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Original Research

Analysis of 105.000 patients with cancer: have they been discussed in oncologic multidisciplinary team meetings? A nationwide population-based study in the Netherlands

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Abstract ***Introduction:*** For optimal oncological care, it is recommended to discuss every patient with cancer in a multidisciplinary team meeting (MDTM). This is a time consuming and expensive practice, leading to a growing demand to change the current workflow. We aimed to investigate the number of patients discussed in MDTMs and to identify characteristics associated with not being discussed.

Methods: Data of patients with a newly diagnosed solid malignant tumour in 2015 and 2016 were analysed through the nationwide population-based Netherlands Cancer Registry (NCR). We clustered tumour types in groups that were frequently discussed within a tumour-specific MDTM. Tumour types without information about MDTMs in the NCR were excluded. Multivariable logistic regression analyses were used to analyse factors associated with not being discussed.

Results: Out of 105.305 patients with cancer, 91% were discussed in a MDTM, varying from 74% to 99% between the different tumour groups. Significantly less frequently discussed were patients aged ≥75 years (odds ratio [OR] = 0.7, 95% confidence interval [CI] = 0.6–0.7), patients diagnosed with disease stage I (OR = 0.5, 95% CI = 0.5–0.6), IV (OR = 0.4, 95% CI = 0.4–0.4) or unknown (OR = 0.2, 95% CI = 0.2–0.2) and patients who received no

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treatment (OR = 0.3, 95% CI = 0.3–0.3). Patients who received a multidisciplinary treatment were more likely to be discussed in contrary to a monodisciplinary treatment (OR = 4.6, 95% CI = 4.2–5.1).

Conclusion: In general, most patients with cancer were actually discussed in a MDTM, although differences were observed between tumour groups. Factors associated with not being discussed may, at least partially, reflect the absence of a multidisciplinary question. These results form a starting point for debate on a more durable and efficient new MDTM strategy.

1. Introduction

Multidisciplinary teamwork is mandatory to provide optimal oncological care for every patient with cancer in a complex and changing oncological field [1–3]. This is nowadays organised in multidisciplinary team meetings (MDTMs), mostly weekly meetings of medical specialists of different health care disciplines [4–6], including a surgeon, medical oncologist, radiation oncologist, radiologist, pathologist, treating physician, specialised nurse and an administrator [7].

After the appearance of the Calman-Hine report in 1995, which described principles about how to organise and structure high-quality multidisciplinary care [8], MDTMs were set out in accordance with these principles worldwide and, today, constitute the standard of care [4, 9–11] although strong evidence supporting survival benefit is lacking. A recent systematic review analysed 27 articles about MDTMs (all tumour types included). Of the 6 studies that assessed survival benefit, only 2 were positive [12–14]. A third more recent article published in 2017 shows that pre-treatment MDTM discussion improved two-year relapse-free survival of patients with sarcoma (65.4% versus 76.9%, $p < 0.001$ for a total of 9646 patients) [15].

Multidisciplinary teamwork is time consuming and therefore expensive. A systematic review published in 2013 concluded that there is insufficient evidence to determine whether multidisciplinary team (MDT) working is actually cost-effective. Fifteen randomised controlled trials about multidisciplinary teamwork were analysed, of whom 4 were cancer MDTMs [16].

Performing a randomised controlled prospective trial, comparing clinical and financial outcomes of patients with cancer discussed or not discussed in MDTMs is no longer feasible because MDTMs are completely integrated in daily practice. Besides, evidence does show that MDTMs improve staging, improve effective planning of diagnostics and therapy, enhance better communication between involved departments and improve decision-making and adherence to guidelines [4,12,17–22].

Several national guidelines, such as in the Netherlands (23), United Kingdom (10, 24), France (25), United States of America (5) and Australia (26), demand to discuss (nearly) all patients with cancer in a MDTM. Owing to increasing incidence and prevalence of cancer, centralisation of care, the rise of more tumour-specific MDTMs (9) and increasing amount of multidisciplinary treatment approaches, the number of patients needed to be discussed in a MDTM is growing in an unsustainable way [27,28].

A change in the organisation of MDTMs is therefore needed. But to restructure oncologic MDT working, it is essential to know more about current practice. Is every patient actually discussed? For this purpose, we investigated whether or not 105.000 Dutch patients with cancer were discussed in MDTMs, trying to identify the factors that contribute to not being discussed. Our results will open up the debate about ways to restructure MDTMs towards a more durable and efficient MDTM strategy.

