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At the tipping point, but yet not routine: Diffusion dynamics of inpatient palliative care

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Abstract

Background

Early integration of specialised palliative care improves quality of life and outcomes in advanced cancer, yet its implementation in inpatient oncology remains inconsistent. This study evaluates the utilisation of specialised inpatient palliative care in German hospitals and interprets adoption patterns using Diffusion of Innovations theory.

Methods

We conducted a retrospective nationwide analysis of hospital cases reimbursed under the German diagnosis-related groups (DRG) system. The analysis included the most common oncological diseases and assessed utilisation of specialised inpatient palliative care overall and stratified by metastatic status, tumour entity, comorbidities, and treating medical specialties.

Results

Specialised inpatient palliative care was provided in 5.4% of hospital cases involving the most common malignant tumours. Among patients with organ metastases, utilisation increased to a median rate of 15.0% of hospital cases, with the highest rates observed in cases with brain (17.8%), bone (17.0%), and pleural metastases (16.1%). Palliative care involvement correlated positively with hospital mortality. Interpreted through diffusion of innovations theory, utilisation among patients with metastatic disease appears to have reached the tipping point associated with early adopters, while uptake among the early majority remains limited.

Conclusion

Despite longstanding guideline recommendations, specialised inpatient palliative care remains underutilised in German oncology care. From the perspective of diffusion of innovations theory, failure to move adoption beyond early adopters risks stagnation and prevents palliative care from becoming a routine component of inpatient oncology. To overcome this barrier, clinicians and policymakers should establish systematic referral pathways, implement interdisciplinary referral triggers, actively disseminate evidence on clinical effectiveness, increase awareness, strengthen palliative care training for healthcare professionals, and align reimbursement structures to support earlier and consistent palliative care integration.

Introduction

Palliative medicine aims to improve the quality of life of patients and their families. It focuses on the prevention, identification, and relief of suffering across physical, psychological, social, and spiritual domains [1]. During its early years, palliative care focused on end-of-life support [2]. Over time, the concept of improving quality of life and alleviating suffering expanded beyond care limited to the

terminal phase after cessation of life-prolonging treatment. Under the concept of early integration, palliative care now accompanies patients at earlier stages of disease in parallel with tumour-directed therapies. Studies by Jennifer Temel and colleagues demonstrated that early palliative care not only improves quality of life but may also positively influence survival [3–5]. Although subsequent studies did not consistently reproduce this survival benefit, the concept gained substantial momentum and became widely incorporated into clinical guidelines and recommendations [6, 7]. The 2024 guideline update of the American Society of Clinical Oncology (ASCO) explicitly recommends early integration of palliative care into the treatment of patients with advanced cancer [8], generally defined a as initiation of palliative care within 8–12 weeks after diagnosis [8–10].

This raises the question of how widely the concept of early palliative care integration and palliative care integration for all patients with palliative oncological diagnoses have diffused into routine clinical practice. Everett M. Rogers' diffusion of innovations theory explains how new ideas and technologies spread within social systems and under what conditions they are adopted or rejected [11]. The theory identifies five core attributes that shape adoption, which are relative advantage, compatibility, complexity, trialability, and observability. Rogers further distinguishes adopter groups according to their timing of adoption, namely innovators (approximately 2.5% of potential users), early adopters (approximately 13.5%), the early majority (approximately 34%), the late majority (approximately 34%), and laggards (approximately 16%) [11]. Although innovators and early adopters together constitute only about 16% of users, they play a critical role as opinion leaders by legitimising innovations within the wider system [11, 12]. Diffusion typically accelerates once adoption extends beyond early adopters to the early majority, which generally occurs at an adoption level of approximately 15–20%. Crossing this tipping point is crucial, as innovations that fail to reach it often lose momentum and risk disappearing [11, 12].

Against this background, the aim of the present study is to quantify the proportion of inpatient palliative care services reimbursed within the German diagnosis-related groups (DRG) system for the most common oncological diseases. We subsequently interpret these findings in light of the diffusion of innovation theory [12, 13].

Methods

Ethical Approval and Data Accessibility

The institutional and local ethics committees at Friedrich Schiller University Jena (Study ID: 2025-3696-BO-D) and Brandenburg Medical School, Germany (Study ID: 190032024-ANF) approved data analysis. The reporting follows the STROBE guidelines for observational studies [14].

Study Design, Setting, and Data Sources

We conducted a cross-sectional analysis using aggregated data from all hospitalisations in Germany in 2023. The dataset derived from routine administrative hospital data collected under § 21 of the German

Hospital Remuneration Act and was provided by the Institute for the Remuneration System in the Hospital Sector (InEK GmbH, Siegburg, Germany).

Cohort Definition, Participants, and Study Size

The study aimed to analyse the frequency of palliative care involvement within the German DRG system among patients with common solid malignancies [15]. We defined common solid tumours as those accounting for more than 3% of all newly diagnosed cancer cases in Germany in 2023 [15]. These tumour entities included malignancies of the breast, prostate, pancreas, lung, colorectum, uterine corpus, cervix, stomach, ovary, kidney, bladder, oral cavity and pharynx, as well as malignant melanoma. Based on this definition, we applied the following inclusion criteria: (1) a diagnosis of one of the specified solid tumours as either a primary or secondary diagnosis, (2) hospital treatment during 2023 and (3) age 18 years or older. Owing to technical constraints of the dataset, the analysis focused on hospital cases rather than individual patients, and individual-level longitudinal data were unavailable. The study population therefore comprised all hospitalisations meeting these criteria in 2023.

To calculate the number of cases for a particular diagnosis, we retrieved counts of hospital cases of each cohort (e.g. defined by the tumour type, combinations of diagnoses or the combination of tumour type and medical speciality), where the diagnosis was listed as either primary, secondary diagnoses or both as primary and secondary diagnoses. We calculated the count of hospital cases by the difference of the sum

Definitions and Variables

All diagnoses, in particular primary tumours and organ metastases, were identified and defined using the International Statistical Classification of Diseases and Related Health Problems, 10th Revision, German Modification (ICD-10-GM, suppl. table 1) [16]. In the German DRG system, each case is assigned a single primary diagnosis and may have multiple secondary diagnoses. Medical procedures and treatments were identified using their corresponding procedural codes (*Operationen- und Prozedurenschlüssel, OPS*) [17]. The selection of analysed comorbidities was guided by the Charlson Comorbidity Index [18]. The individual specialist disciplines (e.g., oncology, radio-oncology, ...) were identified based on their respective codes from Annex 1 of the Federal Nursing Ordinance within the Federal Nursing Fee Ordinance of December 31, 2003.

The mortality rate was defined as the proportion of fatal hospital cases relative to the total number of cases within the corresponding cohort. Fatal hospital cases are identified by querying the coded discharge reason documented according to Section 301, Paragraph 1, Sentence 1 of the German Social Code Book V (discharge reason 09: death).

Addressing Bias

We minimized selection bias by including all German hospital cases with the analysed tumours treated in 2023 that were billed within the DRG system, yielding a comprehensive national sample. Cases with fewer than five observations cannot be included for data protection reasons, which is unlikely to have affected the overall results. The analysis was limited to hospital cases rather than individual patients. The billing codes for specialized palliative care treatment from palliative care units that bill outside the DRG system cannot be captured. This particularly concerns the billing code for specialized palliative care treatment in a palliative care unit (8-98e) of approximately 70 palliative care units [19, 20]. Measurement bias was reduced by identifying palliative and intensive care treatments using predefined OPS and ICD-10 codes, ensuring standardized case identification. Although some misclassification is possible, errors are expected to be minimal in billing data. Key clinical information, including treatment timing, integration of specialized inpatient palliative care, and patient-reported outcomes, was unavailable. To account for disease severity, relevant comorbidities were included, and a separate analysis of patients who died in hospital was performed.

