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Journal of Geriatric Oncology 15 (2024) 101711

Contents lists available at ScienceDirect

Journal of Geriatric Oncology

journal homepage: www.elsevier.com/locate/jgo

Research Paper

The prognostic value of a geriatric risk score for older patients undergoing emergency surgery of colorectal cancer: A retrospective cohort study

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ARTICLE INFO

Keywords:
Colorectal surgery
Colorectal cancer
Emergency surgery
Older patients
Prediction

ABSTRACT

Introduction: Emergency surgery of colorectal cancer is associated with high mortality rates in older patients. We investigated whether information on four geriatric domains has prognostic value for 30-day mortality and postoperative morbidity including severe complications.
Materials and Methods: All consecutive patients aged 70 years or older who underwent emergency colorectal cancer surgery in six Dutch hospitals (2014–2017) were studied. Presence of geriatric risk factors was scored prior to surgery as either 0 (risk absent) or 1 (risk present) in each of four geriatric domains and summed up to calculate a sumscore with a value between 0 and 4. In addition, we separately investigated the use of a mobility aid. Primary outcome was 30-day mortality. Secondary outcomes were any postoperative complications and severe complications. Multivariable logistic regression model was used to evaluate the sumscore and outcomes.
Results: Two hundred seven patients were included. Median age was 79.4 years. One hundred seventy-five patients (76%) presented with obstruction, 22 (11%) with a perforation, and 17 (8%) with severe anemia. Mortality rates were 2.9%, 13.6%, and 29.6% for patients with a sumscore of 0, 1–2, and 3–4 respectively, with odds ratio (OR) 4.8 [95% confidence interval (CI) 1.03–22.95] and OR 10.6 [95% CI 1.99–56.34] for a sumscore of 1–2 and 3–4 respectively. Use of a mobility aid was associated with increased mortality OR 8.0 [95% CI 2.74–23.43] and severe complications OR 2.31 [95% CI 1.17–4.55].
Discussion: This geriatric sumscore and the use of a mobility aid have strong association with 30-day mortality after emergency surgery of colorectal cancer. This could provide better insight into surgical risk and help select high-risk patients for alternative strategies.

1. Introduction

Over 50% of all patients newly diagnosed with colorectal cancer are 70 years or older [1–3]. About 20% of patients over 70 years with colorectal cancer need emergency surgery [3]. Emergency surgery is mostly due to bowel obstruction, perforation, or bleeding. Compared to elective surgery, emergency colorectal cancer surgery is associated with worse postoperative outcomes, increased morbidity, and mortality [3,4]. Based on multiple risk factors, individual postoperative mortality risk after emergency surgery may increase to 41% for older patients [3–5]. A previous Dutch study showed mortality rates after emergency surgery in older patients were doubled compared to elective surgery [6].

Risk factors for poor outcomes in emergency surgery are older age, higher American Society of Anesthesiologists (ASA) score, comorbidity,

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https://doi.org/10.1016/j.jgo.2024.101711
Received 9 September 2023; Received in revised form 24 December 2023; Accepted 22 January 2024
Available online 3 February 2024

and higher tumor stage [3]. Previously, we have shown that geriatric parameters such as activities of daily living (ADL) dependency, falls, malnutrition, and risk of delirium have independent prognostic value for poor surgical outcomes in elective colorectal surgery. This was independently of age, sex, tumor stage, and ASA score [7]. Thus far, the prognostic value of these geriatric parameters has not been studied in emergency surgery for colorectal cancer. Prognostication can yield guidance to optimize treatment decisions [7]. Patients with risk factors for poor surgical outcome could benefit from a less invasive decompressing stoma or stent as a bridge to surgery instead of acute resection [8]. A decompressing stoma as a bridge to surgery improves survival, especially in older patients [8]. Also, tailored post-operative care and interventions to prevent functional deterioration in selected patients with known geriatric risk factors could improve outcomes for these patients [9].

In this study, we investigated whether a cumulative risk score composed of risk assessment for functional impairment, malnutrition, risk for delirium, and fall risk had a prognostic value for postoperative morbidity and mortality after emergency surgery of colorectal cancer.