2. Materials and methods

Data of the nationwide population-based Netherlands Cancer Registry (NCR) were used. This register includes data from an area of approximately 17 million inhabitants, the total Dutch population. The NCR uses the national automated pathological archive, to include all newly diagnosed malignancies in the Netherlands. Additional sources for notifications are the national registry of hospital discharge and radiotherapy institutions. Specially trained data managers of the NCR routinely extract information on diagnosis, tumour stage and treatment from the medical records. Since 2015, for a selection of tumour types, whether or not a patient is discussed in a MDTM is also routinely recorded. Information on vital status is obtained through annual linkage with the Municipal Administrative Database, in which all deceased and emigrated persons in the Netherlands are registered.

We included patients newly diagnosed with an invasive solid malignancy in 2015 and 2016. We formed eight groups of patients according to tumour types, who are regularly discussed within the same tumour-specific MDTM, namely upper gastrointestinal (GI) cancer

(oesophagus, cardiac, stomach and duodenal cancers), hepato-pancreatic-biliary (HPB) cancer, colorectal cancer (CRC), gynaecological cancer (cervical, endometrial and ovarian cancers), central nerve system (CNS) cancer, head and neck cancer (HNC), breast cancer and prostate cancer. For patients with prostate cancer, the necessary data were only available since October 2015 because of an expansion of the items that were collected in the NCR since then, initiated by the ProZIB initiative aimed at providing insight into the quality of prostate cancer care in the Netherlands.

An extensive item set per patient is collected by the NCR data managers. The items within this set differ per tumour type, based on national agreements. Unfortunately, for lung, renal and bladder cancer, melanoma and sarcoma, no data on MDTM discussions were recorded, and therefore, these tumour types were excluded.

Patients with haematologic cancer were excluded because of the different organisation of care in the Netherlands. Furthermore, patients with nonmelanoma skin cancers (squamous cell carcinoma and basal cell carcinoma) were excluded because of the lack of multidisciplinary discussion in these mostly only surgically treated patients.

The percentage of patients being discussed in MDTMs in total and per tumour group was investigated using univariable analyses followed by a multivariable logistic regression on the chance of being discussed in a MDTM. In these multivariable analyses, we adjusted for five different factors that might contribute to being discussed in a MDTM: age at diagnosis (four categories: $\leq$44, 45–59, 60–74 or $\geq$75 years), disease stage (by tumour-node-metastasis (TNM) or International Federation of Gynaecology and Obstetrics (FIGO) for gynaecological cancer—and not applicable for CNS cancer), treatment (none, monodisciplinary or multidisciplinary), number of comorbidities (0, 1, 2–4 or >5) and geographical location of hospital of diagnosis (divided into four regions based on the provinces of the Netherlands). We excluded short-term survival from the multivariable analyses because of possible multicollinearity with receiving no treatment. Comorbidity was not routinely registered for all patients and not included in the analyses if lacking in more than 70% of patients. This applied to HNC, CNS cancer, and breast cancer.

As mentioned, data about MDTM discussion were not recorded for some tumour groups. For an estimation on the percentage of discussion of all patients with a solid malignant tumour (excluding nonmelanoma skin cancer, including the tumour groups with not recorded data), we performed a sensitivity analysis using multiple imputation. Therefore, the missing data on MDTM discussions of all groups except prostate cancer were imputated (10 times per patient) based on the data of the groups for which MDTM discussions were registered within the NCR with a logistic regression model with the following factors: age, disease stage, comorbidity, treatment (none, monodisciplinary or multidisciplinary), region (based on the provinces in the Netherlands), year of diagnosis and 90-day mortality. A separate multiple imputation analysis was made for patients with prostate cancer based on the data of these patients with known MDTM values (October 2015–December 2016) because we missed data from only January–September 2015 for this group.

3. Results

We analysed 105.319 patients with a new diagnosis of an invasive solid malignant tumour in the Netherlands in 2015 and 2016. Of them, 91% were actually discussed in a MDTM (Table 1). The highest MDTM rates were found for CRC (93%), HNC (95%), CNS cancer (91%) and breast cancer (99%). Less frequently discussed were HPB (74%), prostate (80%), upper GI (84%) and gynaecological cancer (89%). Different factors were univariably related to being less frequently discussed: age $\geq$75 years (of this age group, 84% was discussed), disease stages I, IV and unknown (of these disease stage groups, 91%, 83% and 73% of patients, respectively, were discussed), receiving no treatment or only systemic treatment (64% and 86% of patients in these treatment groups were discussed) and deceased within 90 days of diagnosis (of these, only 63% were discussed). Sensitivity analysis based on 181.241 patients with an invasive solid malignant tumour (including tumour types with missing data in the NCR, excluding nonmelanoma skin cancer), diagnosed in 2015 and 2016, shows a discussion rate of 88% (Supplementary table A).

