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The effect of treatment modifications by an onco-geriatric MDT on one-year mortality, days spent at home and postoperative complications

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ABSTRACT

Objectives: Decision-making in older patients with cancer can be complex, as benefits of treatment should be weighed against possible side-effects and life-expectancy. A novel care pathway was set up incorporating geriatric assessment into treatment decision-making for older cancer patients. Treatment decisions could be modified following discussion in an onco-geriatric multidisciplinary team (MDT). We assessed the effect of treatment modifications on outcomes.
Materials and methods: This retrospective study was performed in the surgical department of a University Hospital. Patients of 70 years and older with a solid malignancy were included. All patients underwent a nurse-led geriatric assessment (GA) and were discussed in an onco-geriatric MDT. This could result in a modified or an unchanged treatment advice compared to the regular tumor board. Primary outcome was one-year mortality. Secondary outcomes were post-operative complications and days spent in hospital in the first year after inclusion.
Results: For the 184 patients in the analyses, the median age was 77.5 years and 41.8% were female. For 46 patients (25%), the treatment advice was modified by the onco-geriatric MDT. There was no significant difference in one-year mortality between the unchanged and modified group (29.7% versus 26.1%, $p = 0.7$). There were, however, significantly fewer days spent in hospital (median 5 vs 8.5 days $p = 0.02$) and fewer grade II or higher postoperative complications (13.3% versus 35.5% $p = 0.005$) in the modified group.
Conclusion: Incorporating geriatric assessment in decision-making did not lead to excess one-year mortality, but did result in fewer complications and days spent in hospital.

1. Introduction

Due to demographic changes, an increasing number of older patients with cancer is expected in the near future. Decision-making with older cancer patients can be complex, due to co-morbidities, frailty, and different preferences regarding treatment outcomes compared to younger patients. Older patients with cancer have an increased risk of adverse outcomes of cancer treatment, such a complications, functional decline, and a higher risk of mortality [1–6]. Frailty, a state of decreased reserves due to accumulation of deficits on different domains, is considered a measure of biological age and a better predictor of these adverse outcomes than calendar age [7]. Older patients with cancer are at risk of both over- and undertreatment, especially if decision-making is based on calendar age alone [8,9]. There are accumulating data emphasizing the importance of geriatric assessment and assessment of frailty in older patients with cancer to guide treatment decision-making [10–12].

Implementing geriatric assessment into the work-up of older cancer patients has been shown to affect treatment decision-making, leading to an adjustment of treatment in a median 28% of patients, often toward a less intensive treatment modality or palliative care [13]. Clinicians, however, tend to overestimate prognosis, leading to a focus on potentially curative and often intensive treatment regimes [14]. It can therefore be difficult to refrain from intensive curative treatment, and often it is easier to "err on the side of life" [15]. Clinicians often feel they need to give a patient a chance of survival, even if chances are slim and the risk of adverse functional outcomes high. Refraining from

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treatment is thus often a more difficult and uncertain decision [15]. This is one of many factors that complicates broad implementation of geriatric assessment into current care [12]. Another complicating factor is the scarcity of evidence supporting implementation of frailty assessment to guide treatment decisions, for example by revealing better outcomes [16].

When looking at improving outcomes, it is important to take the patients' perspective into account. Treatment decision-making, especially with older cancer patients, comprises trade-offs, due to an increased risk of complications and functional decline following treatment [17]. For many older patients, survival is not their main outcome of interest, and remaining independent is often considered more important [18,19]. Days spent at home is regarded a novel patient-centered outcome measure, that is gaining attention [20–22]. Most patients would prefer to, when possible, spent their time at home rather than in a hospital or other care facility [21]. Intensive oncological treatment with a high risk of postoperative complications and functional decline often leads to more days spent in a hospital or nursing home [23].

