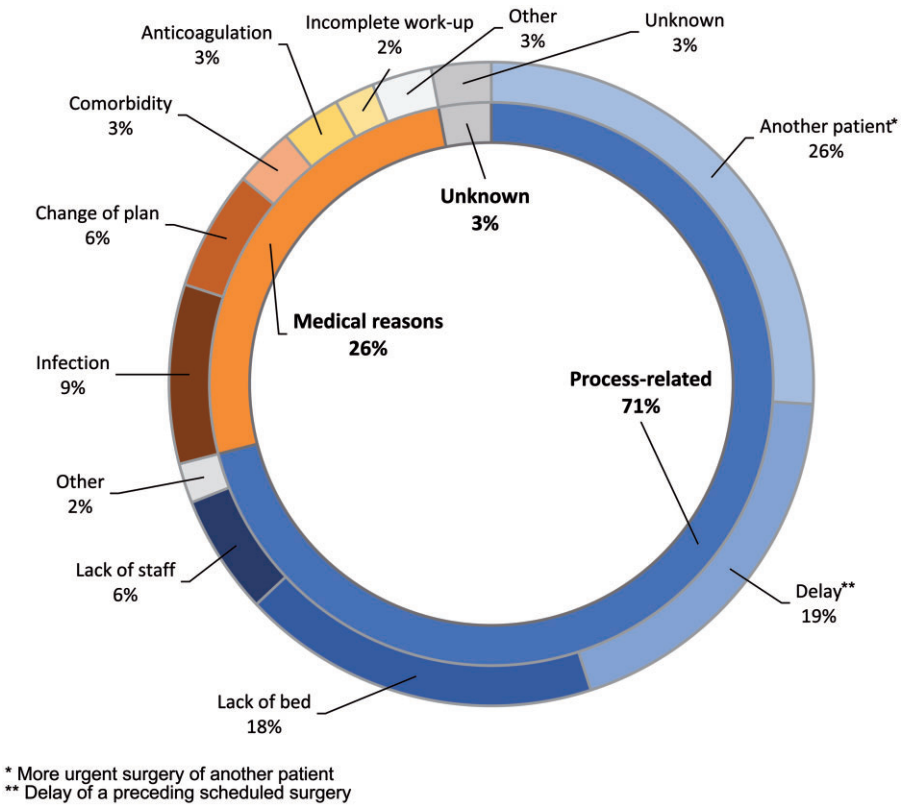



**Figure 2:** Pie chart showing different reasons for cancelled surgical procedures. Inner circle: the main reasons for the cancellations. Outer circle: subdivision of the reasons for the cancellations.

**Table 1:** Patient characteristics

| | No cancellation ($n = 1810$) | Process-related cancellation ($n = 215$) | Medically related cancellation ($n = 78$) | *P*-values |
|---|---|---|---|---|
| Age (years), mean (SD) | 68.7 (10.6) | 67.5 (9.2) | 71.5 (8.8) | 0.004 |
| Male gender, *n* (%) | 1258 (69.5) | 158 (73.5) | 47 (60.3) | 0.093 |
| Operation category, *n* (%) | | | | <0.001 |
| Coronary | 752 (41.5) | 124 (57.7) | 32 (41.0) | |
| Valves | 134 (7.4) | 14 (6.5) | 11 (14.1) | |
| Minimally invasive | 591 (32.7) | 41 (19.1) | 25 (32.1) | |
| Multiple | 333 (18.4) | 36 (16.7) | 10 (12.8) | |
| ASA ≥3, *n* (%) | 1577/1652 (95.5) | 198/215 (92.1) | 68/73 (93.2) | 0.073 |
| EuroSCORE II, median (IQR) | 1.7 (1.1–3.1) | 1.4 (1.0–2.8) | 2.4 (1.3–4.9) | <0.001 |
| Diabetes mellitus, *n* (%) | 372 (20.6) | 50 (23.3) | 17 (21.8) | 0.650 |
| COPD, *n* (%) | 154 (8.5) | 22 (10.2) | 11 (14.1) | 0.171 |
| CRP (mg/l), median (IQR) | 2.0 (1.0–5.0) | 4.1 (1.0–5.0) | 6.0 (2.0–23.0) | <0.001 |
| Hb (mmol/l), mean (SD) | 8.6 (1.0) | 8.8 (1.0) | 8.1 (1.0) | <0.001 |
| Creatinine (μmol/l), median (IQR) | 90.0 (77.0–106.0) | 89.0 (74.0–104.0) | 89.0 (73.5–101.5) | 0.260 |
| Referred with urgency, *n* (%) | 533 (29.4) | 63 (29.3) | 39 (50.0) | <0.001 |
| Referred from secondary care centre, *n* (%) | 1257 (69.4) | 158 (73.5) | 53 (67.9) | 0.445 |