Table 2 presents the multivariable logistic regression analysis on the chance of being discussed in a MDTM. The total group analysis shows a less frequent discussion for patients with age $\geq$75 years (odds ratio [OR] = 0.7, 95% confidence interval [CI] = 0.6–0.7) or without a treatment (OR = 0.3, 95% CI = 0.3–0.3). Patients with a monodisciplinary treatment plan were less likely to be discussed than those with a multidisciplinary treatment plan (OR = 4.6, 95% CI = 4.2–5.1). The chance to be discussed was slightly lower in region D than in A, B or C. The number of comorbidities did not make a difference. Patients were more likely to be discussed with disease stages II and III, compared with I, IV or unknown.

Differences were noted per tumour group. Older patients ($\geq$75 years) were significantly less often discussed within tumour groups CRC, HNC, HPB, gynaecological, breast and prostate cancers. In all different tumour groups, we found significant associations with being less frequently discussed in disease stages I, IV and/or unknown. The number of comorbidities was

Table 1
Univariable analyses of the number and percentage of patients discussed in MDTMs in 2015 and 2016 according to the nationwide population-based Netherlands Cancer registry data.

Tumour groups	Upper GI cancers		HPB cancers		Colorectal carcinoma		Gynaecological cancers		CNS cancers	
	N (%)	% pts discussed in MDTMs	N (%)	% pts discussed in MDTMs	N (%)	% pts dis cussed in MDTMs	N (%)	% pts discussed in MDTMs	N (%)	% pts discussed in MDTMs
Number of patients										
N (% of total)	7704 (7)	84	7397 (7)	74	30831 (29)	93	7671 (7)	89	2000 (2)	91
Gender										
Male	5419 (70)	85	4048 (55)	76	17603 (57)	94	0 (0)	NA	1211 (61)	92
Female	2285 (30)	82	3349 (45)	71	13228 (43)	93	7671 (100)	89	789 (39)	90
Age (years)										
≤44	136 (2)	89	110 (1)	84	567 (2)	98	775 (10)	96	434 (22)	88
45–59	1214 (16)	88	1078 (15)	84	4262 (14)	96	1712 (22)	91	587 (29)	93
60–74	3709 (48)	88	3513 (47)	81	16253 (53)	95	3189 (42)	90	796 (40)	92
≥75	2645 (34)	77	2696 (36)	60	9738 (32)	89	1995 (26)	82	183 (9)	93
Stage (TNM or FIGO[a])										
I	1072 (14)	80	691 (9)	76	7860 (26)	92	3968 (52)	87	NA	NA
II	1097 (14)	95	1585 (21)	90	7270 (24)	97	698 (9)	95	NA	NA
III	2040 (26)	97	1159 (16)	86	8897 (29)	98	1646 (21)	93	NA	NA
IV	3001 (39)	79	3546 (48)	64	6064 (20)	86	1205 (16)	90	NA	NA
X	494 (6)	47	416 (6)	52	729 (2)	61	154 (2)	55	NA	NA
Primary treatment										
No	2004 (26)	63	4028 (54)	60	2394 (8)	64	656 (9)	63	52 (3)	63
Yes	5700 (74)	92	3369 (46)	90	28426 (92)	96	7015 (91)	91	1948 (97)	92
Type of treatment										
None	2004 (26)	63	4028 (54)	60	2394 (8)	64	656 (9)	63	52 (3)	63
Surgery (Sur)	763 (10)	76	1245 (17)	96	16476 (53)	95	2893 (38)	86	466 (23)	87
Radiotherapy (Rtx)	965 (13)	92	134 (2)	81	529 (2)	95	154 (2)	95	14 (1)	86
Systemic therapy (Syst)	909 (12)	83	1306 (18)	82	1700 (6)	86	591 (8)	90	3 (<0.5)	NA
Sur + Rtx	11 (<0.5)	NA	16 (<0.5)	NA	1464 (5)	100	1129 (15)	91	408 (20)	91
Sur + Syst	556 (7)	99	525 (7)	99	5144 (17)	99	1636 (21)	99	109 (5)	95
Rtx + Syst	1068 (14)	96	98 (1)	93	692 (2)	98	323 (4)	99	5 (<0.5)	NA
Sur + Rtx + Syst	1428 (19)	99	45 (1)	100	2421 (8)	100	289 (4)	99	943 (47)	95
Number of comorbidities[b]										
0	1715 (22)	87	1098 (15)	76	5412 (18)	95	2583 (34)	92	117 (6)	NA
1	2010 (26)	86	1604 (22)	75	5765 (19)	94	2146 (28)	89	88 (4)	NA
2–4	3210 (42)	83	2370 (32)	69	7203 (23)	93	2272 (30)	85	58 (3)	NA
>5	315 (4)	78	151 (2)	68	592 (2)	90	118 (2)	81	3 (<0.5)	NA
Unknown	454 (6)	79	2174 (29)	77	11848 (38)	93	552 (7)	85	1734 (87)	NA
Region[c]										
A	995 (13)	84	856 (12)	67	3641 (12)	93	839 (11)	87	232 (12)	92
B	1608 (21)	85	1583 (21)	73	6916 (22)	94	1678 (22)	86	438 (22)	88
C	1966 (26)	86	1741 (24)	73	7895 (26)	94	1978 (26)	89	433 (22)	96
D	3135 (41)	83	3217 (43)	76	12368 (40)	93	3176 (41)	91	897 (45)	90
Short-term survival (days)[d]										
<30	618 (8)	43	1189 (16)	43	897 (3)	44	231 (3)	48	91 (5)	77
30–90	1014 (13)	76	1692 (23)	63	1216 (4)	78	298 (4)	80	204 (10)	91
>90	6072 (79)	90	4516 (61)	86	28707 (93)	96	7142 (93)	90	1705 (85)	92