Data Management and Statistical Analysis

Data were extracted from the InEK data browser and organized using Microsoft Excel for Mac (Version 16.93, Microsoft Corporation, Redmond, WA, USA). GraphPad Prism 9 for macOS (Version 9.5.1, GraphPad Software, La Jolla, CA, USA) was used for statistical analysis and visualization.

Descriptive statistics were used to calculate frequencies, ratios, median values and interquartile ranges [IQR]. Odds ratios (ORs) were estimated using logistic regression models to assess associations between selected patient and treatment characteristics and binary outcomes [14, 21, 22]. Results are reported as ORs with 95% confidence intervals. Linear regression models were used to examine associations between selected patient and treatment characteristics and continuous outcomes. We chose a significance level α of 5% (0.05) for the present study and performed in total ten statistical evaluations ($\kappa = 3$). To adjust for multiple comparisons, Šidák's correction was applied ($\alpha_{adjusted} = 1 - (1 - \alpha)^{1/\kappa}$), and a significance level of < 0,017 was used [23].

Results

In 2023, German hospitals recorded 15,200,893 adult patient hospitalisations. Solid malignant tumours featured in 1,637,202 (11%) of these hospitalisations. A malignant solid tumour was the primary diagnosis in 1,243,449 cases, the secondary diagnosis in 687,690, and both the primary and secondary diagnosis in 293,937 hospitalisations.

The analysis focused on solid malignant tumours with an incidence of ≥ 3% in Germany, accounting for 1,292,726 hospitalisations, or 77% of all admissions involving patients with a solid malignant tumour. Females comprised 47.1% (608,178 cases) and males 52.9% (684,474 cases) of these patients (74 cases involved unknown or diverse gender). Patients aged ≥ 65 years represented 64.9% (839,533 cases), while those aged 18 to 29 years accounted for 0.31% (4,043 cases). The most common solid

tumours were malignant lung tumours (254,444 hospitalisations; 19.7% of the analysed tumour cases), breast tumours (207,681 cases; 16.1%), and colorectal tumours (181,464 cases; 14%). Malignant cervical tumours generated the fewest number hospitalisations in this group (18,215 cases). Table 1 and accompanying Fig. 1 provide detailed age and gender distribution information for each tumour type.

Metastases and Comorbidities

The modified Charlson Comorbidity Index assessed comorbidities, which frequently co-occurred in these oncological hospital cases. Excluding the codes for the primary solid malignancies (C00–C76), the 1,292,726 hospital cases showed 1,691,508 codes for a Charlson Comorbidity Index-associated comorbidity (suppl. tabl. 2). Uncomplicated diabetes occurred in 15.4% of cases, lung disease in 11.2%, kidney disease in 10.4%, and acute myocardial infarction in 2.8%. As expected, pancreatic malignancies demonstrated high diabetes frequencies (31%), lung malignancies showed high rates of lung disease (30%), and cervical cancer higher rates of HIV infections (0.2%).

Among the 1,292,726 hospitalizations examined, clinicians assigned 884,224 (877,750) ICD-10 codes for lymph node or organ metastases and 99,299 codes for organ metastases alone. The most frequent organ metastases were located in the liver and intrahepatic bile duct (11.3% of examined cases), bone or bone marrow (10.2%), lung (7.5%), peritoneum and retroperitoneum (5.2%), and cerebral metastases / leptomeningeal carcinosis (4.9%). As anticipated, different tumour entities exhibited distinct metastasis patterns.

In-hospital mortality rate

A total of 77,025 patients in the 1,292,726 analysed hospitalisations died during their hospital stay, yielding an overall in-hospital mortality rate of 6% (suppl. table 3). The median in-hospital mortality rate across the examined tumour entities was 4.7%. Malignant pancreatic tumours had the highest rate at 10.7%, and bladder malignancies had the lowest at 3.2%. Mortality increased significantly when clinicians diagnosed organ metastases. The median mortality rate for lung metastases was 12.5% (range: 4.1–15.5%), 18.4% for pleural metastases (range: 6.2–24.2%), 16.6% for liver metastases (range: 3.9–19.8%), and 14.3% for cerebral and/or leptomeningeal metastases (range: 10.1–20.3%).

Specialized palliative care involvement

Specialized palliative care was delivered in 70,382 of the 1,292,726 hospital cases analysed, corresponding to an overall rate of 5.4%. In these cases, hospitals recorded a total of 72,634 specialized palliative care procedure codes, including 22,184 codes (30.5%) for complex palliative care, 34,609 codes (47.6%) for specialized complex treatment on a palliative care unit, and 15,841 codes (21.8%) for palliative care consultation services (Table 2, Fig. 2, suppl. Figure 1). Patients with pancreatic malignancies showed the highest utilization of specialized palliative care (10.1% of all cases), whereas

patients with bladder cancer showed the lowest rate (2.2%). Across the analysed tumour entities, the median utilization rate reached 5% (interquartile range [IQR]: 4.3%–6.8%). We calculated odds ratios (OR, Fig. 3) for the use of specialized palliative care relative to all analysed hospital cases. Patients with pancreatic cancer (OR: 1.95; 95% CI: 1.9–2.0, Table 3), ovarian cancer (OR: 1.74; 95% CI: 1.68–1.8), and lung cancer (OR: 1.47; 95% CI: 1.44–1.49) showed the highest odds of specialized palliative care involvement. Linear regression analysis revealed a significant association between in-hospital mortality and the frequency of specialized palliative care involvement across the analysed tumour entities ($y = 0.86x + 0.84$; $R^2 = 0.72$; $F = 28.5$; $p = 0.0002$, Fig. 4). Of the total 77025 hospital cases in which patients died in hospital, 24566 hospital cases (31.9%) involved patients receiving specialized palliative care (table c).

Among comorbidities captured by the Charlson Comorbidity Index, severe liver disease showed the strongest association with specialized palliative care involvement (OR: 5.35; 95% CI: 4.94–5.79), followed by paraplegia (OR: 3.00; 95% CI: 2.89–3.11), heart failure (OR: 1.56; 95% CI: 1.52–1.59), and dementia (OR: 1.45; 95% CI: 1.38–1.52, suppl. Figure 2).

Next, we analysed the frequency of specialised palliative care involvement across medical specialties that commonly serve as the primary treating disciplines in oncological centres (Fig. 5). Haematology/oncology demonstrated the highest rate of specialised palliative care involvement (10.4%), followed by gastroenterology (6.8%) and radiation oncology (6.7%). In contrast, gynaecology (0.7%) and urology (1.0%) showed the lowest rates. Accordingly, the odds ratios ranged from 2.02 (95% CI: 1.98–2.05) for haematology/oncology to 0.12 (95% CI: 0.11–0.12) for gynaecology and 0.17 (95% CI: 0.16–0.18) for urology. Linear regression analysis again revealed a significant association between in-hospital mortality and the frequency of specialised palliative care involvement across medical specialties ($y = 0.70x + 0.96$; $R^2 = 0.64$; $F = 15.7$; $p = 0.003$).