At the University Medical Centre Groningen, a nurse-led geriatric assessment and additional onco-geriatric multidisciplinary team meeting has been implemented, in order to optimize and tailor decision making. This has shown to affect treatment decisions, with a modification in treatment proposals in about a quarter of patients. These modifications were mostly toward less intensive regimes or toward palliative treatment or wait-and-see [24]. We were interested to know how this new care pathway impacts on short and longer term outcomes of our patients. This paper presents the follow-up data of this cohort, looking at one-year mortality after modifying treatment and the effect on post-operative complications and days spent in hospital.

2. Methods

2.1. Setting and Patients

Patients of 70 years and older who were referred with a solid malignancy to the surgical outpatient clinic between September 2014 and July 2017 were included in the study.

2.2. Methods

This study reports on the retrospective analysis of outcomes of a new care pathway that was started in 2014 at the University Medical Center in Groningen, the Netherlands [24]. A nurse-led geriatric assessment and assessment of patients' preferences was implemented in the decision-making process for all patients of 70 years and older with cancer referred the surgical outpatient clinic. This assessment was performed by a (trained) surgery nurse. In order to multidisciplinary discuss the results of this assessment, an onco-geriatric MDT was established, separate from the regular oncological MDTs (tumor boards). In this onco-geriatric MDT, nurses and a geriatrician attended, in addition to the oncology specialists (surgeon, medical oncologist, radiation oncologist). This enabled the fine-tuning and development of this new care pathway, but it also enabled comparison between the treatment proposal by the onco-geriatric MDT and the regular tumor board (which was care as usual until then) [24].

Patient were included at the surgical outpatient clinic. All included patients underwent a nurse-led geriatric assessment (GA), performed by a trained nurse, at their visit to the surgical outpatient clinic. During this GA, information was gathered regarding four geriatric domains (somatic, social, psychological and functional). For the somatic domain, the Charlson Comorbidity Index (CCI) was used as a measure of comorbidity with a cut-off value of 3 for low versus high comorbidity [25]. Current cancer was not included in the CCI. Polypharmacy was defined as 5 or more prescription drugs. Recent weight loss was assessed and dichotomized between less than 10 kg, and 10 kg or more in the last 6 months [26,27]. For the social domain patients were asked about living arrangements and marital status. For the psychological domain, cognitive status was assessed using the letter fluency test (LFT), adjusted for level of education [28,29]. Level of education was classified according to Verhage, which is comparable to the UNESCO and ranges from 1 to 7 with a higher score for a higher level of education [30]. Level of education was dichotomized into low (1–2) versus medium and high (3–7). Patients and their families were also asked about known dementia and previous delirium. Mood was assessed according to the subsection of the Groningen Frailty Index (GFI), with a cut-off of 2 out of 5 points [31]. For the functional domain the Groningen Activity Restriction Scale (GARS-4) was used; a combined measure of instrumental activities of daily living (ADL) and instrumental activities of daily living (IADL). Combined scores ranged from 18 to72:11 to 44 for the ADL subscore and 7 to 28 for the IADL subscore. A higher score indicates more dependencies [32]. The Timed-Up and Go (TUG) test was used as a measure of mobility, with a cut-off value of 15 [33]. The GFI was used as a frailty screening tool. Frailty was defined as a GFI score ≥ 4 [34]. The nurses also structurally assessed the patient preferences regarding treatment outcomes, using the Outcome Prioritization Tool (OPT) [19].

All patients were discussed in a regular tumor board and in an onco-geriatric MDT after the nurse-led geriatric assessment (GA). The onco-geriatric MDT incorporated information from the nurse-led GA in the treatment discussion and formulated a treatment proposal based on tumor and patient characteristics, patients preferences and estimated life-expectancy. This information was discussed in the onco-geriatric MDT and an oncological treatment proposal was provided [24]. This proposal was compared to the treatment proposal by the regular tumor board. A modified advice was defined as different oncological treatment advice between the onco-geriatric MDT and the tumor board, an unchanged advice meant that no adjustments were proposed to the oncological treatment advice. When treatment modifications were proposed, these were mostly toward less intensive curative treatment or palliative treatment. Non-oncological advise was also provided, when appropriate. This advice could be regarding optimization (i.e. physiotherapy, dietary measures) or regarding risk reduction (i.e. delirium prevention, fall prevention). More details regarding the treatment modifications and non-oncological advice, can be found in our previous publication [24]. The final treatment decision was made between the treating physician and the patient in a process of shared decision-making.

