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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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: ≤44, 45–59, 60–74 or ≥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 imputed (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 ≥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 ≥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 (≥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 | Number of patients | Number of patients in MDTMs | Gender | Age (years) | Stage (TNM or FIGO) | Type of treatment | Number of comorbidities | Region | Short-term survival (days) | Tumour groups |
|---------------|--------------------|-----------------------------|--------|-------------|---------------------|-------------------|-----------------------|--------|--------------------------|---------------|
|               | N (% of total)     | N (%) % pts discussed in MDTMs | Male   | ≤44         | I                   | None              | 0                    | A      | <30                      | Head and neck cancers | Breast cancer | Prostate cancer | Total |
| Upper GI cancers | 7704 (7)          | 7397 (7) 74 % pts discussed in MDTMs | 5419 (70) 85 | 136 (2) 89 | 1072 (14) 80 | 2004 (26) 63 | 715 (22) 87 | 995 (13) 84 | 618 (8) 43 | 5398 (5) 95 |
| HPB cancers    | 8483 (5) 76 % pts discussed in MDTMs | 1097 (14) 95 | 1004 (26) 97 | 3001 (39) 74 | 494 (6) 47 | 5700 (26) 63 | 1428 (19) 99 | 1715 (22) 87 | 2010 (26) 86 | 3575 (66) 95 |
| Colorectal carcinoma | 30831 (29) 93 % pts discussed in MDTMs | 2040 (26) 97 | 1159 (16) 86 | 3546 (48) 64 | 416 (6) 52 | 3369 (46) 90 | 556 (7) 99 | 1098 (15) 76 | 1604 (22) 75 | 3575 (66) 95 |
| Gynaecological cancers | 7671 (7) 89 % pts discussed in MDTMs | 2004 (26) 63 | 1245 (17) 96 | 5144 (17) 99 | 62 (10) 99 | 2824 (92) 96 | 1068 (14) 96 | 1098 (15) 76 | 1604 (22) 75 | 3575 (66) 95 |
| CNS cancers    | 2000 (2) 91 % pts discussed in MDTMs | 136 (2) 89 | 110 (1) 84 | 6064 (20) 86 | 72 (2) 61 | 2842 (92) 96 | 1734 (9) 96 | 1189 (16) 43 | 1692 (23) 63 | 3575 (66) 95 |