As the analysed tumour cases also included patients treated with curative intent, most tumour diseases with organ metastases no longer allow curative treatment and therefore require palliative care. To estimate the proportion of specialised palliative care among palliative tumour patients, we analysed hospital cases involving patients with organ metastases (Fig. 5, Table 4). Across all analysed primary tumours and metastatic sites, the median rate of specialised palliative care involvement reached 15.0% (interquartile range [IQR]: 8.3%–19.4%). Among hospitalised cases involving one of the analysed tumours with additional cerebral metastases, specialised palliative care involvement reached 17.8%. Corresponding rates amounted to 17.0% for bone metastases, 16.1% for pleural metastases, and 14.3% for lung metastases. Compared with all analysed hospital cases, the presence of cerebral metastases markedly increased the likelihood of specialised palliative care involvement (OR: 3.8; 95% CI: 3.7–3.8). Bone metastases (OR: 3.6; 95% CI: 3.5–3.6), pleural metastases (OR: 3.3; 95% CI: 3.2–3.4), (retro)peritoneal metastases (OR: 3.4; 95% CI: 3.4–3.5), and lung metastases (OR: 2.9; 95% CI: 2.8–3.0) showed similarly elevated odds. Linear regression analysis again demonstrated a significant association between in-hospital mortality and the frequency of specialised palliative care involvement across metastatic tumour entities ($y = 0.78x - 1.1$; $R^2 = 0.65$; $F = 41.4$; $p < 0.0001$).

Discussion

Our analysis quantified the proportion of inpatient palliative care services reimbursed under the German diagnosis-related groups (DRG) system for the most common oncological diseases and yielded the following key findings.

1. Specialised palliative care was provided in 5.4% of hospital cases involving the most common malignant tumours in Germany.
2. The rate of inpatient palliative care treatment correlated with the hospital mortality.
3. Among hospital cases with one of the analysed tumours and organ metastases, the median rate of specialised palliative care involvement reached 15.0%. Therefore, quality-of-life-centred early palliative care integration for patients with metastases appears to have reached the tipping point at which early adopters have accepted the concept, while adoption by the early majority has not yet occurred.

In Germany, the rate of specialised inpatient care for the malignancies examined with an incidence ≥ 3% is 5.4%. This level remains well below the 15–20% tipping point described in the diffusion of innovations theory. These tumour cases include patients receiving curative treatment. Patients with organ metastases are highly likely to require palliative care, and clinical guidelines and recommendations explicitly advocate early palliative care integration and co-treatment for these groups [6–9]. The Lancet Oncology Commission (2025) identifies a profound "human crisis" in global cancer care, noting that current systems frequently neglect the emotional, relational, and existential dimensions of the patient experience despite significant biomedical progress [24]. This crisis stems from structural failures, including an over-reliance on technology, fragmented delivery models, and economic incentives that prioritise clinical throughput over compassionate, person-centred communication. To resolve this dehumanisation, the Commission advocates for the immediate, universal integration of palliative and psychosocial care, positioning empathetic engagement not as an elective supplement but as a fundamental requirement of oncological practice [24]. Across all analysed primary tumour entities and metastatic sites in the present study, the median utilisation of specialised palliative care reached 15.0%. The highest rates of inpatient specialised palliative treatment occurred in hospital cases with brain metastases (17.8%), bone metastases (17.0%), and pleural metastases (16.1%). Our findings align closely with our previous work on glioblastomas and cerebral metastases [19, 20]. A German study based on statutory health insurance data from the state of Baden-Württemberg identified 3,535 patients with advanced cancer who required palliative care in 2015. Of these patients, 669 (18.9%) were referred to specialised outpatient palliative care teams, and 45.1% of those referrals involved early integration of palliative care [25]. Earlier published data highlighted the gap between patient needs and actual service delivery. The analysis of health insurance records for 80,768 individuals revealed that only 7.8% of cancer patients accessed specialised outpatient palliative care in their final year, while the system provided just 8.4 complex palliative treatments per 10,000 inhabitants [26]. Another study analysing health insurance data on specialised palliative care indicate that approximately one third of all patients receive specialised palliative care during the last year of life [27, 28]. However, comparative European

analyses classify Germany, the Netherlands, the United Kingdom, and Switzerland as countries with a relatively high level of palliative care integration [29]. International data nevertheless reveal substantial variation in the timing of palliative care delivery. In Victoria, Australia, 66% of patients who died from cancer in 2018 received palliative care, 18% accessed palliative care at least three months before death [30]. The median interval between first palliative care contact and death was 22 days [31]. In Canada, 12.6% of inpatients received some form of palliative care during the year preceding death [32]. In the United States, 8.0% of patients with newly diagnosed metastatic cancer received early specialised palliative care within eight weeks of diagnosis in 2018 and 2019 [33]. Palliative care involvement varied by tumour type, with higher rates in lung cancer (12.0%) and lower rates in breast cancer (4.3%) [33]. An analysis of Medicare-insured individuals with advanced cancer further demonstrated an early palliative care integration of 10.4% in 2019 [34].

Across the entire analysed cohort, among hospital cases involving patients with metastatic malignancies, and within individual medical specialties, we observed a significant positive association between inpatient mortality and the rate of specialised palliative care involvement. Evidence on the relationship between inpatient palliative care utilisation and hospital mortality remains inconsistent. On the one hand, studies have shown that patients with a high predicted risk of short-term mortality are more likely to receive palliative care consultation during hospitalisation [35]. Several other studies have identified palliative care involvement as being associated with higher in-hospital mortality and a lower likelihood of intensive care unit admission [32, 36, 37]. On the other hand, other studies have reported a reduction in hospital mortality associated with palliative care involvement, including a systematic review demonstrating a 34% reduction in in-hospital mortality [38, 39]. A retrospective Canadian study similarly reported higher overall hospital mortality among patients receiving palliative care; however, within the subgroup of terminally ill patients receiving palliative care, the probability of dying in hospital or being admitted to an intensive care unit was lower [32].

Everett M. Rogers' diffusion of innovations theory explains how new ideas and technologies spread within social systems and under what conditions they are adopted or rejected [11]. Rogers distinguishes adopter groups according to their timing of adoption, namely innovators, early, the early majority, the late majority, and laggards [11]. Although innovators and early adopters together constitute only about 16% of users, they play a critical role as opinion leaders by legitimising innovations within the wider system [11, 12]. Diffusion typically accelerates once adoption extends beyond early adopters to the early majority, which generally occurs at an adoption level of approximately 15–20%. Crossing this tipping point is crucial, as innovations that fail to reach it often lose momentum and risk disappearing [11, 12].

Although Rogers did not originally develop diffusion of innovations theory for the healthcare sector, researchers increasingly apply it to explain the spread of healthcare innovations. In healthcare, the five innovation factors, relative advantage, compatibility, complexity, trialability, and observability, remain central but require contextual reinterpretation [12, 13, 40, 41]. Stakeholders typically assess relative advantage in terms of clinical effectiveness, patient safety, and evidence-based outcomes. For early integration, evidence gained from randomised clinical trials in early integration [3, 42–44]. Compatibility

reflects alignment with professional norms, ethical standards, clinical workflows, and regulatory requirements, while complexity often relates to training demands, workflow disruption, and system interoperability [12]. For palliative care, must proactively cultivate awareness must proactively be cultivated regarding the necessity of early palliative care access to mitigate the systemic neglect of patient suffering. Oncology training programmes must mandate core competencies in palliative care for all healthcare professionals to ensure they possess the necessary skills to address the profound human suffering inherent in the cancer experience [24].

