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ORIGINAL ARTICLE

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Impact of the coronavirus disease 2019 pandemic on volume of thoracic aortic surgery on a national level

Hector W.L. de Beaufort [a,*], Maaike M. Roefs[b], Edgar J. Daeter[a,b] and Robin H. Heijmen [a]; on behalf of the Cardiothoracic Surgery Registration Committee of the Netherlands Heart Registration[†]

[a] Department of Cardiothoracic Surgery, St. Antonius Ziekenhuis, Nieuwegein, Netherlands
[b] Netherlands Heart Registration, Utrecht, Netherlands

* Corresponding author. Department of Cardiothoracic Surgery, St. Antonius Ziekenhuis, Koekoekslaan 1, Nieuwegein 3435 CM, Netherlands. Tel: 0031-(0)88-320-1176; e-mail: h.de.beaufort@antoniusziekenhuis.nl (H.W.L. de Beaufort).

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Key question

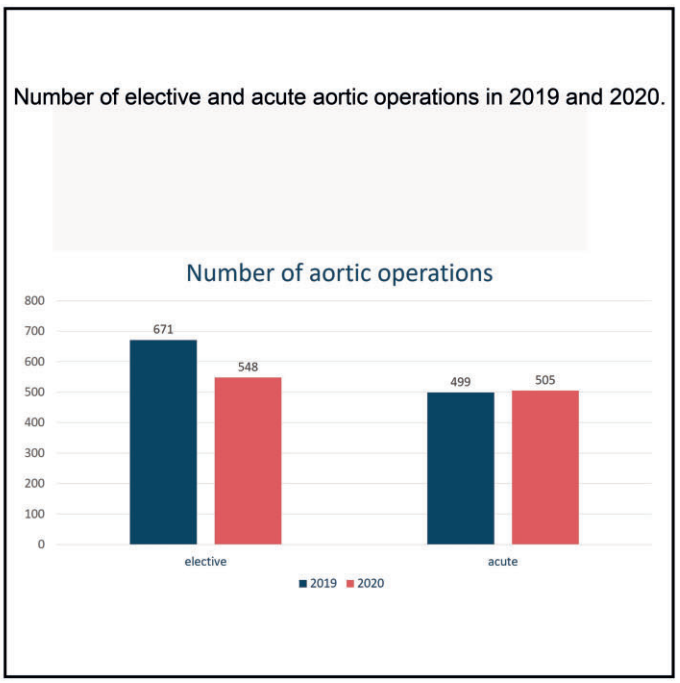
What was the impact of the first year of the COVID-19 pandemic on thoracic aortic surgery in the Netherlands?

Key finding(s)

The volume of elective aortic surgery decreased while that of acute operations remained similar to the volume before the COVID-19 pandemic.

Take-home message

The decrease in elective aortic operations caused by the COVID-19 pandemic did not cause an immediate increase in acute cases.



Abstract

OBJECTIVES: The aim of this study was to evaluate the effects of the coronavirus 2019 pandemic on elective and acute thoracic aortic surgery in the Netherlands.

METHODS: The Netherlands Heart Registration database was used to compare the volume of elective and acute surgery on the thoracic aorta in 2019 and 2020, starting from week 11 in both years. A sub-analysis was done to assess the impact of the pandemic on high-volume and low-volume aortic centres.

[†]The committee members are listed in the Appendix.

RESULTS: During the pandemic, the number of elective thoracic aortic operations declined by 18% [incidence rate ratio (IRR) 0.82 [0.73–0.91]; $P < 0.01$]. The decline in volume of elective surgery was significant in both high-volume (IRR 0.82 [0.71–0.94]; $P < 0.01$) and low-volume aortic centres (IRR 0.81 [0.68–0.98]; $P = 0.03$). The overall number of acute aortic operations during the pandemic remained similar to that in 2019 (505 vs 499; $P = 0.85$), but an increased share of these operations occurred at high-volume centres. The number of acute operations performed in high-volume centres increased by 20% (IRR 1.20 [1.01–1.42]; $P = 0.04$), while the number of acute operations performed in low-volume centres decreased by 17% (IRR 0.83 [0.69–1.00]; $P = 0.04$).