Tumour groups	Head and neck cancers[e]		Breast cancer		Prostate cancer[f]		Total	
	N (%)	% pts discussed in MDTMs	N (%)	% pts discussed in MDTMs	N (%)	% pts discussed in MDTMs[g]	N (%)	% pts discussed in MDTMs
Number of patients								
N (% of total)	5398 (5)	95	31313 (30)	99	13005 (12)	80	105319 (100)	91
Gender								
Male	3575 (66)	95	229 (1)	99	13004 (100)	80	45080 (43)	87
Female	1822 (34)	94	31083 (99)	99	0 (0)	NA	60225 (57)	94

Table 1 (*continued*)

Tumour groups	Head and neck cancers[e]		Breast cancer		Prostate cancer[f]		Total	
	N (%)	% pts discussed in MDTMs	N (%)	% pts discussed in MDTMs	N (%)	% pts discussed in MDTMs[g]	N (%)	% pts discussed in MDTMs
Age (years)								
≤44	148 (3)	96	2937 (9)	99	7 (0)	86	5114 (5)	97
45–59	1266 (23)	97	10388 (33)	99	1268 (10)	83	21775 (21)	95
60–74	2755 (51)	96	12243 (39)	99	8135 (63)	83	50593 (48)	92
≥75	1228 (23)	91	5744 (18)	97	3594 (28)	74	27823 (26)	84
Stage (TNM)								
I	1597 (30)	88	14906 (48)	100	5000 (38)	72	3912 (4)	91
II	804 (15)	98	11383 (36)	99	2534 (19)	85	35094 (33)	96
III	756 (14)	98	3199 (10)	99	2189 (17)	88	25371 (24)	96
IV	2186 (41)	98	1789 (6)	88	3251 (25)	85	19886 (19)	83
X	54 (1)	61	35 (<0.5)	94	30 (<0.5)	23	21042 (20)	73
Primary treatment								
No	481 (9)	87	484 (2)	77	3616 (28)	65	13715 (13)	64
Yes	4916 (91)	96	30828 (98)	99	9388 (72)	86	91590 (87)	95
Type of treatment								
None	481 (9)	87	484 (2)	77	3616 (28)	65	13715 (13)	64
Surgery (Sur)	1554 (29)	88	2518 (8)	100	2858 (22)	84	28773 (27)	92
Radiotherapy (Rtx)	1519 (28)	99	57 (0)	96	1444 (11)	85	4816 (5)	92
Systemic therapy (Syst)	29 (1)	93	2689 (9)	93	2445 (19)	80	9672 (9)	86
Sur + Rtx	792 (15)	99	6358 (20)	100	105 (1)	97	10283 (10)	98
Sur + Syst	6 (<0.5)	NA	4826 (15)	100	210 (2)	93	13012 (12)	99
Rtx + Syst	820 (15)	100	304 (1)	88	1848 (14)	93	5158 (5)	95
Sur + Rtx + Syst	196 (4)	100	14076 (45)	100	478 (4)	97	19876 (19)	>99.5
Number of comorbidities[b]								
0	99 (2)	NA	1950 (6)	NA	1987 (15)	80	14961 (14)	91
1	190 (4)	NA	1605 (5)	NA	2036 (16)	80	15444 (15)	89
2–4	292 (5)	NA	1404 (4)	NA	2242 (17)	78	19051 (18)	86
>5	20 (<0.5)	NA	100 (0)	NA	161 (1)	76	1460 (1)	83
Unknown	4796 (89)	NA	26253 (84)	NA	6578 (51)	81	54389 (52)	94
Region[c]								
A	730 (14)	96	3591 (11)	98	1757 (14)	90	12641 (12)	91
B	1149 (21)	96	6922 (22)	99	2894 (22)	85	23188 (22)	92
C	1297 (24)	97	7483 (24)	99	3137 (24)	79	25930 (25)	92
D	2220 (41)	93	13315 (43)	99	5216 (40)	75	43544 (41)	90
Short-term survival (days)[d]								
<30	87 (2)	78	165 (1)	57	70 (1)	31	3348 (3)	46
30–90	223 (4)	94	225 (1)	84	100 (1)	66	4972 (5)	74
>90	5087 (94)	95	30922 (99)	99	12834 (99)	81	96985 (92)	93