| Number of patients | N (% of total) | N (%) % pts discussed in MDTMs | Gender | Age (years) | Stage (TNM or FIGO) | Type of treatment | Number of comorbidities | Region | Short-term survival (days) | Tumour groups |
|--------------------|----------------|-------------------------------|--------|-------------|---------------------|-------------------|-----------------------|--------|--------------------------|---------------|
| Head and neck cancers | 3575 (66) 95 | 1004 (26) 63 % pts discussed in MDTMs | 1608 (21) 85 | 1680 (21) 73 | 1098 (15) 76 | 2004 (26) 63 | 1098 (15) 76 | 1189 (16) 43 | 1692 (23) 63 | 3575 (66) 95 |
| Breast cancer      | 31313 (30) 99 % pts discussed in MDTMs | 1822 (34) 94 | 1966 (26) 66 | 1741 (24) 73 | 1715 (22) 87 | 5130 (41) 83 | 1715 (22) 87 | 1189 (16) 43 | 1692 (23) 63 | 1822 (34) 94 |
| Prostate cancer    | 13005 (12) 80 % pts discussed in MDTMs | 3575 (66) 95 | 1680 (21) 85 | 1741 (24) 73 | 1715 (22) 87 | 5130 (41) 83 | 1715 (22) 87 | 1189 (16) 43 | 1692 (23) 63 | 1822 (34) 94 |
| Total              | 105319 (100) 91 % pts discussed in MDTMs | 3575 (66) 95 | 1680 (21) 85 | 1741 (24) 73 | 1715 (22) 87 | 5130 (41) 83 | 1715 (22) 87 | 1189 (16) 43 | 1692 (23) 63 | 1822 (34) 94 |
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 | Prostate cancer | Age (years) | Stage (TNM or FIGO) | Type of treatment |
|---------------------|------------------|-------------|----------------------|------------------------|-------------|-----------------|--------------|---------------------|------------------|
|                     | OR               | CI          | OR                   | CI                     | OR          | CI              | ≤44          | I                   | None             |
| Upper GI cancers    | NA               | NA          | NA                   | NA                     | NA          | NA              | 1.2  (0.6–2.1) | 0.9 (0.5–1.5)   | REF              |
| HPB cancers         | NA               | NA          | NA                   | NA                     | NA          | NA              | 1.7  (1.0–3.0) | 3.2 (2.2–4.8)   | REF              |
| Colorectal carcinoma| NA               | NA          | NA                   | NA                     | NA          | NA              | 1.0  (1.0–1.4) | 1.2 (1.0–1.4)   | REF              |
| Gynaecological cancers| NA              | NA          | NA                   | NA                     | NA          | NA              | 1.2  (1.0–1.4) | 1.0 (0.7–1.6)   | REF              |
| CNS cancers         | NA               | NA          | NA                   | NA                     | NA          | NA              | 0.8  (0.7–1.1) | 1.5 (0.8–2.9)   | NA               |
| Head and neck cancers| NA               | NA          | NA                   | NA                     | NA          | NA              | 0.5  (0.4–0.5) | 0.8 (0.6–0.9)   | NA               |
| Breast cancer       | NA               | NA          | NA                   | NA                     | NA          | NA              | 0.7  (0.7–0.8) | 1.0 (0.8–1.2)   | NA               |
| Prostate cancer     | NA               | NA          | NA                   | NA                     | NA          | NA              | 0.8  (0.7–0.8) | 1.5 (0.8–2.9)   | 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         | 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) |                  |             |                      |                        |             |                 |               | I                   | None             |
| 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                    | REF         | REF             |               |                    |                  |
| 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) | 0.2 (0.1–0.2) | 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   |                  |             |                      |                        |             |                 |               | None               |                  |
| None                | 0.4 (0.3–0.4)   | 0.3 (0.3–0.4) | 0.2 (0.2–0.3) | 0.2 (0.1–0.2) | 0.3 (0.1–0.5) |               |               |                    |                  |
| Monodisciplinary    | REF              | 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

| Region | 0 | 1 | 2–4 | ≥5 | Unknown | 0.6 (0.5–0.9) | NA          | NA               |               |                  |
|--------|---|---|-----|----|---------|---------------|-------------|-----------------|----------------|------------------|
| 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      | 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              |               |                  |                  |

Tumour groups

| Tumour groups       | Head and neck cancers | Breast cancer | Prostate cancer | Total |
|---------------------|-----------------------|---------------|-----------------|-------|
| Upper GI cancers    | NA                    | NA            | NA              | 0.6   | (0.5–0.6) |
| HPB cancers         | NA                    | NA            | NA              | 0.5   | (0.4–0.5) |
| Colorectal carcinoma| NA                    | NA            | NA              | 0.5   | (0.4–0.5) |
| Gynaecological cancers| NA                | NA            | NA              | 0.5   | (0.4–0.5) |
| CNS cancers         | NA                    | NA            | NA              | 0.8   | (0.7–1.0) |
| Head and neck cancers| NA                   | NA            | NA              | 1.3   | (1.1–1.5) |
| Breast cancer       | NA                    | NA            | NA              | 2.3   | (2.0–2.6) |
| Prostate cancer     | 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) |
| 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   | 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)

| Type of treatment   | None | NA | NA | NA | 0.2 (0.1–0.3) | 0.2 (0.1–0.2) | 0.2 (0.1–0.2) | 0.5 (0.4–0.6) | 0.3 (0.3–0.3) |
|---------------------|------|---|---|---|---------------|---------------|---------------|---------------|---------------|

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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.

References

[1] Wright FC, Lookhong N, Urbach D, Davis D, McLeod RS, Gagliardi AR. Multidisciplinary cancer conferences: identifying opportunities to promote implementation. Ann Surg Oncol 2009; 16(10):2731–7. https://doi.org/10.1245/s10434-009-0629-6.