In spite of emerging standards and recommendations palliative care appears to be more firmly established and widely accepted primarily as end-of-life care in everyday clinical settings. Interpreting our present data through the lens of diffusion of innovations theory, quality-of-life-centred palliative care for patients with metastatic cancer in Germany remains largely confined to innovators and early adopters, while the early majority has not yet embraced the concept. Utilisation rates around 15% therefore mark a fragile threshold rather than a successful transition to self-sustaining diffusion. This finding is particularly noteworthy given that early palliative care integration has been discussed for more than 15 years [3]. Without broader acceptance by the early majority, early palliative care risks remaining a niche practice instead of becoming a normative component of oncological care. This stagnation has important implications, as it limits population-level access to timely palliative care despite strong evidence and guideline recommendations. From a diffusion and implementation science perspective, failure to convince the early majority necessitates a shift in strategy. Innovations that stall at the early-adopter stage rarely diffuse further through social influence alone and instead require structural reinforcement through policy, organisational change, and incentive realignment [11, 12]. For early palliative care, this implies that continued reliance on professional advocacy and guidelines is insufficient. Instead, health systems must actively lower adoption barriers by embedding early palliative care into standard care pathways, adjusting reimbursement mechanisms, disseminating information on efficacy, raising awareness and training for health care professionals. Without such measures, early palliative care is unlikely to cross into early-majority adoption and may continue to be perceived as optional rather than essential.

Limitations

This study has several limitations:

1. Hospital cases do not correspond directly to individual patients, as some may be hospitalised multiple times but receive specialised inpatient palliative care only once, potentially underestimating patient-level coverage.
2. The evaluation reported on hospital cases, not on health care professionals, and thus provided only indirect evidence on the percentages of innovators and early adopters, assuming that the percentages of patients receiving palliative care and percentages of healthcare professionals initiating such transfers to palliative care would be correlated.

3. Secondary diagnoses (e.g., organ metastases coded as C79.x) may be recorded multiple times within a case, slightly affecting counts.
4. Around 70 palliative care units in Germany operate as “special facilities” (Besondere Einrichtungen), managing roughly 17,500 cases [19], and these cases would not be captured in the reimbursement database. However, some units submit data to InEK for reporting but do not bill statutory health insurance, so their activity may have been captured partially.
5. Hospital mortality was calculated per case without specifying cause but remains a relevant indicator of disease severity.
6. Outpatient care is not included. Patient may receive specialized outpatient palliative care after discharge. These data are not available.
7. Findings rely on accurate coding in the InEK database. Misclassification may introduce bias.
8. Finally, the dataset lacks key information on symptom burden, psychosocial stress, and caregiver experience and quality-of-life.

Conclusion

Specialised inpatient palliative care for patients with metastatic cancer in Germany reaches only around 15% of hospital cases, indicating that early adopters have embraced the practice, but the early majority has not yet followed. According to Rogers’ diffusion of innovations theory, this stalled adoption risks preventing early palliative care from becoming a normative component of oncological care. Clinicians should proactively integrate palliative care into standard pathways, while health systems align incentives and expand capacity to overcome structural barriers. Without such coordinated action, timely access remains limited, and patients may not fully benefit from quality-of-life-centred care.

Declarations

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Disclosure of Potential Conflicts of Interest

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Declaration of generative AI and AI-assisted technologies in the writing process

AI-assisted technology was neither used for the generation, evaluation or interpretation of the data presented in the manuscript, nor for the creation of text, figures or tables. AI-based tools (chat GPT) may

have been used to improve language and text readability.

Human Ethics and Consent to Participate declarations:

not applicable: The study complied with the ethical standards set in the 1964 Declaration of Helsinki and its subsequent revisions. Approval for the study protocol was granted by the institutional and local ethics committee at Brandenburg Medical School, Germany (Study ID: 190032024-ANF). Our manuscript exclusively utilized publicly available data, no individual patient data, thus obviating the need for individual patient consent.

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References

1. World Health Organization (WHO) (2002) WHO definition of palliative care. World Health Organization (WHO). https://www.who.int/health-topics/palliative-care. Accessed 16.09.2019 2019
2. Hui D, Bruera E (2020) Models of Palliative Care Delivery for Patients With Cancer. Journal of Clinical Oncology 38: 852–865 doi:10.1200/JCO.18.02123
3. Temel JS, Greer JA, Muzikansky A, Gallagher ER, Admane S, Jackson VA, Dahlin CM, Blinderman CD, Jacobsen J, Pirl WF, Billings JA, Lynch TJ (2010) Early palliative care for patients with metastatic non-small-cell lung cancer. N Engl J Med 363: 733–742 doi:10.1056/NEJMoa1000678
4. Mos JR, Reis-Pina P (2025) Early Integration of Palliative Care in Nononcological Patients: A Systematic Review. J Pain Symptom Manage 69: e283-e302 doi:10.1016/j.jpainsymman.2024.12.023
5. Vicenzini M, Di Lorenzo S, Venturini M (2025) Early and simultaneous palliative care in cancer patients: an overview. Support Care Cancer 33: 462 doi:10.1007/s00520-025-09501-x
6. Golla H, Nettekoven C, Hellmich M, Appelmann I, Bausewein C, Becker G, Boehlke C, Brumbarova T, Civello D, Clusmann H, Haberland B, Henrik Heiland D, Herrlinger U, Jaspers B, Joshi M, Mülller D, Müller W, Na CH, Neukirchen M, Radbruch L, Rapp M, Rolke R, Ruge M, Sabel M, Schnell O, Schwartz J, Thon N, Vatter H, Baumgarten LV, Voltz R, Goldbrunner R (2025) Early Palliative Care for Patients with Glioblastoma: A randomized phase lll clinical trial (EPCOG). Neuro Oncol doi:10.1093/neuonc/noaf230
7. Haun MW, Estel S, Rücker G, Friederich HC, Villalobos M, Thomas M, Hartmann M (2017) Early palliative care for adults with advanced cancer. Cochrane Database Syst Rev 6: Cd011129 doi:10.1002/14651858.CD011129.pub2