2.3. Outcome Measures

For this follow-up study, data were analyzed regarding one year all-cause mortality, postoperative complications and hospital length of stay. These outcomes were compared between the modified and the unchanged group. Survival status was derived from the municipal registration, which in the Netherlands provides complete information on all deaths. Postoperative complications (30 days postoperative complications graded 0-IV according to the Clavien Dindo classification system [35]) and days spent in hospital during the first year after inclusion were retrieved from the electronic patient records.

Primary outcome was one-year all-cause mortality. Secondary outcome measures were 30 days postoperative complications requiring treatment (defined as Clavien Dindo grade II and higher), and median days spent in hospital during the first year after inclusion (this was defined as days spent admitted to the hospital (any department) and did not include outpatient visits). We also compared low number of days spent in hospital (14 days or less) to high number of days (>14 days) as defined by Chesney and colleagues [36].

For the comparison of complications between the modified an unchanged group we looked at the subgroup who underwent surgery, but also at the entire group. For the latter, we regarded the patients who did not undergo surgery as having no complications.

2.4. Statistical Analysis

Baseline characteristics were presented as numbers and percentages or median and range, as appropriate. For comparison between patients with modified and unchanged treatment, Pearson's Chi square tests were applied for categorized data, and Mann Whitney *U* tests for continuous data. The Kaplan-Meier method was used to estimate time from inclusion to death between the modified and the unchanged group, and this was compared with a log-rank test. Cox proportional hazards regression model was used to estimate independent effects of different variables on one-year mortality. Variables with a p value ≤0.1 in the unadjusted analyses were entered into the multivariable model in addition to treatment modifications and age. Data analysis was performed using the software package IBM SPSS Statistics, version 23.0 for Windows (SPSS, Inc., Chicago, IL, USA). A p-value of <0.05 was considered statistically significant.

2.5. Statement of Ethics

This study was registered in the Netherlands Trial Registry (NTR) under trial registration number NTR6660 [24]. The study was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice Guidelines. Permission was granted by the local medical ethical committee.

This study was funded by the Dutch Cancer Society under number RUG2013-6444.

3. Results

3.1. Patients

Initially 214 patients of 70 years and older were primarily seen at the surgical outpatient clinic. For 29, treatment advice from the onco-geriatric MDT could not be compared to the tumor board, since they were primarily discussed in the onco-geriatric MDT. For one patient data on treatment proposal were missing, leaving 184 patients for analysis.

Table 1 shows the baseline characteristics for both groups. For 46 patients (25%) the treatment advice was modified by the onco-geriatric MDT and for 138 patients (75%) the advice was unchanged compared to the advice of the tumor board. The overall median age was 77.5 years (interquartile range (IQR) 73–82), with a higher median age in the modified group (79.9 [IQR 75.0–83.0] vs 76.0 [IQR 72.0–81.0]; $p = 0.01$). Seventy-seven patients (41.8%) were female. Eighty-two (44.6%) of patients had a CCI of three or more. Most patients had soft tissue and skin malignancy ($n = 58$, 31.5%), colorectal carcinoma ($n = 57$, 31.0%), hepatobiliary cancer ($n = 18$, 9.8%) and upper GI malignancies (n = 18, 9.8%). One-hundred and six (57.6%) had stage III-IV cancers.

Table 1
Description of baseline characteristics of included patients, stratified by modified versus unchanged treatment ($n = 184$)[a].