CONCLUSIONS: The coronavirus 2019 pandemic led to a significant decrease in elective thoracic aortic surgery but did not cause a change in the volume of acute thoracic aortic surgery in the Netherlands. Moreover, the pandemic led to a centralization of care for acute thoracic aortic surgery.

Keywords: Thoracic aorta • COVID-19 • Aortic surgery • The Netherlands • Surgical volume

ABBREVIATIONS

COVID-19	Coronavirus disease 19
IRR	Incidence rate ratio
NHR	Netherlands Heart Registration

INTRODUCTION

The coronavirus disease 19 (COVID-19) pandemic has impacted the delivery of health care around the world. Factors such as restrictive government regulations and the fear of infection with COVID-19 during a hospital visit have led to profound shifts in healthcare use. For example, during the first wave of the pandemic, ∼40% decreases in admissions for myocardial infarction were noted in different regions of the USA [1, 2] and a 41% decrease in presentations of acute coronary syndrome was found in the Netherlands [3]. Similar declines were seen in the admissions for heart failure and myocardial infarction during the second wave in the UK [4], for the number of diagnostic cardiological procedures performed at centres around the world [5] and for admissions for myocardial infarction and stroke in Northern California [6].

Considering the fact that aortic surgery relies on the use of limited hospital resources, including intensive care unit beds, it comes as no surprise that the pandemic has affected the care for patients with aortic disease as well. Czerny *et al.* [7] recently investigated the impact of the first wave of the pandemic on the care of patients with aortic disease in a large number of hospitals, mostly located in Europe, and found a significant reduction of 35% in elective surgery, while the number of acute operations remained more or less stable.

The current study was performed as a continuation of the study by Czerny *et al.* [7], but then on a national level including all Dutch cardiac surgical centres. Using available data from the Netherlands Heart Registration (NHR), a national data registry collected for quality control and improvement purposes, we aimed to evaluate the effects of the COVID-19 pandemic on thoracic aortic surgery in the Netherlands.

MATERIALS AND METHODS

Ethics statement

The use of data in the NHR database for research purposes has been approved by the Medical Research Ethics Committees United (reference number W19.270) that issued a waiver for informed consent for the current analysis of anonymized data.

Data collection and analysis

The NHR is a national quality registry which aims to contribute to quality improvement and safety in cardiac care. The NHR processes data on all cardiac surgeries by order of the 16 Dutch hospitals in which these procedures are performed. NHR data are collected in the following way: participating centres submit their data to the registry quarterly. All procedures that are performed by a cardiac surgeon and in which there has been an incision or puncture, even if they were aborted shortly after, are registered. Each centre has 1 or more affiliated physicians and data managers dedicated to the registration of all cardiac procedures. For each procedure, variables on patient characteristics (i.e. age, Euroscore II), operative characteristics (i.e. type of operation) and outcomes (i.e. mortality, stroke) are collected. Data are validated using multiple methods, for example the hospitals receive an automated data quality report directly after upload of the data and each year a monitor visit (audit) is conducted to compare the data in the NHR database with the information in the medical records

Operations classified as 'surgery on the thoracic aorta' which were performed in 2019 and 2020 on patients ≥18 years old were included for analysis. Operations classified as 'elective' were analysed as such, while procedures classified as 'life-saving', 'emergent' or 'urgent' were considered acute. Information on indication for surgery was also collected. Centres were classified as high-volume if they performed ≥50 elective operations on the thoracic aorta in 2019. Following this criterium 10 centres were classified as low-volume centres and 6 centres as high-volume centres. Since the COVID-19 pandemic did not lead to significant government measures or hospital policies before week 11, the first 10 weeks of both years were excluded from analysis. Week numbers were counted as each 7 days from the 1st of January of each year, so they were slightly different from calendar week numbers. For 2020, weeks 11–21 were considered the first wave of the pandemic, and weeks 40–53 as the second wave.