8. Sanders JJ, Temin S, Ghoshal A, Alesi ER, Ali ZV, Chauhan C, Cleary JF, Epstein AS, Firn JI, Jones JA, Litzow MR, Lundquist D, Mardones MA, Nipp RD, Rabow MW, Rosa WE, Zimmermann C, Ferrell BR (2024) Palliative Care for Patients With Cancer: ASCO Guideline Update. J Clin Oncol 42: 2336–2357 doi:10.1200/JCO.24.00542
9. Ferrell BR, Temel JS, Temin S, Alesi ER, Balboni TA, Basch EM, Firn JI, Paice JA, Peppercorn JM, Phillips T, Stovall EL, Zimmermann C, Smith TJ (2017) Integration of Palliative Care Into Standard Oncology Care: American Society of Clinical Oncology Clinical Practice Guideline Update. J Clin Oncol 35: 96–112 doi:10.1200/JCO.2016.70.1474
10. Kaasa S, Loge JH, Aapro M, Albreht T, Anderson R, Bruera E, Brunelli C, Caraceni A, Cervantes A, Currow DC, Deliens L, Fallon M, Gomez-Batiste X, Grotmol KS, Hannon B, Haugen DF, Higginson IJ, Hjermstad MJ, Hui D, Jordan K, Kurita GP, Larkin PJ, Miccinesi G, Nauck F, Pribakovic R, Rodin G, Sjogren P, Stone P, Zimmermann C, Lundeby T (2018) Integration of oncology and palliative care: a Lancet Oncology Commission. Lancet Oncol 19: e588-e653 doi:10.1016/S1470-2045(18)30415-7
11. Rogers EM (2003) Diffusion of Innovations, 5th Edition. Free Press,
12. Greenhalgh T, Robert G, Macfarlane F, Bate P, Kyriakidou O (2004) Diffusion of innovations in service organizations: systematic review and recommendations. Milbank Q 82: 581–629 doi:10.1111/j.0887-378X.2004.00325.x
13. Dearing JW, Cox JG (2018) Diffusion Of Innovations Theory, Principles, And Practice. Health Aff (Millwood) 37: 183–190 doi:10.1377/hlthaff.2017.1104
14. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP (2007) The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. The Lancet 370: 1453–1457 doi:10.1016/S0140-6736(07)61602-X
15. (2025) Krebs in Deutschland für 2021–2023. Robert Koch-Institut & Deutsche Krebsregister e. V., Berlin
16. Bundesinstitut für Arzneimittel und Medizinprodukte (2025) Internationale statistische Klassifikation der Krankheiten und verwandter Gesundheitsprobleme, 10. Revision, German Modification, Version 2024. Bundesinstitut für Arzneimittel und Medizinprodukte,. https://klassifikationen.bfarm.de/icd-10-gm/kode-suche/htmlgm2024/index.htm. Accessed 03.03.2025 2025
17. Bundesinstitut für Arzneimittel und Medizinprodukte (2025) Operationen- und Prozedurenschlüssel, Version 2024. https://klassifikationen.bfarm.de/ops/kode-suche/htmlops2024/index.htm. Accessed 03.03.2025 2025
18. Charlson M, Szatrowski TP, Peterson J, Gold J (1994) Validation of a combined comorbidity index. Journal of Clinical Epidemiology 47: 1245–1251 doi:10.1016/0895-4356(94)90129-5
19. Fink L, van Oorschot B, von Sass C, Dibue M, Foster MT, Golla H, Goldbrunner R, Senft C, Lawson McLean A, Hellmich M, Dinc N, Voltz R, Melching H, Jungk C, Kamp MA (2024) Palliative care for in-patient malignant glioma patients in Germany. J Neurooncol 167: 323–338 doi:10.1007/s11060-024-04611-8

20. Fink L, von Sass C, Golla H, Voltz R, Muehlensiepen F, Ploner CJ, Slotty P, van Oorschot B, Kowski AB, Kamp MA (2025) Epidemiology and palliative care of in–patient cerebral metastases cases in Germany. J Neurooncol in press
21. Bland JM, Altman DG (2000) The odds ratio. BMJ 320: 1468 doi:10.1136/bmj.320.7247.1468
22. Szumilas M (2010) Explaining odds ratios. J Can Acad Child Adolesc Psychiatry 19: 227–229
23. Šidák Z (1967) Rectangular Confidence Regions for the Means of Multivariate Normal Distributions. Journal of the American Statistical Association 62: 626–633 doi:10.1080/01621459.1967.10482935
24. Rodin G, Feldman A, Trapani D, Skelton M, Unger-Saldana K, Essue B, Pihlak R, Walshe C, Rosa WE, Banegas MP, Zambrano-Lucio M, Salah Daood R, Aggarwal A, Dewachi O, Shapiro GK, Munisamy M, Rajah HDA, Atreya S, Dhyani VS, Kong YC, Mathew M, Ochoa-Dominguez CY, Rao AP, Rao SR, Simha S, Preston N, Lam WWT, Davis H, Zimmermann C, Namisango E, Ntizimira C, Smyth E, Li M, Salins N, Bhoo-Pathy N, Sullivan R (2025) The human crisis in cancer: a Lancet Oncology Commission. Lancet Oncol doi:10.1016/S1470-2045(25)00530-3
25. Engeser P, Glassman J, Leutgeb R, Szecsenyi J, Laux G (2021) Early integration of palliative care for outpatients with advanced cancer in general practice: how is the situation?-a cohort study. Ann Palliat Med 10: 2843–2848 doi:10.21037/apm-20-2377
26. Radbruch L, Andersohn F, Walker J (2014) Palliativversorgung – Modul 3 – Überversorgung kurativ – Unterversorgung palliativ? Analyse ausgewählter Behandlungen am Lebensende. Bertelsmann Stiftung https://www.bertelsmann-stiftung.de/fileadmin/files/BSt/Publikationen/GrauePublikationen/Studie_VV__FCG_Ueber-Unterversorgung-palliativ.pdf. Accessed 30.12.2025 2025
27. Ditscheid B, Krause M, Lehmann T, Stichling K, Jansky M, Nauck F, Wedding U, Schneider W, Marschall U, Meissner W, Freytag A, die S-S (2020) [Palliative care at the end of life in Germany: Utilization and regional distribution]. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 63: 1502–1510 doi:10.1007/s00103-020-03240-6
28. Ditscheid B, Meissner F, Gebel C, Hennig B, Marschall U, Meissner W, Wedding U, Freytag A (2023) Utilization of palliative care at the end of life in Germany: temporal trend (2016–2019) and regional variability. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 66: 432–442 doi:10.1007/s00103-023-03683-7
29. Sanchez-Cardenas MA, Garralda E, Arias-Casais NS, Benitez Sastoque ER, Van Steijn D, Moine S, Murray SA, Centeno C (2021) Palliative care integration indicators: an European regional analysis. BMJ Support Palliat Care doi:10.1136/bmjspcare-2021-003181
30. Philip J, Collins A, Brand CA, Gold M, Moore G, Sundararajan V, Murphy MA, Lethborg C (2015) Health care professionals' perspectives of living and dying with primary malignant glioma: Implications for a unique cancer trajectory. Palliat Support Care 13: 1519–1527 doi:10.1017/S1478951513000576

31. Philip J, Collins A, Warwyk O, Sundararajan V, Le B (2022) Is the use of palliative care services increasing? A comparison of current versus historical palliative care access using health service datasets for patients with cancer. Palliat Med 36: 1426–1431 doi:10.1177/02692163221118205
32. Hsu AT, Garner RE (2020) Associations between the receipt of inpatient palliative care and acute care outcomes: A retrospective study. Health Rep 31: 3–13 doi:10.25318/82-003-x202001000001-eng
33. Guo L, LeBlanc TW, Smith CB, Morrison RS, Hua M (2025) Early Specialist Palliative Care in Patients with Metastatic Cancer: A Population-Based Cohort Study. J Pain Symptom Manage 70: 140–148.e142 doi:10.1016/j.jpainsymman.2025.04.005
34. Hu X, Kwon Y, Jiang C, Fan Q, Shi KS, Zheng ZJ, Zhao J, Warren JL, Yabroff KR, Han X (2025) Trend and Provider- and Organizational-Level Factors Associated With Early Palliative Care Billing Among Patients Diagnosed With Distant-Stage Cancers in 2010–2019 in the United States. J Clin Oncol 43: 1789–1799 doi:10.1200/jco-24-01935
35. Agarwal R, Domenico HJ, Balla SR, Byrne DW, Whisenant JG, Woods MC, Martin BJ, Karlekar MB, Bennett ML (2022) Palliative Care Exposure Relative to Predicted Risk of Six-Month Mortality in Hospitalized Adults. J Pain Symptom Manage 63: 645–653 doi:10.1016/j.jpainsymman.2022.01.013
36. Im JH, Chow R, Novosel M, Xiang J, Strait M, Rao V, Kapo J, Zimmermann C, Prsic E (2023) Association of palliative care and hospital outcomes among solid tumour oncology inpatients. BMJ Support Palliat Care doi:10.1136/spcare-2023-004207
37. Sekiguchi K, Bell CL, Masaki KH, Fischberg DJ (2014) Factors associated with in-hospital death by site of consultation among elderly inpatients receiving pain and palliative care consultations. J Palliat Med 17: 1353–1358 doi:10.1089/jpm.2013.0596
38. Liu X, Dawod Y, Wonnaparhown A, Shafi A, Doo L, Yoo JW, Ko E, Choi YS (2017) Effects of hospital palliative care on health, length of stay, and in-hospital mortality across intensive and non-intensive-care units: A systematic review and metaanalysis. Palliat Support Care 15: 741–752 doi:10.1017/S1478951516001164
39. Barkley JE, McCall A, Maslow AL, Skudlarska BA, Chen X (2019) Timing of Palliative Care Consultation and the Impact on Thirty-Day Readmissions and Inpatient Mortality. J Palliat Med 22: 393–399 doi:10.1089/jpm.2018.0399
40. Berwick DM (2003) Disseminating innovations in health care. Jama 289: 1969–1975 doi:10.1001/jama.289.15.1969
41. Overbye-Thompson H, Hamilton KA (2025) A diffusion of innovations measurement scale for reinvention, relative advantage, compatibility, complexity, trialability and observability. PLoS One 20: e0334616 doi:10.1371/journal.pone.0334616
42. Greer JA, Jacobs J, Pensak N, MacDonald JJ, Fuh CX, Perez GK, Ward A, Tallen C, Muzikansky A, Traeger L, Penedo FJ, El-Jawahri A, Safren SA, Pirl WF, Temel JS (2019) Randomized Trial of a