2. Materials and Methods

2.1. Study Population

All patients aged 70 years or older that underwent emergency surgery for colorectal cancer between January 1, 2014 and December 31, 2017 in six teaching hospitals in The Netherlands (Haga Hospital in The Hague, Diakonessenhuis in Utrecht, Reinier de Graaf Gasthuis in Delft, Alrijne Hospital in Leiderdorp, Dijklander Hospital in Hoorn, and Meander Medical Center in Amersfoort) were included in this retrospective cohort study. Ethical approval for this study was obtained from the Medical Ethics Committee Southwest Holland. Patients with elective surgery, transanal endoscopic microsurgery (TEM), or a synchronous second malignancy were excluded. Emergency surgery is defined as acute surgery <24 h of presentation and urgent surgery <72 h of presentation.

The primary outcome for this study was 30-day mortality due to any cause. Secondary outcome was any complication within 30 days after surgery, including severe complications. Severe complications were defined as those leading to surgical, endoscopic, or radiological re-intervention; a length of hospital stay of >14 days; or death [9].

2.2. Data Collection

Preoperative patient characteristics and surgical outcome parameters were retrieved from the prospectively collected Dutch Colorectal Audit (DCRA) and electronic medical records (EMR). It is mandatory for all Dutch hospitals to register their surgical patients in the DCRA. Geriatric parameters were retrieved from the EMR and were registered as part of standard preoperative care.

The following data were retrieved from the DCRA: age, sex, ASA score, comorbidity, oncological data (i.e., tumor type, tumor location, and staging), type of surgery (acute, urgent, or elective), surgical approach (open or laparoscopic), pre- and postoperative complications, and 30-day mortality. Charlson comorbidity index (CCI) [10]was calculated for all patients. The total number of patients with complications refers to the number of patients with one or more complications. The most severe surgical complication was registered, when two or more complications in one patient occurred.

2.3. Geriatric Characteristics

In the participating hospitals the following four geriatric domains were assessed: physical impairment, fall risk, risk for malnutrition (or at risk of becoming undernourished), and risk for delirium. These were assessed preoperatively by nursing staff using screening questionnaires as part of the National Patient Safety Program (VMS) [7].

Functional impairment was assessed using the six-item Katz-ADL [11], assessment of fall risk, and the preoperative use of a mobility aid. Katz-ADL consists of six questions regarding bathing, dressing, using the toilet, eating, transferring from bed to chair, and if the patient used incontinence materials. A Katz ADL score ≥ 2 was defined as functional impairment. Fall risk was assessed with one question and was either present or absent. Use of a mobility aid included the use of a cane, crutches, a walking frame, walkers, or wheelchair. Risk for malnutrition was assessed using either the Short Nutritional Assessment Questionnaire (SNAQ) [12] or Malnutrition Universal Screening Tool (MUST) [13]. SNAQ score ≥ 3 or MUST score ≥ 2 was defined was an increased risk for malnutrition. Assessment of risk for delirium consisted of three yes or no questions scoring 1 or 0 [7], with a score ≥ 1 considered as an increased risk as suggested by national guidelines [14].

In line with our previous study, a low risk score was defined as sumscore of 0, intermediate risk as sumscore of 1 or 2, and high risk as sumscore of 3 or 4 [7].

All geriatric information is registered in the EMR prior to surgery. Information from the VMS does not alter the therapeutic plan but is used to guide supportive measures after surgery. For instance, when VMS shows a high risk of malnutrition, a dietician can be consulted.

2.4. Statistical Analysis

Baseline and outcome variables were assessed on missing variables. Missing data on candidate predictors were subsequently imputed with a single imputation technique. For missing data, imputation was performed using the Multivariate Imputation by Chained Equations (MICE) package in R (R Foundation for Statistical Computing, Vienna, Austria, Version 3.5.2.). Because of the low number of missing events, analysis was performed on the first imputed dataset.

Descriptive statistical analysis was used expressing normally distributed variables as mean with standard deviation (SD) and non-normally distributed variables as median with interquartile range (IQR). Frequencies are presented as number and percentage.

Association between risk factors and postoperative outcomes was assessed using univariable and multivariable logistic regression models to estimate odds ratios with corresponding 95% confidence interval [CI]. Age, male sex, and ASA score were added to the multivariable model to assess the independent prognostic value of the VMS sumscore. Tumor stage was added in an additional model. SPSS version 24.0 (SPSS, Inc., Chicago, IL) and R software (Version 3.5.2) was used to perform all analyses. *P*-Values <0.05 were considered statistically significant.