MDTM = multidisciplinary team meeting; N = number of patients; stage X = unknown; pts = patients; TNM = tumour-node-metastasis; FIGO = International Federation of Gynaecology and Obstetrics.
upper GI cancers = oesophagus, cardiac, stomach and duodenal cancers; HPB cancers = hepato-pancreatic-biliary cancers; gynaecological cancers = cervical, endometrial and ovarian cancers; CNS cancers = central nervous system cancers.

[a] FIGO staging for gynaecological cancers.

[b] When <0.5% of patients received a certain type of treatment or when comorbidities were not registered for >70% of patients, analyses according to percentages of patients discussed in MDTMs were deleted.

[c] Region = regions of hospital of diagnosis divided into four based on the provinces in the Netherlands. The regions were coded.

[d] Short-term survival = time between the date of diagnosis and the date of death.

[e] Head and neck cancers only include patients referred to academic centres (missing = 2%).

[f] Prostate cancers: data available since October 2015.

[g] Being discussed with MDTM report in the medical record.

more difficult to investigate because it was unavailable in HNC, breast and CNS cancers. For CRC, the presence of >5 comorbidities was related to more frequently being discussed. Geographical region appeared to have impact on being discussed in a MDTM for all tumour groups except breast cancer.

4. Discussion

In our large cohort of 105.000 patients with cancer, 91% was discussed in a MDTM. This is in accordance with the Dutch SONCOS (national multidisciplinary platform to provide guidelines for oncological care)

guidelines, which state that at least 90% of patients should be discussed [23]. Many international guidelines state that (nearly) all patients should be discussed in a MDTM without quantification [5,10,23–26]. The threshold of 90% was reached for CRC, HNC, CNS and breast cancers but was not reached for HPB, prostate, upper GI and gynaecological cancers. Based on our dataset, we cannot explain the differences between the tumour groups. It might be clear that this 90% is an arbitrarily chosen threshold, with a lack of supportive evidence.

In a recent Belgian study of 205.062 patients, the number of patients being discussed in MDTMs increased over time, from 36–77% in 2004 to 69–94% in 2011. As in our study, patients aged ≥80 years or with disease stages I, IV and/or unknown were less likely to be discussed for all seven included tumour types [29]. In addition, our data were up to 2016 and we showed that patients with multidisciplinary treatment were significantly more likely to be discussed than those with monodisciplinary treatment.

Taken together, the need to formulate a multidisciplinary treatment plan seems the most important determinant for being discussed in a MDTM. Older patients might be unable or unwilling to receive (multidisciplinary) treatment because of reduced physical condition, and we hypothesise that patients with disease stages I and IV are more likely to receive a monodisciplinary treatment, such as local surgical resection (stage I) or systemic medical treatment approaches or no treatment (stage IV). For patients with disease stage 'unknown', we assume that the inability to perform all necessary diagnostics to complete staging is associated with getting no treatment and/or impaired performance status. Our data support this hypothesis; for instance, patients with upper GI cancer were less frequently discussed (84%). This lower discussion rate is explained by disease stage I (80%), IV (79%) and 'unknown' (47%). Patients with stages II and III have remarkably higher discussion rates (95% and 97%, respectively). We see similar patterns for the other tumour types with lower discussion rates. However, limited by the retrospective design of the current analysis, one might hypothesise that patients were not receiving multidisciplinary treatments as a result of not being discussed.