Tailored Cognitive-Behavioral Therapy Mobile Application for Anxiety in Patients with Incurable Cancer. Oncologist 24: 1111–1120 doi:10.1634/theoncologist.2018-0536

43. Greer JA, Jacobs JM, Pensak N, Nisotel LE, Fishbein JN, MacDonald JJ, Ream ME, Walsh EA, Buzaglo J, Muzikansky A, Lennes IT, Safren SA, Pirl WF, Temel JS (2020) Randomized Trial of a Smartphone Mobile App to Improve Symptoms and Adherence to Oral Therapy for Cancer. J Natl Compr Canc Netw 18: 133–141 doi:10.6004/jnccn.2019.7354
44. Temel JS, Jackson VA, El-Jawahri A, Rinaldi SP, Petrillo LA, Kumar P, McGrath KA, LeBlanc TW, Kamal AH, Jones CA, Rabideau DJ, Horick N, Pintro K, Gallagher Medeiros ER, Post KE, Greer JA (2024) Stepped Palliative Care for Patients With Advanced Lung Cancer: A Randomized Clinical Trial. JAMA 332: 471–481 doi:10.1001/jama.2024.10398

Tables

Tables 1 to 4 are available in the Supplementary Files section.

Figures

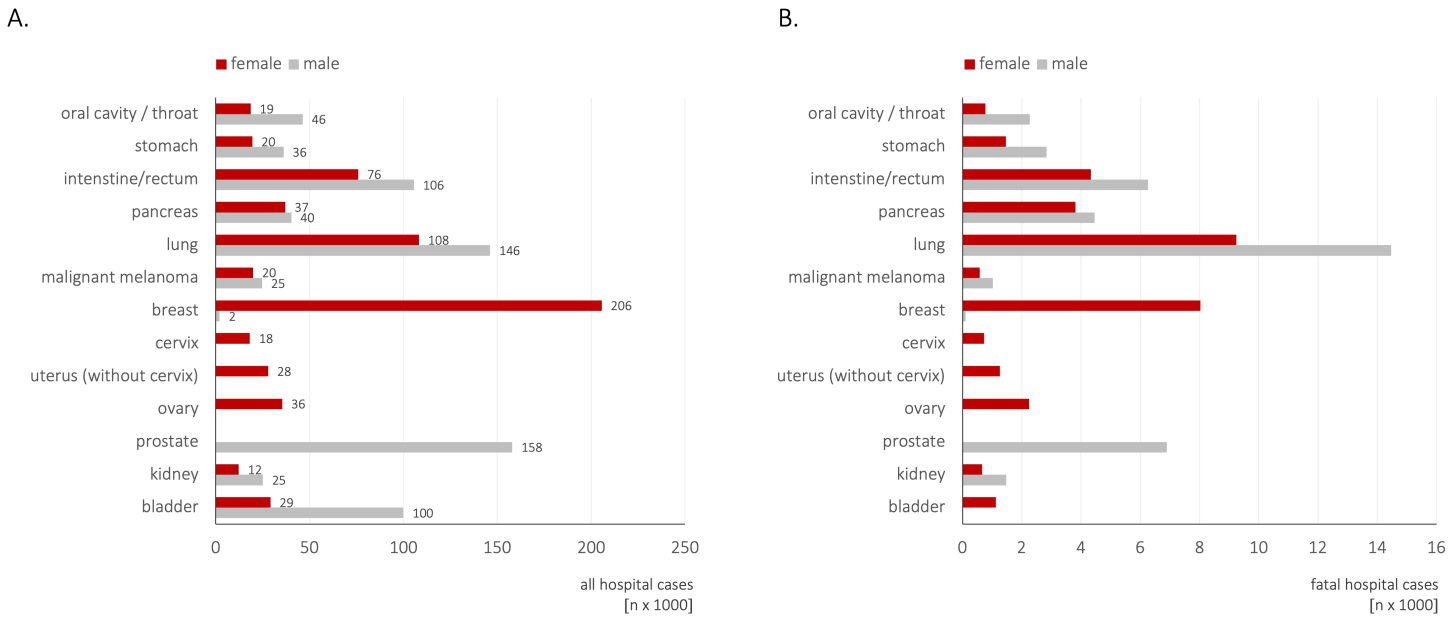


Figure 1

Gender distribution

Gender distribution across the analysed tumour entities in the total study cohort (A) and among hospital cases resulting in in-hospital death (B).