Characteristics		Modified ($n = 46$, 25%)	Unchanged ($n = 138$, 75%)
Age	Median, IQR	**79.0 (75.0–83.0)**	**76.0 (72.0–81.0)**[b]
Comorbidity	CCI ≥ 3	20 (43.5)	62 (44.9)
Gender	Female	18 (39.1)	59 (42.8)
Tumor type	Soft tissue and skin	13 (28.3)	45 (32.6)
	Colorectal	18 (39.1)	39 (28.3)
	Upper GI	4 (8.7)	14 (10.1)
	Hepatobiliary	2 (4.3)	16 (11.6)
	Other[c]	9 (17.4)	24 (17.4)
Cancer stage	I-II	20 (43.5)	51 (37.0)
	III-IV	26 (56.5)	80 (58.0)
	Benign disease[f]	0	7 (5.1)

a: All values are numbers (%) unless otherwise specified. Not all percentage add up to 100 due to missing data.
b: bold: Statistical significant difference ($p < 0.05$) between groups as assessed with Chi square for categorical variables, and Mann-Whitney-*U* test for continuous variables.
c: Other included: skin tumor other than melanoma (5), thyroid (5), breast (4), benign disease or no proven malignancy (4), urological (3), anal carcinoma (2) hepatocellular carcinoma (2), pseudomyxoma (2), chordoma (2), gastro-intestinal stromal tumor (1), gynaecological (1), multiple malignancies (1), and unknown primary (1).
f: All patients had a suspected malignancy but for 7 patients pathology turned out to be negative.
Abbreviations: IQR: interquartile range, CCI: Charlson Comorbidity Index, GI: Gastro-intestinal.

3.2. Geriatric Assessment

Table 2 shows the results of geriatric assessment. Ninety-five patients (52.2%) used five or more medications, with a higher percentage of polypharmacy in the modified group (64.4% vs 48.2%, $p = 0.06$).

Table 2
Results of the geriatric assessment, stratified by modified versus unchanged treatment ($n = 184$)[a].

Variable		**Modified** ($n = 46$, 25%)	**Unchanged** ($n = 138$, 75%)
SOMATIC			
Number of medications	Median, IQR	6.0 (3–8)	4 (3–7)
Polypharmacy (5)	5 or more medications	29 (63.0)	66 (47.8)
Weight loss previous 6 months	*< 10 kg*	39 (84.8)	117 (84.8)
	≥10 kg	5 (10.9)	18 (13.0)
PSYCHOLOGICAL			
Level of education	*High*	18 (39.1)	62 (44.9)
	Medium	13 (28.3)	37 (26.8)
	Low	15 (32.6)	35 (25.4)
Cognition	*LFT high*	11 (23.9)	35 (25.4)
	LFT low	26 (56.5)	67 (48.6)
	Previous delirium	**11 (243.9)**	**15 (10.9)**[b]
	Known dementia	3 (6.5)	2 (1.4)
Psychological	*Psychosocial GFI subscale < 2*	27 (58.7)	70 (50.7)
	Psychosocial GFI subscale ≥ 2	18 (39.1)	67 (48.6)
SOCIAL			
Living situation	*independent*	42 (91.3)	126 (91.3)
	assisted	3 (6.5)	11 (8.0)
Marital status	*Living with partner*	29 (63.0)	85 (61.6)
	Living without partner	17 (37.0)	52 (37.7)
FUNCTIONAL			
ADL & IADL	*GARS-4 sum, Median, IQR*	**28 (19–42)**	**24 (18–33.3)**[b]
ADL	*GARS-4 ADL Median, IQR*	**15 (12–22.5)**	**12.5 (11-17)**[b]
IADL	*GARS-4 iADL subscore Median, IQR*	14 (7–19)	11 (7–16)
Mobility (TUG)	*Median, IQR*	11.6 (10.3–14.0)	11.1 (9.6–13.1)
	<15	30 (65.2)	102 (73.9)
	≥15	6 (13.0)	22 (16.9)
FRAILTY			
GFI frailty	>4	28 (60.9)	64 (46.4)
PREFERENCES			
Main preference (OPT)	*Extending life*	13 (28.3)	41 (29.7)
	Maintaining independence	14 (30.4)	39 (28.3)
	Reduction of pain	5 (10.9)	15 (10.9)
	Reduction of other symptoms	2 (4.3)	8 (5.8)

a: All values are numbers (%) unless otherwise specified. Not all percentage add up to 100 due to missing data.
b: statistical significant ($p < 0.05$) difference between the groups; chi square for categorical variables, Mann-Whitney-u test for continuous variables.
Abbreviations: IQR interquartile range, (I)ADL: (instrumental) activities of daily living, LFT: Letter Fluency test, GFI: Groningen Frailty Indicator, GARS: Groningen Activity Restriction Scale, TUG: Timed-Up and Go test, OPT: Outcome Prioritization Tool.