3. Results

Out of 1837 patients operated for colorectal cancer between 2014 and 2017, 207 patients with emergency surgery (11%) were included in

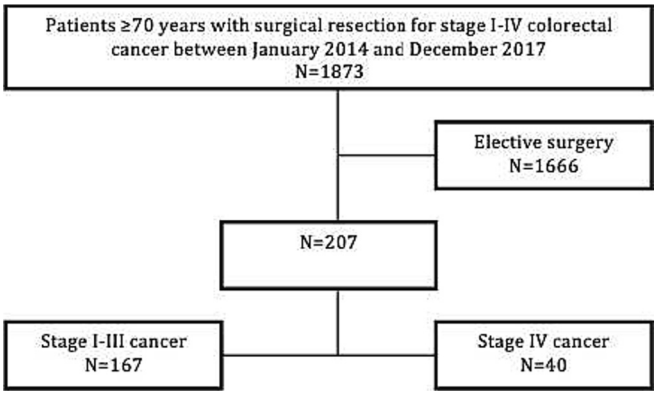

Fig. 1. Flow diagram.

this analysis (Fig. 1). Table 1 presents demographic characteristics and geriatric parameters. Median age was 79.4 years (IQR 74.5–84.9) and 103 were male (50%). Forty patients (19%) had stage IV colorectal cancer.

Most tumors were located in the colon (n = 203; 98%) and most patients had open surgery (n = 179; 87%). Seventy-six patients (37%) received an ostomy. One hundred seventy-five patients (76%) presented with an obstruction, 22 patients (11%) with a perforation, 17 patients (8%) with anemia or blood loss requiring transfusion, and six patients (3%) with an abdominal abscess. Fifteen patients (7%) had other presenting symptoms. Twelve patients (6%) presented with two or more pre-operative complications simultaneously. For eleven patients (5%), the reason for emergency surgery was not specified.

Thirty-six patients (17%) were ADL dependent with a Katz ADL score of 2 or higher and 98 patients (47%) were at risk for malnutrition. Thirty-five patients (17%) reported at least one fall in the past six months and 65 patients (31%) were at risk for delirium. Sixty-four (31%) reported use of a mobility aid.

A total of 70 patients (34%) had no deficits in the geriatric domains resulting in a low risk sumscore of 0, 110 patients (53%) had deficits in 1 or 2 geriatric domains resulting in an intermediate risk sumscore, and 27 patients (13%) had deficits in 3 or 4 geriatric domains resulting in a high risk sumscore.

3.1. Primary Outcome

Twenty-five out of 207 patients (12%) died within 30 days after surgery. Mortality rates were 2.9%, 13.6%, and 29.6% for patients with a sumscore of 0, 1–2, and 3–4, respectively. Patients with intermediate or high risk sumscore were at significantly higher risk for 30-day mortality after correction for age, sex, and ASA score, with OR 4.85 (95% CI 1.03–22.95; p = 0.047), and 10.60 (95% CI 1.99–56.34; p = 0.006), respectively. Geriatric risk factors for 30-day mortality were Katz ADL score of 2 or higher [OR 4.23 (95% CI 1.66–10.78; p = 0.002)], fall risk [OR 2.76 (95% CI 1.05–7.29; p = 0.040)], risk for delirium [OR 3.08 (95% CI 1.24–7.62; p = 0.015)], and use of a mobility aid [OR 8.02 (95% CI 2.74–23.43; p ≤0.001)]. The multivariable model is presented in Table 2. When adjusted for tumor stage, fall risk was no longer independently associated with 30-day mortality. Intermediate or high risk sumscore remained significant, OR 5.47 (95% CI 1.12–26.73; p = 0.036) and OR 10.42 (95% CI 1.92–56.37; p = 0.007), respectively. Katz ADL score, risk for delirium, and use of a mobility aid remained statistically significant, OR 4.05 (95% CI 1.58–10.38; p = 0.004), 3.13 (95% CI 1.24–7.90; p = 0.016), and 7.98 (95% CI 2.69–23.69; p ≤0.001) respectively. The multivariable model is presented in the Appendix.

Table 1
Patients characteristics at baseline.