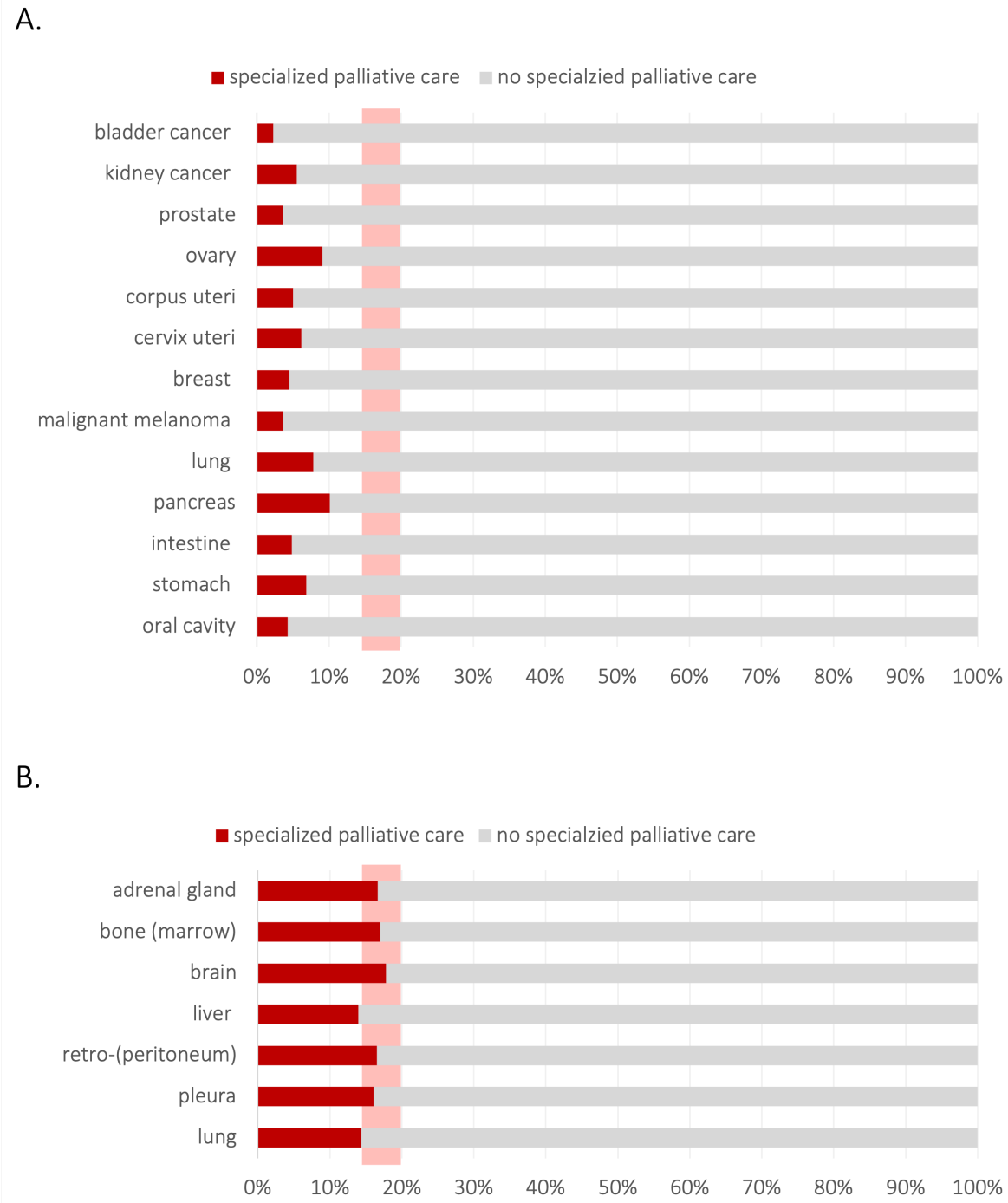


Figure 2

Frequency of palliative care involvement in hospital cases with oncologic patients.

Panel A shows the proportion of hospital cases that included specialized palliative care involvement care as defined by OPS codes 8-982, 8-98e, and 8-98h. Panel B depicts the proportion of hospital cases of patients with frequent organ metastases that included specialized palliative care involvement. The

shaded pink area indicates the tipping-point range described by diffusion of innovations theory (approximately 15–20% adoption), beyond which acceptance extends from early adopters to the early majority and diffusion becomes self-sustaining.

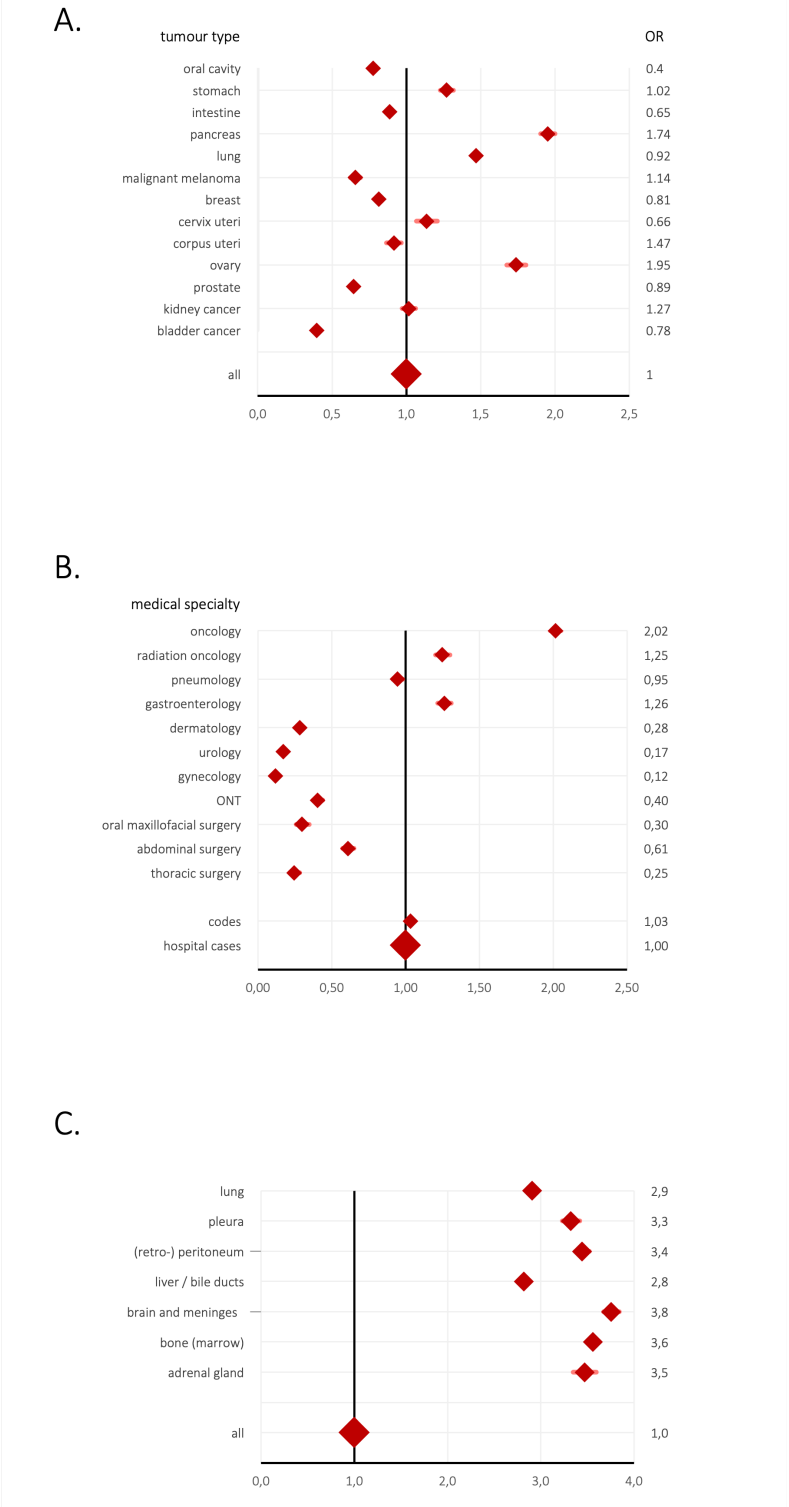


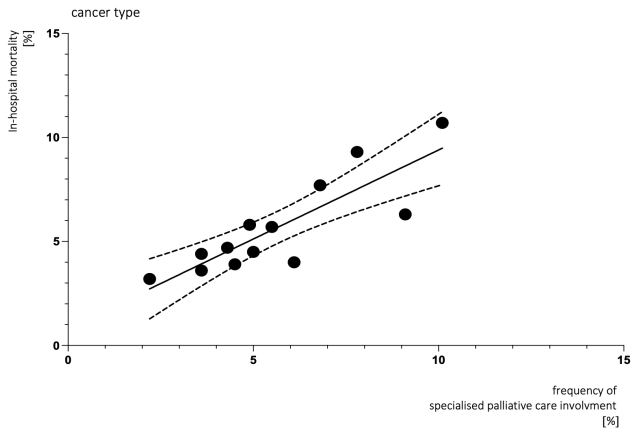
Figure 3

Odds ratios for specialised palliative care utilisation.