ASA: American Society of Anesthesiology score; COPD: chronic obstructive pulmonary disorder; CRP: C-reactive protein; Hb: haemoglobin; IQR: interquartile range; SD: standard deviation.

**Table 2:** Patient outcomes

| | No cancellation ($n = 1810$) | Process-related cancellation ($n = 215$) | Medically related cancellation ($n = 78$) | *P*-values |
|---|---|---|---|---|
| Rescheduled, *n* (%) | | 212 (98.6) | 56 (71.8) | <0.001 |
| Days till surgery, median (IQR) | | 5.0 (1.0–7.0) | 13.0 (7.0–31.0) | <0.001 |
| 30-Day deaths, *n* (%) | 41 (2.3) | 3 (1.4) | 4 (5.1) | 0.310 |
| 1-Year deaths, *n* (%) | 98 (5.4) | 7 (3.3) | 10 (12.8) | 0.011 |

IQR: interquartile range.

cancellation are shown in Table 1. The overall population is defined by men of almost 70 years of age. In comparison to the 2 other groups, patients who had a medically related cancellation were older, more often scheduled for valve or minimally invasive surgery, had a higher EuroSCORE II, a higher CRP level and a lower haemoglobin level and were more often referred with urgency.

## Implications of last-minute cancellations

Operations that were cancelled for process-related reasons were rescheduled in 98.6% of the cases within a median of 5 days. Operations that were cancelled for medical reasons were only rescheduled in 72% of the cases within a median of 13 days (Table 2).

During 30 days of follow-up, 4 deaths (5.1%) occurred in the medically related cancellation group and 41 (2.3%), in the no cancellation group [unadjusted hazard ratio (HR) for the medically related cancellation group compared with the no cancellation group, 2.34; 95% confidence interval (CI) 0.84–6.52; $P = 0.105$]. A total of 3 deaths (1.4%) occurred in the process-related cancellation group (unadjusted HR for the process-related cancellation group compared with the no cancellation group 0.61, 95% CI 0.19–1.98; $P = 0.412$) (Tables 2 and 3).

After 1 year of follow-up, 10 deaths (12.8%) occurred in the medically related cancellation group and 98 (5.4%) in the no cancellation group (unadjusted HR for the medically related cancellation group compared with the no cancellation group 2.50, 95% CI 1.30–4.78; $P = 0.006$). In the group of patients with a medically related cancellation the mortality of the rescheduled patients was 7.1% and in the group that was not rescheduled, it was 27.3%. A total of 7 deaths (3.3%) occurred in the process-related cancellations group (unadjusted HR for the process-related cancellation group compared with the no cancellations group 0.60, 95% CI 0.28–1.28; $P = 0.185$) (Tables 2 and 3).

Figure 3 shows the survival curves up 1 year from the (initial) scheduled surgery for patients with no cancellation, a medically related cancellation or a process-related cancellation. The Cox proportional hazard model results showed EuroSCORE II and cancellation group to be independent predictors affecting survival during 1 year of follow-up (Table 3). In the unadjusted model, there is an increased risk of death in patients with a medically related cancellation compared to no cancellation over 1 year of follow-up. After adjustment for the EuroSCORE II, the difference in risk of mortality between a medically related cancellation and no cancellation remained statistically significant, with a doubled risk of mortality after a medically related cancellation compared to no cancellation (Table 3).