We might have expected an impact of the number of comorbidities on MDTM discussion rates, but in fact, there was no significant association, with the exception of patients with CRC with more than 5 comorbidities. For HNC, CNS and breast cancers, no data on the number of comorbidities was available. Because the number of comorbidities did not make a difference in discussion rates in the remaining tumour groups, this does not seem to be crucial.

We found differences between the tumour groups based on the geographical region even in a small country such as the Netherlands, with a lowered discussion rate in region D, compared with regions A, B and C. Within the collected data, no explanation for this difference can be found. There are no differences in the health care system and its accessibility within the Netherlands. However, regional differences are not completely unusual in oncological care. A study in 2016 showed regional differences in liver surgery for patients with colorectal cancer [30], and another article reported that the hospital of diagnosis influences the probability to get gastric surgery in patients with gastric cancer [31].

A limitation of this study is the exclusion of patients with melanoma, sarcoma, lung, renal, and bladder cancers due to lack of information about MDTMs in the NCR, accounting for 42% of the total cancer incidence. Nevertheless, more than 105.000 patients, with a large variety of tumour types, were analysed, and the general conclusions may be extrapolated to all tumour types in the Netherlands. This hypothesis is reinforced by the sensitivity analysis that shows a discussion percentage of 88% for all patients, when missing data was imputated.

Can we exclude patients without a multidisciplinary question from MDTMs, in an era where MDTMs are under pressure because of high costs and confiscation of lots of time? In a retrospective analysis of a breast cancer MDTM, 31% of the patients who were considered 'fit' after geriatric assessment did not receive the appropriate adjuvant treatment, influenced by high age and comorbidities as monitored by the MDT members [32]. A 'simple' factor such as age is thus not able to distinguish the need for MDT discussion. Distinguishing based on the disease stage alone is not possible either. A retrospective analysis of 1600 operated patients with squamous cell carcinomas of the oral cavity showed improved survival rates among patients who were discussed in MDTMs, compared with patients not being discussed (for stage I, a 5-year overall survival rate was 82%–92% [$p = 0.023$], and for stage IV, this was 45%–50% [$p = 0.0194$]) [33]. Should patients then be excluded from MDT discussion based on individual characteristics? This gives a chance of incorrectly excluding patients to advanced multidisciplinary treatment options, such as, for instance, curative treatment approaches of liver surgery in patients in stage IV colorectal cancer with liver metastasis [34].

5. Future directions

As mentioned, restructuring the workflow around MDTMs seems inevitable in a changing oncological field. Based on our results, it is not easy to exclude one specific group from MDT discussion. Further research should focus on patients who received a monodisciplinary treatment plan to make detailed comparisons of being discussed in MDTMs or not and receiving

Table 2
Multivariable logistic regression analyses of percentage of patients discussed in multidisciplinary team meetings in 2015 + 2016.