Statistics

Poisson regression analysis was used to calculate incidence rate ratios (IRR) to compare the numbers of operations in 2019 and 2020, without adjustment for possible confounders, since the patient populations in 2019 and 2020 were presumed to be comparable. Statistical significance was assumed

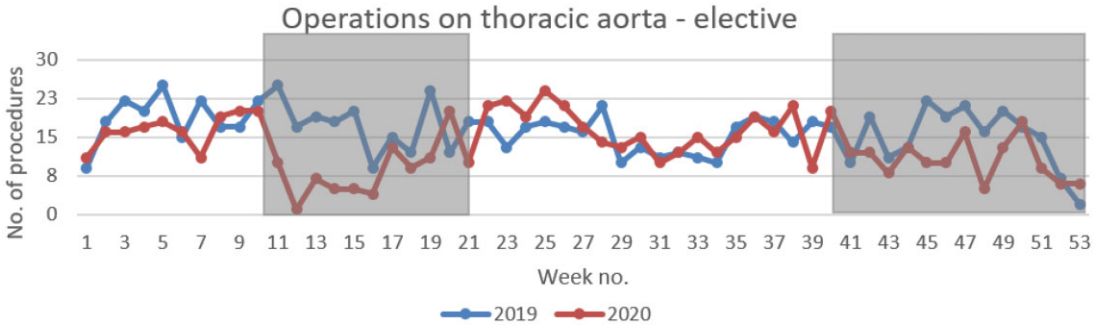


Figure 1: Number of elective operations on the thoracic aorta by week. The first and second waves of the pandemic in 2020 are shown in grey.

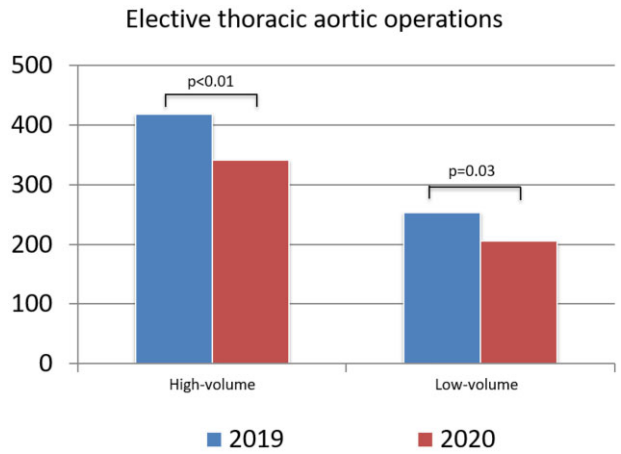


Figure 2: Total number of elective operations for high-volume and low-volume aortic centres in 2019 and 2020. Poisson regression analysis was used to calculate incidence rate ratios to compare the numbers of operations in 2019 and 2020.

at $P < 0.05$ and 95% confidence intervals were calculated. Statistical analysis was performed using IBM SPSS Statistics software (version 26).

Data availability statement

All relevant data are within the manuscript.

RESULTS

Fourteen interventions (0.6%) were excluded from analysis, since the urgency of the operation had not been documented ($n = 6$ in 2019 and $n = 8$ in 2020), which left 1170 operations in 2019 and 1053 operations in 2020 available for analysis.

Elective aortic surgery

In 2020, 548 elective operations were performed compared to 671 in 2019, an 18% reduction which was statistically significant (IRR 0.82 [0.73–0.91]; $P < 0.001$). The number of elective operations per week is shown in Fig. 1. The decrease in operations is clearly related to the first and second wave of the pandemic, whereas in weeks 21–41, when there were relatively few new cases of COVID-19, there was no compensatory increase in elective aortic surgery. The reduction in elective operations was present in both high-volume and low-volume aortic centres. In high-volume centres, 342 elective operations were performed in 2020 compared to 418 in 2019, an 18% reduction which was statistically significant (IRR 0.82 [0.71–0.94]; $P \leq 0.01$). In low-volume centres, 206 operations were performed in 2020 compared to 253 in 2019, a 19% reduction that was also statistically significant (IRR 0.81 [0.68–0.98]; $P = 0.03$; Fig. 2). Aneurysm disease was the most common indication for elective aortic surgery, although the share of patients treated for aneurysm disease decreased from 72% in 2019 to 60% in 2020, while a greater percentage of cases were classified as having an unknown indication in 2020 (Fig. 3).