**Table 3:** Cox proportional HR multivariable model for predictor affecting deaths

| | 30-Day deaths | | | 1-Year deaths | | |
|---|---|---|---|---|---|---|
| | HR | 95% CI | *P*-value | HR | 95% CI | *P*-value |
| Unadjusted model | | | | | | |
| Medically related cancellation versus no cancellation | 2.34 | 0.84–6.52 | 0.105 | 2.50 | 1.30–4.78 | 0.006 |
| Process-related cancellation versus no cancellation | 0.61 | 0.19–1.98 | 0.412 | 0.60 | 0.28–1.28 | 0.185 |
| EuroSCORE-adjusted model | | | | | | |
| Medically related cancellation versus no cancellation | 2.00 | 0.70–5.47 | 0.201 | 2.16 | 1.12–4.14 | 0.021 |
| Process-related cancellation versus no cancellation | 0.67 | 0.21–2.20 | 0.518 | 0.64 | 0.30–1.39 | 0.262 |
| EuroSCORE | 1.09 | 1.06–1.12 | <0.001 | 1.08 | 1.06–1.10 | <0.001 |

CI: confidence interval; HR: hazard ratio.

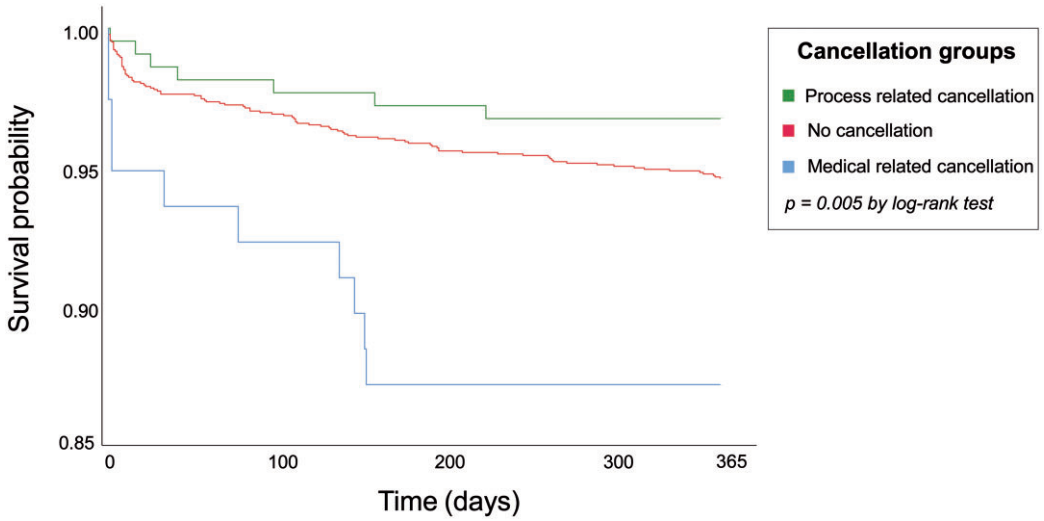



**Figure 3:** Kaplan–Meier survival analysis during 1 year of follow-up from (scheduled) surgery.

## DISCUSSION

The main finding of this study is that medical reasons for last-minute cancellations of cardiothoracic surgery are associated with adverse outcomes.

In total, we found 301 (14.3%) last-minute cancellations in our cohort of 2111 patients who were scheduled for cardiothoracic surgery. In 26% of the cases, cancellation was due to medically related reasons and 71% of the cancellations were attributable to process-related reasons. These results are in line with prior data from our department that showed that 19% of CABG procedures were cancelled <24 h from the scheduled procedure [3] and are similar to results of former studies examining the rate of last-minute cancellations in surgery [6, 8, 14].