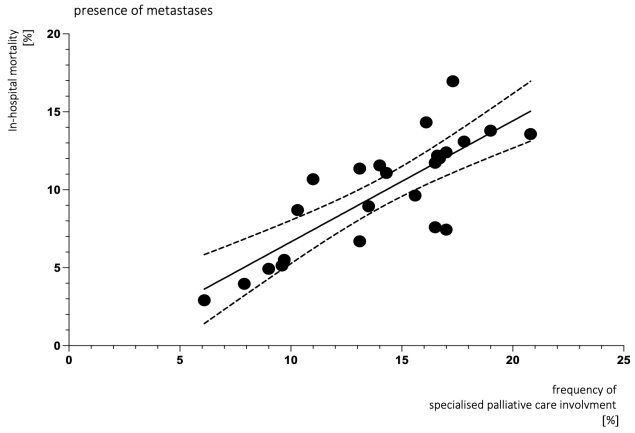
This figure presents odds ratios for specialised palliative care treatment according to tumour entities (A), presence of metastases (B), and treating medical specialties (C). Odds ratios are calculated relative to the overall frequency of specialised palliative care utilisation in the entire analysed cohort (OR = 1).

Abbreviations: OR, odds ratio

A.



B.



C.

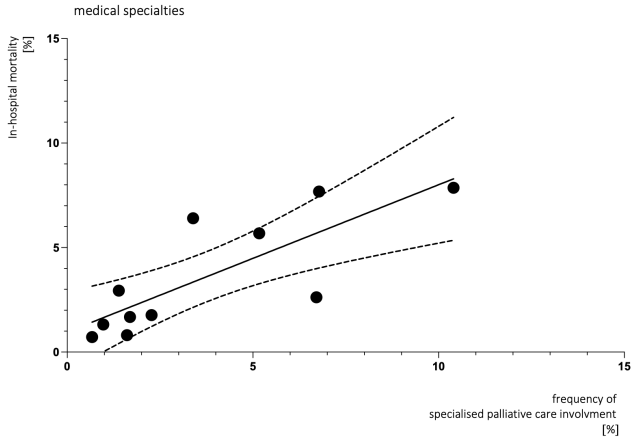
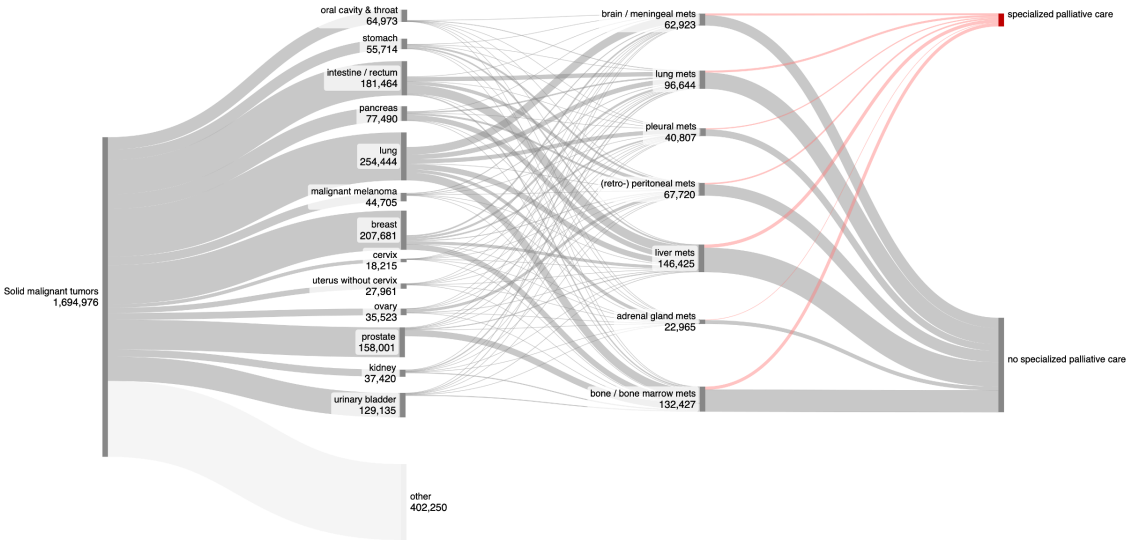


Figure 4

Linear regression analyses

Linear regression analyses for the association between in-hospital mortality and the frequency of specialised palliative care involvement for different tumour types (A.: $y = 0.86x + 0.84$; $R^2 = 0.72$; $F = 28.5$; $p = 0.0002$), in case presence of metastases (B: $y = 0.78x - 1.1$; $R^2 = 0.65$; $F = 41.4$; $p < 0.0001$) and across different medical specialties (C: $y = 0.70x + 0.96$; $R^2 = 0.64$; $F = 15.7$; $p = 0.003$).

A.



B.

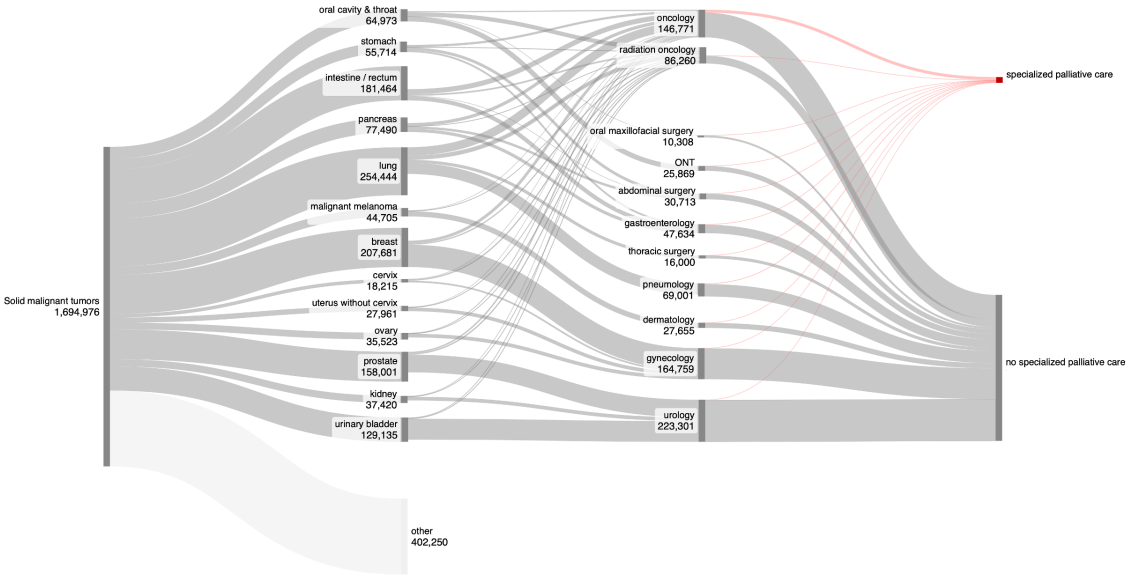


Figure 5

Sankey diagram

The Sankey diagram illustrates frequency of specialised palliative care in presence of metastases (A.) and across different medical specialties

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Tab1genderage.xlsx
- Tabl2SPC.xlsx
- Tab3OR.xlsx
- Tab4SPCmets.xlsx
- suppltab1codedefinition.xlsx
- suppltab2CCI.xlsx
- suppltab3mortality.xlsx
- supplfig1absolutefigures.png
- supplfig2ORCCI.png