[2] Gouveia J, Coleman MP, Haward R, Zanetti R, Hakama M, Borras JM, et al. Improving cancer control in the European Union: conclusions from the Lisbon round-table under the Portuguese EU Presidency, 2007. Eur J Cancer 2008;44(10):1457–62. https://doi.org/10.1016/j.ejca.2008.02.006.

[3] Ouwens M, Hulscher M, Hermens R, Faber M, Marres H, Wollersheim H, et al. Implementation of integrated care for patients with cancer: a systematic review of interventions and effects. Int J Qual Health Care : Journal of the International Society for Quality in Health Care 2009;21(2):137–44. https://doi.org/10.1093/intqhc/mzn061.

[4] El Saghir NS, Keating NL, Carlson RW, Khoury KE, Fallowfield L. Tumor boards: optimizing the structure and improving efficiency of multidisciplinary management of patients...
with cancer worldwide. In: American society of clinical oncology educational book. American society of clinical oncology. Meeting; 2014. e461—6. https://doi.org/10.14694/EdBook_AM.2014.34.e461.

[8] American college of surgeons C, IL. Commission on cancer. Cancer program standards 2012, ensuring patient-centered care. 2012.

[9] Fennell ML, Das IP, Clauser S, Petrelli N, Salner A. The organization of multidisciplinary care teams: modeling internal and external influences on cancer care quality. J Natl Cancer Inst Monogr 2010;2010(40):72—80. https://doi.org/10.1093/jncimonographs/lgq010.

[10] Griffith C, Turner J. United Kingdom national health service, Juan A, Berlanga P, Bisogno G, Michon J, Valteau-Couanet D, Pillay B, Wootten AC, Crowe H, Corcoran N, Tran B, Bowden P, Bydder S, Nowak A, Marion K, Phillips M, Atun R. The impact of multidisciplinary team meetings on patient assessment, management and outcomes in oncology settings: a systematic review of the literature. Cancer Treat Rev 2018;63:S152. https://doi.org/10.1111/jep.12022.

[11] Health Do. A policy framework for commissioning cancer services: a report by the expert advisory group on cancer to the chief medical officers of England and Wales. BMJ 1995. https://doi.org/10.1136/bmj.310.6992.1425.

[12] Borras JM, Albreht T, Audisio R, Briers E, Casali P, Esperou H, et al. Policy statement on multidisciplinary cancer care. Eur J Cancer 2014;50(3):475—80. https://doi.org/10.1016/j.ejca.2013.11.012.

[13] Griffith C, Turner J. United Kingdom national health service, cancer services collaborative “improvement partnership”, redesign of cancer services: a national approach. Eur J Surg Oncol: the European journal of Surgical Oncology 2004;30(Suppl 1):1—86. https://doi.org/10.1016/ejso.2004.07.010.

[14] Juan A, Berlanga P, Bisogno G, Michon J, Valteau-Couanet D, Kearns P, et al. Paediatric tumour boards in Europe: current situation and results of an international survey in expo-r-net. Pediatr Blood Cancer 2016;63:S152.

[15] Pillay B, Wootten AC, Crowe H, Corcoran N, Tran B, Bowden P, et al. The impact of multidisciplinary team meetings on patient assessment, management and outcomes in oncology settings: a systematic review of the literature. Cancer Treat Rev 2016;42:56—72. https://doi.org/10.1016/j.ctrv.2015.11.007.

[16] Bydder S, Nowak A, Marion K, Phillips M, Atun R. The impact of case discussion at a multidisciplinary team meeting on the treatment and survival of patients with inoperable non-small cell lung cancer. Intern Med J 2009;39(12):838—41. https://doi.org/10.1111/j.1445-5994.2009.02019.x.

[17] MacDermid E, Hooton G, MacDonald M, McKay G, Grose D, Mohammed N, et al. Improving patient survival with the colorectal cancer multi-disciplinary team. Colorectal Dis: The Official Journal of the Association of Coloproctology of Great Britain and Ireland 2009;11(3):291—5. https://doi.org/10.1111/j.1463-1318.2008.01580.x.

[18] Blay JY, Soibinet P, Penel N, Bompass E, Duffaud F, Stoeckle E, et al. Improved survival using specialized multidisciplinary board in sarcoma patients. Ann Oncol: Official Journal of the European Society for Medical Oncology 2017;28(11):2852—9. https://doi.org/10.1093/annonc/mdx484.