We have divided reasons for last-minute cancellations into medically related reasons and process-related reasons to be able to examine the effect of both categories separately on patient outcomes. The reasons assigned to one or the other category have such different origins that the potential interventions to reduce the last-minute cancellations also differ. In other words, both categories need separate understanding and strategies.

Due to their frequent occurrence, process-related cancellations play an important role in the burden of hospital logistics and healthcare costs. Fortunately, it appears that process-related cancellations are often quickly rescheduled (rescheduling occurred in 98.6% of the cases within a median of 5 days) and have no influence on 1-year mortality (3.3%). It is possible that in the case of shortage of capacity, patients with lower urgency and lower EuroSCORE II are cancelled more frequently (Table 1).

The high frequency of process-related cancellations emphasizes the need for an improved scheduling method using patient and treatment characteristics. Innovations in scheduling may help predict the expected duration of treatment in the operating room and length of stay in downstream departments like the ICU and the ward [15], resulting in a reduction of capacity problems due to lack of ICU beds or overrun of a preceding surgery.

The smaller group of medical cancellations had different patient characteristics and outcomes. We saw an important effect on the percentage of rescheduling (only 71.8%) and on the waiting time to get rescheduled (13 days). The time for rescheduling greatly depends on the cause of the cancellation, for example, a patient with newly diagnosed anaemia needs consultation with another specialist and additional testing. Also, we noticed a dramatic effect on 1-year mortality: 12.8% died during follow-up—twice as high compared to no cancellation, even after adjusting for EuroSCORE II. Factors associated with cancellation for medical reasons were older age, referral with urgency, operation category, higher EuroSCORE II, higher CRP levels and lower haemoglobin levels. The adverse outcomes in this vulnerable population indicate that we need to identify these patients during the preoperative work-up period.

Because previously published results showed that more than 50% of last-minute surgery cancellations potentially can be prevented [1, 16, 17], we are currently changing our preoperative work-up [18]. Previously, elective patients waiting for surgery in our department were seen preoperatively at the outpatient clinic by a cardiac surgeon, anaesthesiologist and a cardiosurgical resident. Vital signs, physical examination and some routine tests were done, like chest X-ray, electrocardiogram and blood tests. After assessing the operability of the patient, the type of operation was discussed with the patient and informed consent was obtained. This preoperative work-up is changed with more extensive screenings and guidance. Before visiting the outpatient clinic, patients are screened for modifiable risk factors for adverse perioperative medical outcomes. This screening gives the medical team the opportunity to discuss the best treatment strategy in a multidisciplinary meeting [19] and make a shared decision with the patient and relatives before the operation [20, 21]. This step correspondents with the preoperative phase mentioned in the phase-of-care mortality analysis to reduce mortality in cardiac surgery [22]. In addition, patients with risk factors for adverse medical outcomes can benefit from a prehabilitation programme [23, 24]. Such a programme might not only reduce negative perioperative medical outcomes but also potentially reduce last-minute cancellations [25].

Although we did not measure patient experience after being confronted with a last-minute cancellation, previous research showed a negative impact on the psycho-social health status of patients and their relatives [4]. Last-minute cancellations cause not only disappointment but also anxiety about whether it is safe to go home again. Guidance prior to the surgical procedure must be paramount for these patients.

To reduce last-minute cancellations, digital interventions can be used to prevent frequent reasons for last-minute cancellations. Previous articles in the literature already showed that mobile apps can inform patients about the date of surgery and other appointments during the preoperative process, remind them to start or stop specific medication(s) and monitor them for medical deterioration or an emerging infection [26, 27].

## Limitations

Unfortunately, because there is no uniform definition of a last-minute cancellation or a clear construct on how to categorize reasons for last-minute cancellations, it is difficult to compare results among studies. We realize that the classification of reasons is subjective, but we believe our qualitative method gives direction to a general definition and appropriate interventions.