There were significant differences on GARS-sum score between the modified and unchanged group (median 28 (IQR 19–42) vs 24 (IQR 18–33.3), $p = 0.02$) and the GARS-4 ADL subscore (median 15 (IQR 12–22) vs median 12 (IQR 11–17); $p = 0.007$). Patients in the modified group had a higher percentage of previous delirium (24.4% versus 11.1% $p = 0.05$), but no significant differences on cognitive testing with the LFT and on known dementia. Based on the Groningen Frailty Index, 92 (50.3%) patients were considered frail, with no significant differences between the two groups (modified 60.9%, unchanged 46.7%, $p = 0.1$). Regarding patients' preferences, there was a (non- significant) higher percentage of patients regarding maintaining independence as the main health outcome in the modified group, compared to the unchanged group (41.2% vs 37.9%). An equal number of patients regarded life extension as their main health outcome of interest (38.2% and 39.8%). There were no significant differences between the groups on the other geriatric measures.

3.3. Treatment

The treatment intention was curative in 129 (70.1%) patients, with a significantly lower percentage of curative treatment intent in the modified group (43.5% versus 79.0%, $p < 0.001$). One-hundred and eighteen patients (64.5%) underwent surgery, with a significantly lower percentage in the modified group (43.5% vs 71.1%, $p = 0.00$; Table 3). For 14 patients (30.4%), an adjusted curative treatment intention was advised. For 22 patients (47.8%), a modification from curative treatment intention to palliative treatment was advised (palliative oncological treatment ($n = 11$) or palliative symptom relief/wait and see (n = 11)). For ten patients an adjusted palliative treatment was advised (palliative treatment ($n = 4$) or palliative symptom relief/wait and see ($n = 6$)).

Non-oncological advice was provided in 42.9% of patients. The percentage of patients for whom non-oncological advice was provided was higher in the unchanged group (47.1% vs 30.4%, $p = 0.05$; data not shown).

3.4. Outcomes

3.4.1. One-year mortality

Fig. 1 shows the survival curve comparing the modified and unchanged group. One-year all-cause mortality was 28.8% ($n = 53$). There was no significant difference between the modified and unchanged group (26.1% versus 29.7%, $p = 0.7$). Outcomes stratified by treatment proposal are shown in Table 3. Table 4 shows the result for the univariable and multivariable analysis of variables prognostic for one-year mortality. Higher tumor stage (III-IV), weight loss of ≥10 kg and deficits in IADL were prognostic factors for one-year mortality in the univariable analysis. Age, comorbidity and treatment modifications by the onco-geriatric MDT were not. In multivariable Cox regression analysis, higher tumor stage (hazard ratio (HR) 2.52; 95% confidence interval (CI) 1.25–5.07; $p = 0.01$) and iADL deficits (HR 1.08; 95% CI 0.03–1.13; $p = 0.003$) remained individual prognostic factors for one-year mortality. (Table 4).

Table 3
Treatment decisions and outcomes stratified by modified versus unchanged treatment (n = 184)[a].

Variable	Modified (n = 46, 25%)	Unchanged (n = 138, 75%)	*P*[b]
Treatment variables:			
Curative treatment intention	20 (43.5)	109 (79.0)	<0.001
Surgical treatment	20 (43.5)	98 (71.1)	0.001
Outcome variables:			
Complications grade ≥ II (surgery group[c])	6 (28.6)	53 (49.5)	0.2
Complications grade ≥ II (total group[d])	6 (13.0)	48 (34.8)	0.005
Days spent in hospital[e], median, IQR	5 (0–13.3)	8.5 (1.5–19.25)	0.002
Days spent in hospital, >14 days	8 (17.4)	48 (34.8)	0.03
One-year mortality	12 (26.1)	41 (29.7)	0.7

a: all values are numbers (%) unless otherwise specified.
b: Chi square for categorical variables, Mann Whitney U for continues variables.
c: 30 days complications, only for the patients who underwent surgery.
d: all patients; no surgery is counted as no complications (CD grade 0),
e: days spent in hospital during the first year after inclusion.
Abbreviations: IQR interquartile range.