Acute aortic surgery

In 2020, 505 acute operations were performed, which was similar to the 499 operations during the same period in 2019 ($P = 0.85$). There was no easily discernible effect of the pandemic on the number of acute operations per week during first wave, second wave, or the period in between the 2 waves, as can be seen in Fig. 4. While the total number of acute operations remained the same on a national level, an increased share of these operations occurred at high-volume centres. In high-volume centres, 298 acute operations were performed in 2020 compared to 249 in 2019, a 20% increase that was statistically significant (IRR 1.20 [1.01–1.42]; $P = 0.04$). In low-volume centres, 207 operations were performed in 2020 compared to 250 in 2019, a 17% reduction that was statistically significant (IRR 0.83 [0.69–1.00]; $P = 0.04$; Fig. 5). Aortic dissection was the most common indication for acute aortic surgery (43% of cases in 2019 and 48% of cases in 2020), followed by aneurysm disease (28% in 2019 compared to 18% in 2020; Fig. 6).

DISCUSSION

The results of the current study show that the first and second waves of the COVID-19 pandemic have led to a significant decrease in elective thoracic aortic operations on a national level, but this has not led to a significant change in acute thoracic aortic operations. This confirms the study results noted for the first wave of the pandemic by Czerny *et al.* [7] for a selection of aortic centres around Europe. While fear of contracting the coronavirus during a hospital visit is likely to have played a role in the reduction of admissions for heart failure or myocardial infarction, this effect was not seen for acute thoracic aortic disease. The intensity of pain associated with aortic disease, which is described as

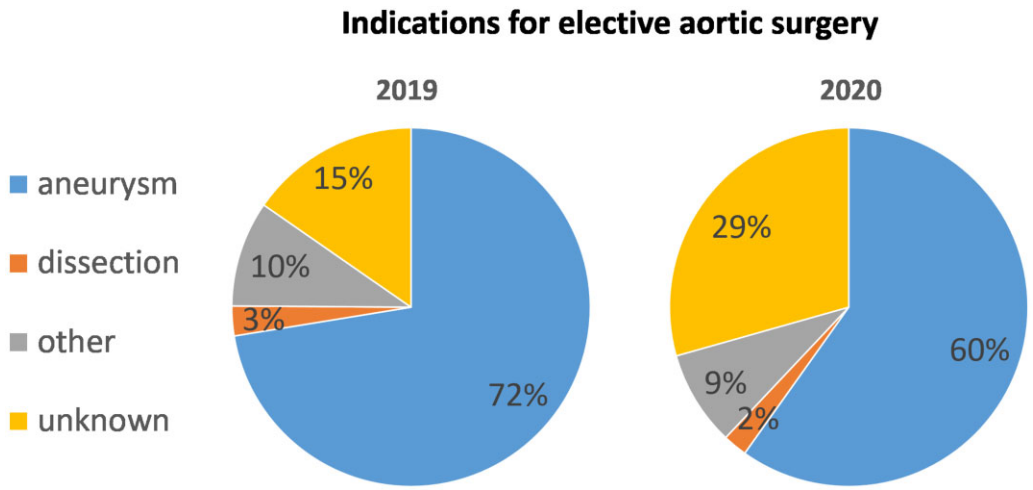


Figure 3: Pie charts showing the distribution of indications for elective aortic surgery in 2019 and 2020.

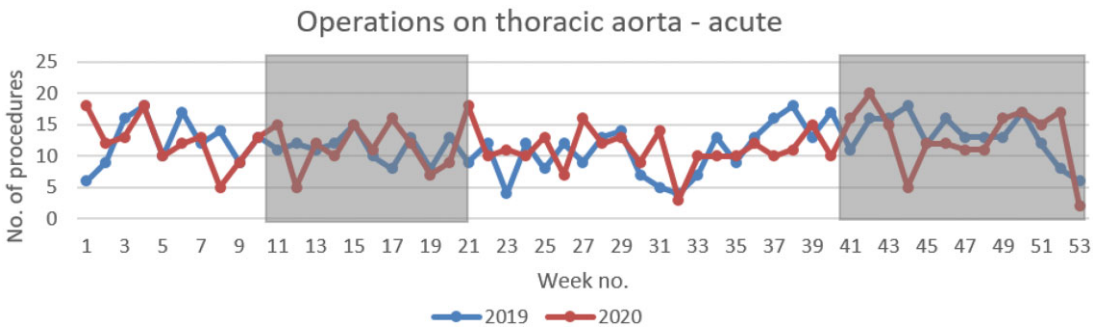


Figure 4: Number of acute operations on the thoracic aorta by week. The first and second waves of the pandemic in 2020 are shown in grey.