Tumour groups	Upper GI cancers		HPB cancers		Colorectal carcinoma		Gynaecological cancers		CNS cancers	
	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI
Tumour groups										
Upper GI cancers	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
HPB cancers	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Colorectal carcinoma	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gynaecological cancers	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CNS cancers	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Head and neck cancers	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Breast cancer	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Prostate cancer	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Age (years)										
≤44	1.2	(0.6–2.1)	0.9	(0.5–1.5)	1.7	(1.0–3.0)	**3.2**	**(2.2–4.8)**	0.7	(0.5–1.1)
45–59	1.0	(0.7–1.3)	0.9	(0.8–1.1)	1.2	(1.0–1.4)	1.2	(1.0–1.4)	1.0	(0.7–1.6)
60–74	REF		REF		REF		REF		REF	
≥75	1.0	(0.9–1.2)	**0.5**	**(0.4–0.5)**	**0.7**	**(0.7–0.8)**	**0.8**	**(0.6–0.9)**	1.5	(0.8–2.9)
Stage (TNM or FIGO[a])										
I	**0.3**	**(0.2–0.4)**	**0.5**	**(0.4–0.7)**	**0.3**	**(0.3–0.4)**	**0.4**	**(0.2–0.6)**	NA	NA
II	REF		REF		REF		REF		NA	NA
III	1.4	(0.9–2.0)	1.0	(0.8–1.3)	0.8	(0.7–1.1)	1.3	(0.8–2.0)	NA	NA
IV	**0.4**	**(0.3–0.6)**	**0.3**	**(0.3–0.4)**	**0.2**	**(0.2–0.3)**	1.2	(0.8–1.8)	NA	NA
X	**0.1**	**(0.1–0.2)**	**0.3**	**(0.2–0.4)**	**0.1**	**(0.1–0.2)**	**0.3**	**(0.2–0.5)**	NA	NA
Type of treatment[b]										
None	**0.4**	**(0.3–0.4)**	**0.3**	**(0.3–0.4)**	**0.2**	**(0.2–0.2)**	**0.2**	**(0.1–0.2)**	**0.3**	**(0.1–0.5)**
Monodisciplinary	REF		REF		REF		REF		REF	
Multidisciplinary	**6.1**	**(4.5–8.1)**	**3.7**	**(2.2–6.5)**	**5.0**	**(4.0–6.3)**	**2.6**	**(2.1–3.2)**	**2.3**	**(1.6–3.2)**
Number of comorbidities[c]										
0	REF		REF		REF		REF		REF	
1	1.1	(0.9–1.3)	1.1	(0.9–1.3)	1.1	(1.0–1.4)	0.9	(0.7–1.1)	NA	NA
2–4	1.2	(1.0–1.4)	1.0	(0.8–1.2)	1.2	(1.0–1.4)	0.8	(0.7–1.0)	NA	NA
>5	1.2	(0.9–1.7)	1.1	(0.7–1.7)	**1.4**	**(1.0–2.0)**	0.9	(0.5–1.5)	NA	NA
Unknown	0.8	(0.6–1.0)	1.1	(0.9–1.4)	1.0	(0.9–1.2)	**0.6**	**(0.5–0.9)**	NA	NA
Region[d]										
A	1.0	(0.8–1.2)	**0.7**	**(0.6–0.8)**	1.1	(1.0–1.3)	**0.7**	**(0.6–1.0)**	1.4	(0.8–2.5)
B	1.1	(0.9–1.3)	**0.8**	**(0.7–1.0)**	1.1	(1.0–1.2)	**0.6**	**(0.5–0.8)**	0.7	(0.5–1.0)
C	**1.3**	**(1.1–1.5)**	0.9	(0.8–1.1)	**1.3**	**(1.1–1.5)**	0.8	(0.7–1.0)	**2.5**	**(1.4–4.2)**
D	REF		REF		REF		REF		REF	

Tumour groups	Head and neck cancers[e]		Breast cancer		Prostate cancer[f]		Total	
	OR	CI	OR	CI	OR	CI	OR	CI
Tumour groups								
Upper GI cancers	NA	NA	NA	NA	NA	NA	**0.6**	**(0.5–0.6)**
HPB cancers	NA	NA	NA	NA	NA	NA	**0.5**	**(0.4–0.5)**
Colorectal carcinoma	NA	NA	NA	NA	NA	NA	REF	REF
Gynaecological cancers	NA	NA	NA	NA	NA	NA	**0.5**	**(0.4–0.5)**
CNS cancers	NA	NA	NA	NA	NA	NA	0.8	(0.7–1.0)
Head and neck cancers	NA	NA	NA	NA	NA	NA	**1.3**	**(1.1–1.5)**
Breast cancer	NA	NA	NA	NA	NA	NA	**2.3**	**(2.0–2.6)**
Prostate cancer	NA	NA	NA	NA	NA	NA	**0.4**	**(0.4–0.4)**
Age (years)								
≤44	1.1	(0.4–2.7)	1.5	(0.8–2.5)	1.2	(0.1–10.8)	**1.4**	**(1.2–1.7)**
45–59	1.3	(0.9–1.9)	**1.4**	**(1.0–2.0)**	1.3	(1.0–1.3)	**1.1**	**(1.0–1.2)**
60–74	REF		REF		REF		REF	
≥75	**0.6**	**(0.5–0.8)**	**0.7**	**(0.6–1.0)**	**0.6**	**(0.5–0.6)**	**0.7**	**(0.6–0.7)**
Stage (TNM)								
I	**0.2**	**(0.1–0.3)**	**1.8**	**(1.2–2.7)**	**0.7**	**(0.6–0.8)**	**0.5**	**(0.5–0.6)**
II	REF		REF		REF		REF	
III	1.2	(0.6–2.5)	**0.6**	**(0.4–1.0)**	1.1	(0.9–1.3)	1.0	(0.9–1.1)
IV	1.3	(0.8–2.4)	**0.1**	**(0.1–0.2)**	1.0	(0.9–1.2)	**0.4**	**(0.4–0.4)**
X	**0.1**	**(<0.05–0.1)**	0.5	(0.1–2.1)	**0.1**	**(<0.05–0.2)**	**0.2**	**(0.2–0.2)**
Type of treatment[b]								
None	**0.2**	**(0.1–0.3)**	**0.2**	**(0.1–0.2)**	**0.5**	**(0.4–0.6)**	**0.3**	**(0.3–0.3)**