3.4.2. Postoperative complications and days spent in hospital

Table 3 shows the differences in postoperative complications and days spent in hospital between the modified and the unchanged group. In the group of patients who underwent surgery, there was a lower percentage of grade II or higher complications in the modified group (31.6% versus 50.0%), but this did was not significant ($p = 0.7$). Comparison of postoperative complications between the modified and the unchanged group for all patients, with the non-surgical group regarded as having had no complications, did show a significant difference between the modified and the unchanged group (13.3% vs 35.3%, $p = 0.005$). The modified group spent significantly fewer days in hospital during the first year after inclusion (median 5 days (IQR 0–13.3) compared to the unchanged group (median 8.5 days, IQR 1.5–19.25: $p = 0.02$). There was also a significant difference between the groups regarding a high (> 14) number of days spent in hospital (17.4% vs 34.8%, $p = 0.03$).

The presented results represent the treatment advice provided by the onco-geriatric MDT. As we described in our previous paper, both the oncological and the non-oncological advice of the onco-geriatric MDT were not always followed by the treating physician. The oncological advice was initially followed in 78.3% of patients ($n = 36$). Leaving the 21.7% out of analysis did not lead to different results regarding mortality, complications and days spent at home (data not shown).

4. Discussion

These follow-up data of an onco-geriatric surgical cohort show a high all-cause one-year mortality rate of 28.8% during the first year for all included patients. Outcomes were compared between a group of patients for whom the treatment advice, provided by an onco-geriatric MDT, was modified compared to the advice from the regular tumor board and a group of patients with an unchanged advice. Treatment modifications by the onco-geriatric MDT did not result in a higher one-year mortality rate. Poorer outcomes, such as excess mortality, are sometimes feared when treatment modifications are proposed, especially when these modifications are toward a less intensive treatment, as was the case in our cohort [24]. Our study does not support this fear of potential undertreatment [37]. The modified patient group also experienced less grade II or higher postoperative complications and less days spent in hospital in the modified group, with a median difference of 3.5 days, suggesting better patient centred outcomes as well.

Many studies report on frailty as an independent predictor of adverse outcomes [6,38–40]. There is, however, still a paucity of data regarding the effect of incorporating geriatric assessment (thereby assessing frailty) in treatment decision-making on patient outcomes. Our study is one of few studies reporting on the outcomes of incorporating geriatric assessment into treatment decision-making in surgical patients. To our knowledge, only one other study in surgical patients reported reduced postoperative mortality after implementation of a frailty screening initiative and notifying clinicians when a patient was classified as frail. Whether this effect was due to treatment modifications, or a result of other optimization strategies, was unfortunately not assessed [16]. Other studies report on better postoperative outcomes, following optimization (prehabilitation) strategies based on frailty assessment, but treatment modifications were not made [3,41,42]. A recent RCT by Corre and colleagues, incorporating GA in