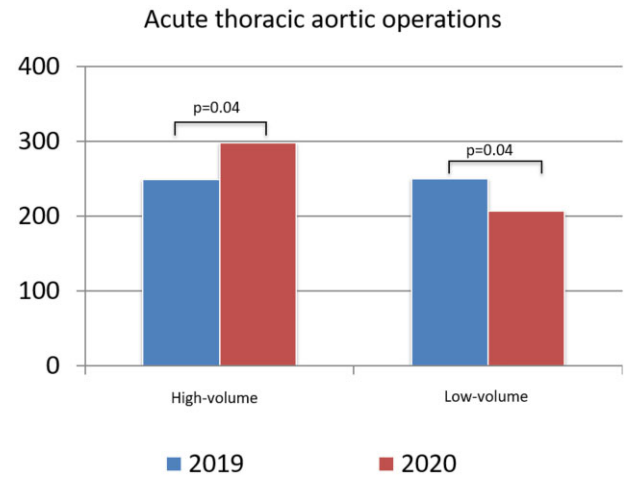


Figure 5: Total number of acute operations for high-volume and low-volume aortic centres in 2019 and 2020. Poisson regression analysis was used to calculate incidence rate ratios to compare the numbers of operations in 2019 and 2020.

either severe or the worst pain imaginable by 90% of patients with aortic dissection [8], has been coined as the explanation. This hypothesis is further supported by the results of Seiffert *et al.* [9], who noted decreases in admissions for stroke, myocardial infarction and acute limb schema but not for aortic rupture during the pandemic in Germany. In contrast, El-Hamamsy *et al.* [10] reported significant decreases in admissions also for acute aortic dissections during the pandemic in New York.

The decrease in elective aortic operations is easily explained by the exceptional demands on healthcare resources during the pandemic. However, while the care and distribution of patients with COVID-19 in the Netherlands is coordinated on a national level, this is not the case for patients with aortic disease. It is therefore all the more remarkable that the pandemic had the side effect of causing a centralization of care for patients with acute thoracic aortic disease, as is shown by the increase in aortic operations in centres that were already high-volume centres in 2019. The reasons why the COVID-19 pandemic led to an increased share of acute aortic care by high-volume aortic centres are unknown. It is possibly due to a combination of factors which differ in high- and low-volume aortic centres. These differences could include the available intensive care capacity for acute aortic pathologies, the mindset to accept patients for relatively high-risk aortic surgery during times of scarcity, and the obligations of a centre to deliver other emergency surgical services (trauma, neuro, transplantation, etc.) besides aortic surgery.

Apparently, the delivery of acute thoracic aortic care in the Netherlands remained guaranteed throughout the pandemic. We have not tested whether this centralization led to a change in outcomes, including mortality, since the outcomes of surgery were not included in the current study. However, these data are available within the NHR and could be the subject for a follow-up study. Moreover, we do not know whether the centralization

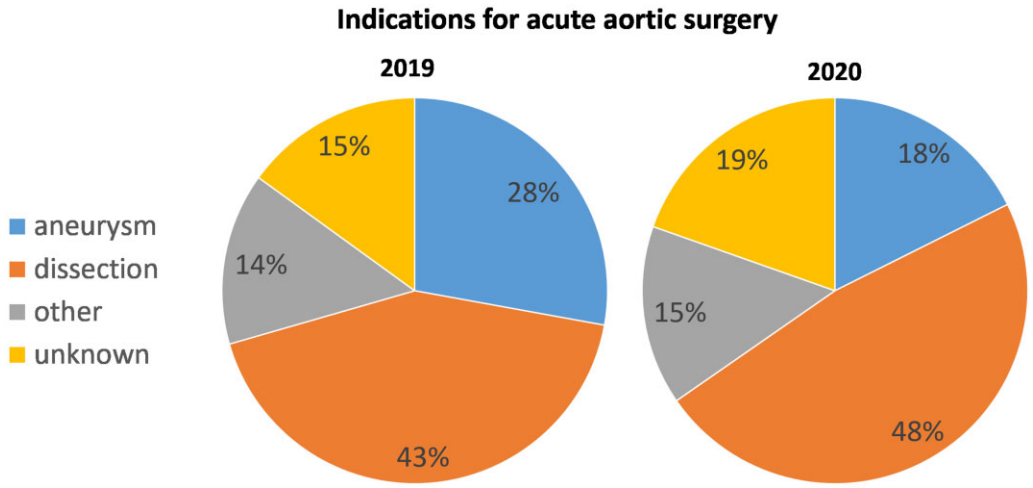


Figure 6: Pie charts showing the distribution of indications for acute aortic surgery in 2019 and 2020.

of care will prove to be a temporary or a lasting effect of the pandemic.