	N = 207	N missing
Median age (IQR)	79.4 (74.5–84.9)	
Sex		
Female	104 (50)	
ASA score		
III-V	116 (56)	
Charlson score ≥ 2	94 (45)	
Tumor location		
Colon	203 (98)	
Rectum	4 (2)	
Tumor stage		
I	4 (2)	
II	92 (44)	
III	71 (34)	
IV	40 (19)	
Surgical approach		
Laparoscopical	28 (13)	
Open	179 (87)	
Colostomy	76 (37)	
Presenting symptoms*		
Ileus	157 (76)	
Perforation	22 (11)	
Anemia / Blood loss	17 (8)	
Abscess	6 (3)	
Other	15 (7)	
Geriatric characteristics		
Katz-ADL ≥2	36 (17)	13 (6)
Risk for malnutrition	98 (47)	11 (5)
Fall risk	35 (17)	30 (14)
Risk for delirium	65 (31)	15 (7)
Use of walking device	64 (31)	17 (8)

Values expressed as number (%).
Median age expressed as mean with interquartile range (IQR).
ASA American Socciety of Anesthesiologists.
ADL Activities of Daily Living.
* *Twelve* patients presented with ≥2 symptoms.

3.2. Secondary Outcomes

One hundred and eighteen patients (57%) had one or more complications. No association was demonstrated between risk sumscore or deficits on individual geriatric domains after emergency colorectal cancer surgery and general complications.

Eighty patients (39%) had severe complications. In the multivariable model, impaired functionality (Katz ADL score ≥ 2) and use of a mobility aid were significantly associated with severe complications, with OR 2.43 (95% 1.12–5.27; p = 0.025), and 2.31 (95% 1.17–4.55; p = 0.015) respectively. There was no independent association between the risk sumscore and severe complications, with OR 1.01 (95% CI 0.52–1.97; p = 0.976), and 1.94 (95% CI 0.75–4.98; p = 0.169) for intermediate and high risk, respectively. The multivariable model is presented in Table 3.

Forty-eight patients (23%) had cardiopulmonary complications and 61 patients (30%) had surgical complications. No independent associations were found between the risk sumscore or the individual geriatric domains with cardiopulmonary and surgical complications. Cardiopulmonary complications showed OR 1.46 (95% CI 0.64–3.30; p = 0.369), and OR 2.18 (95% CI 0.74–6.42; p = 0.156) for intermediate and high risk sumscore, respectively. Surgical complications showed OR 1.21 (95% CI 0.61–2.40; p = 0.594), and OR 1.17 (95% CI 0.42–3.23; p = 0.769) for intermediate and high risk sumscore, respectively. The multivariable model is presented in Table 4.

4. Discussion

A sumscore reflecting cumulative deficits in four geriatric domains is prognostic for 30-day mortality in older patients who had emergency surgery for colorectal cancer. Mortality rate in our study was high, up to 30% for high risk patients. Patients with an intermediate risk and high risk sumscore had a 4.85-fold and 10.60-fold greater risk of 30-day mortality, respectively. We also showed that functional impairment, a positive Katz-ADL, and use of a mobility aid were independently

Table 2
Multivariable model for 30-day mortality.

		OR (95% CI)	p-value
Katz-ADL		4.23 (1.66–10.78)	0.002
Risk for malnutrition		1.13 (0.55–2.34)	0.738
Fallrisk		2.76 (1.05–7.29)	0.040
Risk for delirium		3.08 (1.24–7.62)	0.015
Sumscore	0	*reference*	
	1–2	4.85 (1.03–22.95)	0.047
	3–4	10.60 (1.99–56.34)	0.006
Use of mobility aid		8.02 (2.74–23.43)	<0.001

Risk scores corrected for age, sex, and ASA score.
Use of walking device was not included in the sumscore.
ADL Activities of Daily Living.
OR Odds Ratio.
CI Confidence Interval.

Table 3
Multivariable model for any and severe complications.