(*continued on next page*)

Table 2 (*continued*)

Tumour groups	Head and neck cancers[e]		Breast cancer		Prostate cancer[f]		Total	
	OR	CI	OR	CI	OR	CI	OR	CI
Monodisciplinary	REF		REF		REF		REF	
Multidisciplinary	**4.6**	**(2.3–9.0)**	**7.0**	**(5.0–9.8)**	**3.6**	**(3.0–4.3)**	**4.6**	**(4.2–5.1)**
Number of comorbidities[c]								
0	NA	NA	NA	NA	REF		REF	
1	NA	NA	NA	NA	1.0	(0.9–1.2)	1.0	(0.9–1.1)
2–4	NA	NA	NA	NA	0.9	(0.8–1.1)	1.0	(0.9–1.1)
>5	NA	NA	NA	NA	0.9	(0.6–1.4)	1.1	(0.9–1.3)
Unknown	NA	NA	NA	NA	**1.1**	**(1.0–1.3)**	1.0	(1.0–1.1)
Region[d]								
A	**2.1**	**(1.4–3.2)**	0.8	(0.5–1.1)	**3.4**	**(2.9–4.1)**	**1.3**	**(1.2–1.4)**
B	**1.9**	**(1.4–2.8)**	1.2	(0.9–1.6)	**2.0**	**(1.8–2.3)**	**1.2**	**(1.1–1.2)**
C	**2.1**	**(1.5–3.0)**	1.3	(1.0–1.8)	**1.4**	**(1.2–1.6)**	**1.2**	**(1.6–1.3)**
D	REF		REF		REF		REF	

OR = odds ratio; CI = confidence interval; stage X = unknown; TNM = tumour-node-metastasis.
Upper GI cancers = oesophagus, cardiac, stomach and duodenal cancers; HPB cancers = hepato-pancreatic-biliary cancers; gynaecological cancers = cervical, endometrial and ovarian cancers; CNS cancers = central nervous system cancers.
Significant results are marked in bold with p-values < 0.05.
[a] FIGO staging for gynaecological cancers.
[b] Monodisciplinary treatment contains surgery, radiotherapy or systemic therapy. Multidisciplinary treatment contains a combination of two or three of these treatment modalities.
[c] When comorbidities were not registered for >70% of patients, analyses according to percentages of patients discussed in MDTMs were deleted (except for the total analysis).
[d] Region = regions of hospital of diagnosis divided into four based on the provinces in the Netherlands. The regions were coded.
[e] Head and neck cancers only include patients referred to academic centres (missing = 2%).
[f] Prostate cancers; data available since October 2015.

the expected treatment based on clinical guidelines or not.

We suggest subdividing patients into three different categories: (1) low-volume high-complex cases, who should be discussed by regional or national expert teams, (2) high-volume low-complex cases with a good performance status, to discuss by local panels of only 2 or 3 medical specialists and (3) the remaining patients should be discussed in regular tumour-specific MDTMs, with possibility to use expert consultation. A further restructuring method for selected tumour types would be a MDTM exclusively for patients with metastatic disease to explore additional local (curative) treatment options for these patients. This is to provide optimal care for every patient, regardless of the hospital of first referral. These restructuring methods are efficient and prevent patients from being discussed several times at different places.

6. Conclusion

Of more than 105.000 patients with a solid invasive malignant tumour, diagnosed in 2015 or 2016, a high number of patients (91%) were discussed in a MDTM. Differences between different tumour groups were found based on characteristics such as high age, disease stage and the need of a multidisciplinary treatment plan. These results form the starting point for debate on restructuring MDTMs in such a way that high-quality care and speed of care are maintained and time efforts and costs are reduced, while increasing number of patients with cancer need to be discussed multidisciplinary.

Conflict of interest statement

All authors have no disclaimers of conflict of interest. There were no funding sources for this research.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejca.2019.08.007.

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