Our study was limited by its execution as a retrospective, single-centre study. Because of the retrospective nature of this study, the information about the cancellations was retrieved from printed timetables. Therefore, it was not possible to determine the reason for the cancellation in 8 patients. However, as a large tertiary academic referral centre performing a wide range of invasive and minimally invasive procedures, our centre is representative of other centres performing cardiothoracic surgery. We believe the current data provide a reason for prospective interventional studies to improve logistic challenges in cardiothoracic surgery planning as well as the need to identify patients at risk for cancellation for medical reasons. Such interventions may improve cost efficacy and patient outcomes.

## CONCLUSION

Medical reasons for last-minute cancellations in patients scheduled for cardiothoracic surgery are associated with a significantly higher 1-year mortality compared with patients whose surgery was not cancelled or whose surgery was cancelled for a process-related reason. Systematic screening for common medical reasons for last-minute cancellations might reduce these cancellations and negative outcomes in patients scheduled for cardiothoracic surgery.

**Conflict of interest:** none declared.

## Author contributions

**Bart Scheenstra:** Conceptualization; Writing—original draft. **Anouk M.A. Princée:** Data curation; Writing—original draft. **Maike S.V. Imkamp:** Conceptualization; Data curation; Formal analysis; Methodology; Writing—original draft. **Bas Kietselaer:** Supervision; Writing—review & editing. **Yuri M. Ganushchak:** Methodology; Writing—review & editing. **Arnoud W.J. van't Hof:** Supervision; Writing—review & editing. **Jos G. Maessen:** Supervision; Writing—review & editing.

## Reviewer information

European Journal of Cardio-Thoracic Surgery thanks Rakesh Christopher Arora, Vito Domenico Bruno, Alexander Wahba and the other, anonymous reviewer(s) for their contribution to the peer review process of this article.

## REFERENCES

[1] Campbell C, Mora A, Perniciaro S, Abdur-Rahman N, Pierre N, Rosinia F *et al.* The financial burden of cancelled surgeries: implications for performance improvement. American Society of Anesthesiologists' Practice Management Conference. 2011.
[2] Argo JL, Vick CC, Graham LA, Itani KM, Bishop MJ, Hawn MT. Elective surgical case cancellation in the Veterans Health Administration system: identifying areas for improvement. Am J Surg 2009;198:600–6.
[3] Schretlen S, Ogden N. Reducing cardiac surgery cancellations. Int Forum Qual Saf Healthcare. Londen april 2017.
[4] Ivarsson B, Larsson S, Sjoberg T. Postponed or cancelled heart operations from the patient's perspective. J Nurs Manag 2004;12:28–36.
[5] Sobolev BG, Levy AR, Kuramoto L, Hayden R, Brophy JM, FitzGerald JM. The risk of death associated with delayed coronary artery bypass surgery. BMC Health Serv Res 2006;6:85.
[6] Wong DJN, Harris SK, Moonesinghe SR; SNAP-2: EPICCS Collaborators; Health Services Research Centre, National Institute of Academic Anaesthesia; Study Steering Group. Cancelled operations: a 7-day cohort study of planned adult inpatient surgery in 245 UK National Health Service hospitals. Br J Anaesth 2018;121:730–8.
[7] Smith MM, Mauermann WJ, Cook DJ, Hyder JA, Dearani JA, Barbara DW. Same-day cancellation of cardiac surgery: a retrospective review at a large academic tertiary referral center. J Thorac Cardiovasc Surg 2014; 148:721–5.
[8] Sultan N, Rashid A, Abbas SM. Reasons for cancellation of elective cardiac surgery at Prince Sultan Cardiac Centre, Saudi Arabia. J Saudi Heart Assoc 2012;24:29–34.
[9] Fitzsimons MG, Dilley JD, Moser C, Walker JD. Analysis of 43 intraoperative cardiac surgery case cancellations. J Cardiothorac Vasc Anesth 2016; 30:19–22.
[10] Sanjay P, Dodds A, Miller E, Arumugam PJ, Woodward A. Cancelled elective operations: an observational study from a district general hospital. J Health Organ Manag 2007;21:54–8.
[11] Tan AL, Chiew CJ, Wang S, Abdullah HR, Lam SS, Ong ME *et al.* Risk factors and reasons for cancellation within 24h of scheduled elective