A final finding of note is that the postponement of elective thoracic aortic operations during first and second wave of the pandemic has not (yet) led to an increase in acute operations. Apparently, an effective method of triage has been applied to the waiting list of elective operations, and most elective aortic operations can be safely postponed by 6 months to 1 year. The decreasing share of patients treated for aneurysm disease in 2020 may be a reflection of the applied methods of triage. The natural history of aneurysm disease predicts a <5% risk of an adverse aortic event within 1 year for 'smaller' aneurysms of 5.0–6 cm [11, 12]. It is imaginable that these are the patients who have been postponed for a few months, without immediate measurable consequences in our patient population. Whether pushing back the date of surgery even further will lead to increases in acute admissions with aortic disease, remains to be seen. In extension of the postponement of elective surgery, surveillance imaging visits may also have been postponed as a result of the pandemic. It seems that this, too, has not (yet) led to an increase in acute cases with aneurysm. Broadly speaking, the distribution of pathologies treated acutely remained similar during the pandemic and, in fact, the share of patients treated acutely for aneurysm has even seemed to decrease a bit in 2020.

Limitations

Besides the lack of follow-up data mentioned above, other limitations of this study include the lack of insights on outcomes after surgery, and the fact that no data were gathered on patients with aortic disease who were treated conservatively. Moreover, the variety of thoracic aortic operations may not have been the same for all centres during the study period.

CONCLUSION

The COVID-19 pandemic led to a significant decrease in elective thoracic aortic operations but did not cause a change in acute thoracic aortic operations in the Netherlands. Moreover, the pandemic led to a centralization of care for acute thoracic aortic operations. The future will have to prove whether this centralization is temporary or not, and whether the backlog of elective thoracic aortic operations in 2020 will lead to an increase in acute operations in the following years.

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Conflict of interest: none declared.

Author contributions

Hector W.L. de Beaufort: Investigation; Methodology; Project administration; Visualization; Writing—original draft. **Maaike M. Roefs:** Formal analysis; Investigation; Visualization; Writing—review & editing. **Edgar J. Daeter:** Conceptualization; Methodology; Project administration; Writing—review & editing. **Robin H. Heijmen:** Conceptualization; Methodology; Project administration; Supervision; Writing—review & editing.

Reviewer information

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APPENDIX

S. Bramer, Amphia Ziekenhuis, Breda, the Netherlands
W.J.P. van Boven, Amsterdam UMC, locatie AMC, the Netherlands
A.B.A. Vonk, Amsterdam UMC, locatie VUmc, the Netherlands
B.M.J.A. Koene, Catharina Ziekenhuis, the Netherlands
J.A. Bekkers, Erasmus MC, the Netherlands
G.J.F. Hoohenkerk, HagaZiekenhuis, the Netherlands
A.L.P. Markou, Isala Klinieken, Zwolle, the Netherlands
A. de Weger, Leids Universitair Medisch Centrum, Leiden, the Netherlands
P. Segers, Maastricht UMC+, Maastricht, the Netherlands
F. Porta, Medisch Centrum Leeuwarden, Leeuwarden, the Netherlands
R.G.H. Speekenbrink, Medisch Spectrum Twente, Enschede, the Netherlands
W. Stooker, Onze Lieve Vrouwe Gasthuis, Amsterdam, the Netherlands
W.W.L. Li, Radboud UMC, Nijmegen, the Netherlands
E.J. Daeter, St. Antonius Ziekenhuis, Nieuwegein, the Netherlands
N.P. van der Kaaij, UMC Utrecht, Utrecht, the Netherlands
Y.L. Douglas, Universitair Medisch Centrum Groningen, Groningen, the Netherlands