[19] Ke KM, Blazeby JM, Strong S, Carroll FE, Ness AR, Hollingsworth W. Are multidisciplinary teams in secondary care cost-effective? A systematic review of the literature. Cost Eff Resour Allocation C/E. 2013;11(1):7. https://doi.org/10.1186/1478-7547-11-7.

[20] Taplin SH, Weaver S, Salas E, Chollette V, Edwards HM, Bruinooge SS, et al. Reviewing cancer care team effectiveness. Journal of Oncology Practice 2015;11(3):239—46. https://doi.org/10.1200/jop.2014.003350.

[21] Abdulrahman Jr GO. The effect of multidisciplinary team care on cancer management. The Pan African medical journal 2011;9:20.

[22] Brar SS, Hong NL, Wright FC. Multidisciplinary cancer care: does it improve outcomes? J Surg Oncol 2014;110(5):494—9. https://doi.org/10.1002/jso.23700.

[23] Devitt B, Philip J, McLachlan SA. Team dynamics, decision making, and attitudes toward multidisciplinary cancer meetings: health professionals’ perspectives. Journal of oncology practice 2010;6(6):e17—20.

[24] Fleissig A, Jenkins V, Catt S, Fallowfield L. Multidisciplinary teams in cancer care: are they effective in the UK? The Lancet. Oncology 2006;7(11):935—43. https://doi.org/10.1016/s1470-2045(06)70940-8.

[25] Prades J, Remue E, Van Hoof E, Borras J. Multidisciplinary teams in cancer care: a systematic review of the evidence. Eur J Cancer 2013;49:S327.

[26] SONCOS normeringrapport 6; Multidisciplinaire oncologische zorg in Nederland. 2018.

[27] Dew K, Stubbe M, Signal L, Staimand J, Dennett E, Koea J, et al. Cancer care decision making in multidisciplinary meetings. Qual Health Res 2015;25(3):397—407. https://doi.org/10.1177/1049733814553010.

[28] Cannell E. The French cancer plan: an update. Lancet Oncol 2005;6(10):738.

[29] Victorian cancer plan 2016-2020; Improving cancer outcomes for all Victorians: www.health.vic.gov.au/cancer.

[30] Registry NpbNC. https://www.cijfersoverkanker.nl/.

[31] Kowalski C, Graeven U, von Kalle C, Lang H, Beckmann MW, Blohmer JU, et al. Shifting cancer care towards Multidisciplinarity: the cancer center certification program of the German cancer society. BMC Canc 2017;17(1):850. https://doi.org/10.1186/s12885-017-3824-1.

[32] Dubois C, De Schutter H, Leroy R, Stordeur S, De Gendt C, Schillemans V, et al. Multidisciplinary work in oncology: population-based analysis for seven invasive tumours. Eur J Cancer 2018;86. https://doi.org/10.1016/j.ejca.2018.02.003.

[33] Lam-Boer J, van der Stok EP, Huiskens J, Verhoeven RH, van Putten M, Verhoeven RH, van Sandick JW, Plukker JT, Llamas VE, Wijnhoven BP, et al. Hospital of diagnosis and probability of having surgical treatment for resectable gastric cancer. Br J Surg 2016;103(3):233—41. https://doi.org/10.1002/bjs.10054.

[34] Barthelemy P, Heitz D, Mathelin C, Polesi H, Asmane I, Littique V, et al. Adjuvant chemotherapy in elderly patients with early breast cancer. Impact of age and comprehensive geriatric assessment on tumor board proposals. Crit Rev Oncol Hematol 2011;79(2):196—204.

[35] Liao CT, Kang CJ, Lee LY, Hsueh C, Lin CY, Fan KH, et al. Association between multidisciplinary team care approach and survival rates in patients with oral cavity squamous cell carcinoma. Head Neck 2016;38(Suppl 1):E1544—53. https://doi.org/10.1002/hed.24276.

[36] Weledji EP. Centralization of liver cancer surgery and impact on multidisciplinary teams working on stage IV colorectal cancer. Onco Rev 2017;11(2):331. https://doi.org/10.4081/oncol.2017.331.