surgery in an academic medical centre: a cohort study. Int J Surg 2019; 66:72–8.
[12] Abouleish AE, Leib ML, Cohen NH. ASA provides examples to each ASA physical status class. ASA Newsletter 2015;79:38–49.
[13] Nashef SAM, Roques F, Sharples LD, Nilsson J, Smith C, Goldstone AR *et al.* EuroSCORE II. Eur J Cardiothorac Surg 2012;41:734–45.
[14] Cihoda JH, Alves JR, Fernandes LA, de Souza NE. The analysis for the causes of surgical cancellations in a Brazilian university hospital. Care Manag J 2015;16:41–7.
[15] van den Broek d'Obrenan A, Ridder A, Roubos D, Stougie L. Minimizing bed occupancy variance by scheduling patients under uncertainty. Eur J Oper Res 2020;286:336–49.
[16] Tezel C, Derdiyok O, Evman S, Kanbur S, Demir M, Alpay L *et al.* Prospective study of last minute cancellations of thoracic surgery operations and preventive measures. Eur Res J 2018;52(Suppl 62): PA3166.
[17] Hovlid E, Bukve O, Haug K, Aslaksen AB, von Plessen C. A new pathway for elective surgery to reduce cancellation rates. BMC Health Serv Res 2012;12:154.
[18] Scheenstra B, Mohansingh C, Bongers BC, Dahmen S, Wouters IMS, Lenssen TF *et al.* Personalised teleprehabilitation in elective cardiac surgery: study protocol of the Digital Cardiac Counselling randomised controlled trial. European Heart Journal - Digital Health, 2021.
[19] Luckraz H, Norell M, Buch M, James R, Cooper G. Structure and functioning of a multidisciplinary 'Heart Team' for patients with coronary artery disease: rationale and recommendations from a joint BCS/BCIS/SCTS working group. Eur J Cardiothorac Surg 2015;48:524–9.
[20] Schneider AW, Putter H, Hazekamp MG, Holman ER, Bruggemans EF, Versteegh MIM *et al.* Twenty-year experience with stentless biological aortic valve and root replacement: informing patients of risks and benefits. Eur J Cardiothorac Surg 2018;53:1272–8.
[21] Montori VM, Ting HH. Sharing decision-making about cardiac surgery: improving the quality of the decision to undergo or forego surgery. Circ Cardiovasc Qual Outcomes 2009;2:519–21.
[22] Shannon FL, Fazzalari FL, Theurer PF, Bell GF, Sutcliffe KM, Prager RL. A method to evaluate cardiac surgery mortality: phase of care mortality analysis. Ann Thorac Surg 2012;93:36–43; discussion 43.
[23] Batchelor TJP, Rasburn NJ, Abdelnour-Berchtold E, Brunelli A, Cerfolio RJ, Gonzalez M *et al.* Guidelines for enhanced recovery after lung surgery: recommendations of the Enhanced Recovery After Surgery (ERAS®) Society and the European Society of Thoracic Surgeons (ESTS). Eur J Cardiothorac Surg 2019;55:91–115.
[24] McCann M, Stamp N, Ngui A, Litton E. Cardiac prehabilitation. J Cardiothorac Vasc Anesth 2019;33:2255–65.
[25] McKendrick DRA, Cumming GP, Lee AJ. A 5-year observational study of cancellations in the operating room: does the introduction of preoperative preparation have an impact? Saudi J Anaesth 2014;8:S8–14.
[26] Bass E, Gill P. Report into "on the day cancellations" for plastic surgery in patients who failed to stop their medication. BMJ Qual Improv Report 2014;3:u204762.w2037.
[27] Stewart JJ, Fayed I, Henault S, Kalantar B, Voyadzis JM. Use of a smartphone application for spine surgery improves patient adherence with preoperative instructions and decreases last-minute surgery cancellations. Cureus 2019;11:e4192.