		Any complications		Severe complicaitons	
		OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
Katz-ADL		1.30 (0.59–2.87)	0.511	2.43 (1.12–5.27)	0.025
Risk for malnutrition		1.05 (0.65–1.68)	0.849	0.99 (0.60–1.60)	0.954
Fallrisk		1.41 (0.64–3.10)	0.392	1.84 (0.86–3.94)	0.118
Risk for delirium		0.82 (0.44–1.55)	0.541	1.55 (0.83–2.92)	0.173
Sumscore	0	*reference*			
	1–2	0.91 (0.48–1.70)	0.757	1.01 (0.52–1.97)	0.976
	3–4	1.20 (0.46–3.10)	0.708	1.94 (0.75–4.98)	0.169
Use of mobility aid		1.09 (0.55–2.16)	0.807	2.31 (1.17–4.55)	0.015

Risk scores corrected for age, sex, and ASA score.
Use of walking device was not included in the sumscore.
ADL Activities of Daily Living.
OR Odds Ratio.
CI Confidence Interval.

Table 4
Multivariable model for cardiopulmonary and surgical complications.

		Cardiopulmonary complications		Surgical complicaitons	
		OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
Katz-ADL		2.10 (0.92–4.80)	0.077	0.99 (0.43–2.32)	0.985
Risk for malnutrition		0.73 (0.41–1.32)	0.299	1.18 (0.71–1.96)	0.521
Fallrisk		1.07 (0.45–2.52)	0.887	2.18 (0.98–4.86)	0.056
Risk for delirium		1.79 (0.88–3.64)	0.111	0.71 (0.35–1.44)	0.346
Sumscore	0	*reference*			
	1–2	1.46 (0.64–3.30)	0.369	1.21 (0.61–2.40)	0.594
	3–4	2.18 (0.74–6.42)	0.156	1.17 (0.42–3.23)	0.769
Use of mobility aid		1.69 (0.79–3.60)	0.176	0.73 (0.34–1.55)	0.413

Risk scores corrected for age, sex and ASA score.
Use of walking device was not included in the sumscore.
ADL Activities of Daily Living.
OR Odds Ratio.
CI Confidence Interval.

associated with postoperative mortality and severe complications. For patients with ADL dependency, the risk of 30-day mortality was 4.23-fold higher, and for those who used a mobility aid, it was 8.02-fold higher.

Previous studies have shown that postoperative mortality after emergency surgery of colorectal cancer is high, up to 28% compared to 4% in elective surgery, with a higher risk of postoperative complications [3–5,15,16].

Previously identified risk factors for poor outcomes in emergency colorectal resections are high ASA score and type of surgical procedure [3]. The study by Kolfschoten et al. did not show a significant association between disseminated disease and postoperative mortality or complications [3]. The effect of tumor stage seems limited. Our study adds to this field that specific geriatric parameters such as functional and cognitive impairment contribute to the risk for postoperative mortality, as known risk factors in general geriatric medicine. It is important to identify geriatric parameters associated with post-operative complications, which can be used to provide more complete information prior to surgery to the patient to improves decision making. Selecting vulnerable patients could create awareness regarding post-operative complications. Patients at risk for surgical and non-surgical complications related to pre-existing vulnerabilities could benefit from an optimized care pathway. Geriatric co-management for patients with colorectal cancer receiving elective surgery has shown lower 90-day mortality, more inpatient supportive care (e.g., physical therapy), and lower hospital readmissions [17].

Impaired functionality was significantly associated with severe complications after emergency surgery for colorectal cancer, which is in line with our previous study presenting functional impairment as the greatest independent risk factor for poor outcome [7]. Another study also showed that deficits in physical functioning as measured by ADL or instrumental ADL are associated with postoperative complications, including severe complications, in elective colorectal cancer surgery [18]. However, there are no data available about geriatric parameters as predictors for mortality and complications after emergency surgery for colorectal cancer. Although impaired functionality is associated with 30-day mortality and severe complications, these questions could possibly identify frail patients without use of a mobility aid or with a Katz-ADL score of 0 or 1 as fit patients. We believe the combined domains as used in our sumscore are important to estimate if there could be a risk for worse postoperative outcome.

In patients undergoing elective surgery for non-metastatic colorectal cancer, the sumscore used in this study was strongly associated with mortality and overall survival up to three years after surgery [7]. In elective surgery, the sumscore was associated with any complications, not only surgical complications [7]. This current study on acute surgery shows no significant associations with complications other than 30-day mortality. A recent study showed that frailty has limited interaction with surgical complications in elective colorectal cancer surgery, and that tumor and surgical characteristics may outweigh frailty [19]. Another study showed comorbidity as a risk factor for mortality and prolonged stay of hospital admission, and only patients with severe comorbidities were at risk for surgical complications. Limited comorbidity does not necessarily change treatment decisions [20].