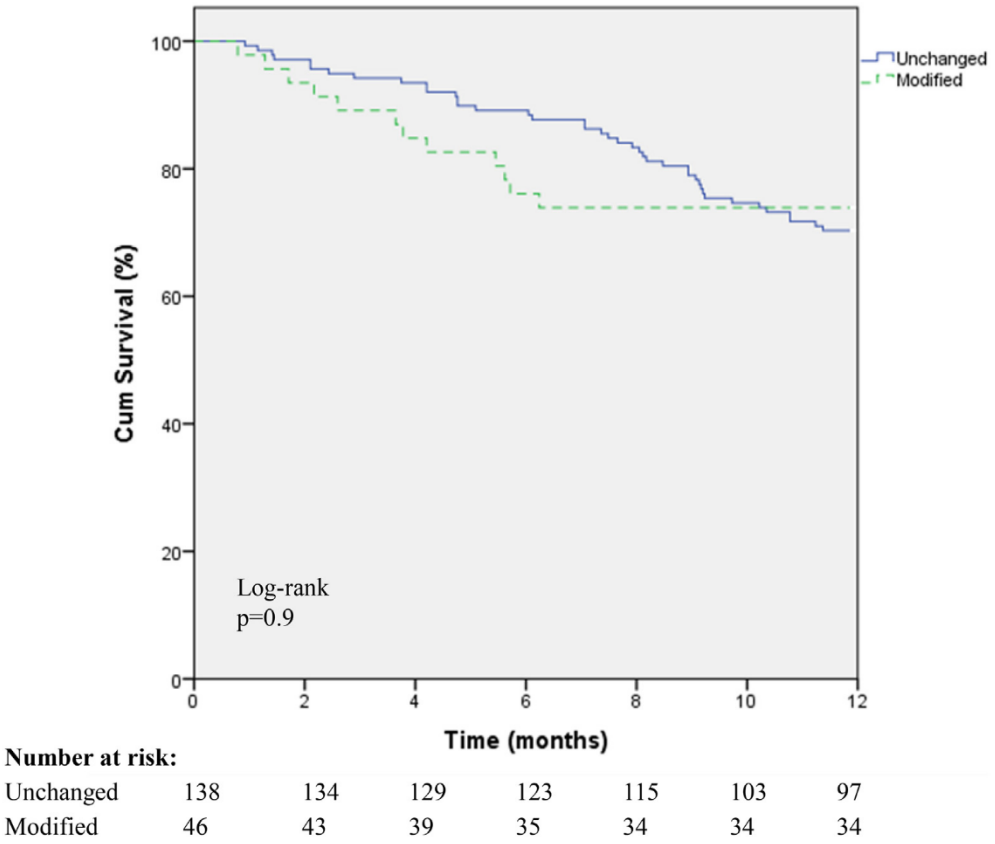

Fig. 1. Kaplan-Meier plot of one-year survival between the modified (n = 46) versus the unchanged (n = 138) group.

lung cancer patients, found similar results to our study, namely unchanged mortality, but less toxicity and complications in the GA group [43].

There are some limitations to our study worth mentioning. Most importantly, we assessed differences in treatment advice between the tumor board and the onco-geriatric MDT. We know, however, that not all oncological and non-oncological advices were followed, due to different reasons (patient, disease or health care provider related). Treatments can also be altered due to the course of the disease or complications. Leaving out the patients where the advice was initially not followed did not lead to different results regarding mortality, complications and days spent at home. The patients were not randomized, as we describe the results of a new care pathway. Because treatment modifications were proposed based on disease characteristics as well as assessment of frailty and patients preferences, the modified group was more frail than the unadjusted group, introducing bias by nature. For the same reason, not all tumor types are included, since the new care pathway was not yet implemented in some departments. Since all patients of 70 years and older were included, there is heterogeneity in tumor types and stages. However, this also makes our data more widely applicable. We had no information on the causes of death available and can therefore only report on all-cause mortality. Because of the frailty of the population, we considered one-year survival as the best outcome measure; a longer follow-up time would have led to more patients being lost to follow-up due to the high mortality rates inherent to this frail patient group. However, for some tumor types, this time span may be considered short. We have no information on complications other than surgical complications, but the reported days spent in hospital are for all hospital wards, and serious complications leading to hospital admission were expected to show in this number. We can also only report on days spent in our hospital, and have no information on days spent in other institutions, for instance in a nursing home or rehabilitation center.

The aim of the geriatric assessment and onco-geriatric MDT was to tailor care to the individual patients, and improve outcomes. This involved spending extra time for patient assessment in the decision-making process. A nurse-led geriatric assessment is estimated to take up 30 min, and 40 min including MDT attendance. Time is sometimes considered a limiting factor to implementation of a geriatric assessment [12]. However, tailoring treatment decisions to frailty and patient preferences may improve patient outcomes and, as this study shows, does not lead to worse outcomes [12]. Costs of incorporating nurse-led geriatric assessment are low compared to other assessments during oncological work-up [12]. Since frailty is a marker of adverse outcomes, tailoring care to the level of frailty is expected to reduce costs caused by complications and prolonged hospital stay. This is supported by the results of this study. It is also expected to enhance patient relevant outcomes such as physical functioning and independence. Research has shown that for many older patients life extensions is not their main preference, and independence is often rated as a more important or equally important goal [19]. Days spent at home has recently been identified as a relevant patient-centered outcome measure [20–22]. Our study shows that patients in the modified treatment group spent fewer days in hospital, reflecting less dependence and better quality of life, but not at the cost of higher one-year mortality. The next step is to reveal which patients-centered outcome measures are most relevant for patients and their families in order to further improve treatment tailoring and optimize care.

In conclusion, incorporating geriatric assessment in treatment decision-making improved patient outcomes, without increasing one-year mortality rate. These data support broader implementation of geriatric assessment in oncology care.

Table 4
Predictive models for one-year survival (cox proportional hazards).

	Univariable analysis		Multivariable analysis[a]	
Variable	**HR (95% CI)**	***p***	**HR (95% CI)**	***p***
Treatment proposal				
Treatment proposal onco-geriatric MDT[b]				
Unchanged	1[c]		1[c]	
Modified	0.94 (0.49–1.79)	0.85	0.89 (0.43–1.85)	0.8
Baseline characteristics				
Tumor stage				
I-II	1[c]		1[c]	
III-IV	**1.90 (1.04–3.450)**	**0.04**	**2.52 (1.25–5.07)**	**0.01**
Age	0.98 (0.93–1.03)	0.32	0.97 (0.91–1.02)	0.2
Gender				
Male	1.33 (0.76–2.33)	0.32		
Comorbidity				
CCI < 3	1[c]			
CCI ≥3	0.68 (0.39–1.19)	0.18		
Geriatric assessment				
Polypharmacy (≥5)	0.88 (0.51–1.52)	0.65		
Weight loss previous 6 months				
<10 kg	1[c]		1[c]	
≥10 kg	**2.41 (1.26–4.61)**	**0.01**	1.75 (0.85–3.59)	0.1
Marital status				
No partner	1.07 (0.62–1.86)	0.81		
Living situation				
Assisted living	1.32 (0.53–3.32)	0.56		
Level of education				
High	1[c]			
Low and medium	1.64 (0.93–2.89)	0.09		
Cognition				
LFT Low	1.64 (0.93–2.89)	0.09		
Previous delirium	1.10 (0.52–2.33)	0.81		
Dementia	0.05 (0.00–43.94)	0.38		
Mood				
GFI subscale ≥2	1.32 (0.76–2.29)	0.32		
ADL/iADL				
GARS-sum	1.02 (1.00–1.05)	0.50		
GARS-ADL	1.03 (0.98–1.07)	0.27		
GARS-IADL	**1.06 (1.02–1.11)**	**0.07**	**1.08 (0.03–1.13)**	**0.003**
Mobility				
TUG <15	1[c]			
TUG ≥15	1.44 (0.72–2.89)	0.31		
Frailty screening				
GFI <4	1[c]			
GFI ≥4	1.30 (0.75–2.25)	0.34		

a = Treatment modification, age and variables with a p value of <0.1 in univariable analysis were entered in to the multivariable model. b = treatment proposal as compared to regular tumor board (see text). c = Reference group (specified where relevant). bold; Statistical significant difference ($p < 0.05$).
Abbreviations: HR: Hazard ratio, CI: confidence interval, MDT: multidisciplinary team, CCI: Charlson Comorbidity Index, LFT: Letter Fluency test, (I)ADL: (instrumental) activities of daily living, GARS: Groningen Activity Restriction Scale, TUG: Timed-Up and Go test, GFI: Groningen Frailty Indicator.,

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There has been no role of a sponsor in the design, conduction or analysis of this study.

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Declaration of Competing Interest

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