Other studies investigating VMS on geriatric domains are limited to hospitalized patients [21], older patients in emergency wards [22], or patients with hip fractures [23]. Winters et al. investigated the predictive value of the VMS frailty score in older patients with hip fractures who underwent emergency surgery. Frailty was assumed when fall risk and one other question was scored “yes.” They did not include malnutrition. Their study showed that VMS was significantly associated with 30-day mortality and overall mortality with a corresponding hazard ratio of 3.5 for overall mortality. An increase in positive answers on the VMS questionnaire was associated with an increase in mortality, which is consistent with our findings on 30-day mortality [23].

The Dutch guidelines for colorectal cancer have recently been updated and advise a decompressing stoma or stent when patients are 70 years or older and present with leftsided obstructive coloncarcinoma, which can be treated curatively. An emergency surgery in older patients is discouraged because of high mortality rates [24]. A large Dutch study showed a decompressing stoma as a bridge to surgery is associated with lower 90-day mortality and better three-year overall survival compared to emergency surgery, especially in older patients [8]. The process of selecting patients for alternative treatment options instead of surgery, such as palliative care, might be improved by adding geriatric parameters to the known risk factors in emergency surgery for colorectal cancer, which include ASA score and surgical procedure [3]. Alternative options other than surgery could be selected in highly frail patients. These patients are not included in our study or those previously mentioned because the DCRA only registers surgical patients. If the most vulnerable patients had been selected for surgery, we might have found an even stronger association with worse outcomes. For patients with suspected poor surgical outcome, an end colostomy alone can be considered. Quality of life and physical functioning are important for older patients. An earlier study showed older patients with colostomy

more frequently required help in caring for their colostomy, but they did not report higher physical and social limitations than younger patients [9].

The major strength of this study is the multicenter design. Despite the retrospective nature of our study, the number of missing variables was low. For data imputation we used a predictive mean matching method which provide least biased estimates and better model performance measures; however, analysis with single imputed dataset should be interpreted with some caution [25].

We could not perform a 90-day or one-year survival analysis due to missing survival data. Therefore, 30-day mortality was our primary outcome, although it is known excess mortality after colorectal cancer surgery proceeds up to one year after surgery [16,26]. Thirty-day mortality already rises up to 30% in high-risk patients. It is assumed that the sumscore is also predictive of mortality beyond 30 days after emergency surgery, with an even higher risk for mortality.

In the future, a prospective cohort study with geriatric co-management throughout admission time at the hospital, with follow-up for at least one year, would provide more information about post-operative complications but furthermore about functional decline and quality of life.

5. Conclusions

Emergency surgery of colorectal cancer in older patients has 30-day mortality up to 30% in patients with deficits in multiple geriatric domains. A sumscore reflecting geriatric impairments is prognostic for 30-day mortality. Physical limitations like use of a mobility aid and ADL dependency are prognostic for 30-day mortality and severe post-operative complications. The geriatric information is easy to collect and can be used for decision making in emergency surgery of colorectal cancer in older patients. It could provide better insight into surgical risk and select high-risk patients for alternative treatment.

Author Contributions

D. Hultink: Study concepts, Study design, Data acquisition, Quality control of data and algorithms, Data analysis and interpretation, Statistical analysis, Manuscript preparation, Manuscript editing, Manuscript review.

E.T.D. Souwer: Study concepts, Study design, Data acquisition, Quality control of data and algorithms, Data analysis and interpretation, Statistical analysis, Manuscript preparation, Manuscript editing, Manuscript review.

E. Bastiaannet: Quality control of data and algorithms, Statistical analysis, Manuscript review.

J.W.T. Dekker: Data acquisition, Manuscript review.

W.H. Steup: Data acquisition, Manuscript review.

M.E. Hamaker: Data acquisition, Manuscript review.

D.J.A. Sonneveld: Data acquisition, Manuscript review.

E.C.J. Consten: Data acquisition, Manuscript review.

P.A. Neijenhuis: Data acquisition, Manuscript review.

J.E.A. Portielje: Study concepts, Study design, Manuscript review.

F. van den Bos: Study concepts, Study design, Manuscript preparation, Manuscript editing, Manuscript review.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jgo.2024.101711.

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