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Palliative Radiation Treatment in Patients Managed With Advanced/Interventional Pain Therapy such as Pump-delivered Continuous Opioids

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Abstract. *Background/Aim: The study aim was to analyze the feasibility and efficacy of palliative radiotherapy in patients receiving advanced/interventional pain therapy, such as epidural or spinal anesthesia or subcutaneous pump delivery of opioids. Endpoints such as pain relief, treatment in the last month of life and survival were evaluated. Patients and Methods: Different baseline parameters including but not limited to age and Eastern Cooperative Oncology Group performance status (ECOG PS) were assessed. Outcomes were abstracted from electronic health records. The Edmonton Symptom Assessment System (ESAS) was utilized to score pain intensity. Results: The study included 48 patients, 44 of whom completed radiotherapy as prescribed. Device malfunction was not observed. Overall, 31 patients (65%) had journal notes available allowing for evaluation of pain relief. Twenty-six of 31 experienced pain relief (54% in the intention-to-treat population of 48 study patients). Twelve patients (25%) stopped interventional pain therapy and were converted to transdermal or oral drugs. Median survival was 1.6 months. Forty-four percent had received radiotherapy during the last month of life. Sixty-four percent of patients with ECOG PS 3-4 had received radiotherapy during the last month of life, compared to 22% of those with ECOG PS <3, p=0.004. Conclusion: Palliative radiotherapy was feasible in this setting, but given the short median survival and high likelihood of treatment during the last month of life, patient selection and choice of fractionation regimen should be optimized. The record review identified several patients who experienced worthwhile pain relief, sometimes leading to conversion of pain therapy back to non-invasive oral or transdermal application.*

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Palliative radiotherapy often aims at pain relief, particularly in patients with bone metastases or multiple myeloma (1-3). Extraosseous lesions, such as lymph node metastases and abdominal or pelvic primary tumors, *e.g.*, pancreatic or rectal cancer, may also cause serious pain, which results in referral for palliative radiotherapy (4-9). Pain intensity varies widely and so does prescription of different types of analgesics and co-analgesics (10). Commonly, oral or transdermal analgesics are utilized and outpatient radiotherapy is feasible. However, some patients require intense, multimodal pain management, which often is supervised by a dedicated palliative care team (PCT) and also may require temporary hospital administration.

Palliative radiotherapy often results in gradual pain improvement. For example, a systematic review and meta-analysis of conventional irradiation for bone metastases assessed using international consensus pain response endpoints demonstrated response in 60% of evaluable patients (n=4,775) and 45% of intent-to-treat patients (n=6,775) (11). Due to limited survival and difficult follow-up of patients with reduced performance status (PS), most studies had high rates of non-evaluable patients. Little research has focused on patients who needed advanced/interventional pain therapy such as pump-delivered continuous analgesics. Such approaches are often the final step after insufficient titration of standard oral or transdermal drugs (12, 13).

Over a long period of time, our group has studied the feasibility and appropriateness of palliative radiotherapy in different settings with or without involvement of a PCT (14-17). The present retrospective analysis was undertaken

to specifically address the feasibility and efficacy in patients who received advanced/interventional pain therapy.

Patients and Methods

In 2022 a single-institution database (2009-2016) was evaluated, which includes information about the type of pain management at the start of palliative radiotherapy. Forty-eight consecutive patients managed with standard palliative external beam radiotherapy regimens, such as a single fraction of 8 Gy, 5 fractions of 4 Gy or 10 fractions of 3 Gy (3-D conformal; no stereotactic ablative body radiotherapy) who had advanced/interventional pain therapy were analyzed. The latter included epidural or spinal anesthesia or subcutaneous pump delivery. Pain management and setting (in- or outpatient) were at the discretion of the PCT. Symptom severity was classified according to the Edmonton Symptom Assessment System (ESAS) (18, 19), *e.g.*, at the time of radiotherapy planning (score 10: maximum pain, score 0: no pain). Radiotherapy fractionation was at the discretion of the treating oncologist. Interrupted or permanently discontinued radiotherapy series were included to comply with the intention-to-treat principle. The patients received standard-of-care systemic anticancer treatment as indicated (tailored to organ function, Eastern Cooperative Oncology Group (ECOG) PS, frailty *etc.*). Follow-up was individualized and tailored to patients' needs, but many patients continued care in close contact with the PCT.

The review-board approved database is regularly updated for survival and has been previously utilized for different quality-of-care projects (15, 16). Data were extracted from the regional hospitals' shared electronic health records (6 hospitals in Nordland county). We did not have access to the records of health care providers outside of the hospitals, *e.g.,* primary health care or nursing home physicians. Standard descriptive analyses were employed. Overall survival (time to death) from the first day of radiotherapy was calculated employing the Kaplan-Meier method (SPSS 28, IBM Corp., Armonk, NY, USA). In one case, survival was censored after eight years of follow-up (newly diagnosed multiple myeloma). Kaplan-Meier curves were compared by means of log-rank tests. Outcomes of interest, *e.g.*, death within 30 days of last radiation treatment were dichotomized (alive/dead) and the chi-square test (2-sided) was utilized for further analyses. *p*-Values ≤0.05 were considered statistically significant.

Table I. *Baseline characteristics and selected outcomes for 48 patients.*

Parameter	N	Median (range) or N (%)
Sex		
Female	21	44
Male	27	56
Age, years		63 (42-84)
ECOG PS	48	100
1	4	8
2	19	40
3	23	48
4	2	4
Months from diagnosis of cancer		20 (1-148)
Months from first metastasis	44	10 (1-55)
Progressive disease		
No	5	10
Yes	43	90
Status at RT		
Outpatient	9	19
Inpatient	39	81
Supported by palliative care team		
No	2	4
Yes	46	96
Systemic therapy		
None	9	19
Before RT, within 4 weeks	19	37
Before RT, 4 weeks - 3 months	6	13
Earlier than 3 months	13	27
Not documented	1	2
Steroids at RT start		
Yes	12	25
No	35	79
Not documented	1	2
Days spent outside of hospital post RT		31 (0-413)
Place of death		
Home	11	23
Hospital	23	48
Nursing home	10	21
Not documented	3	6
Alive	1	2

ECOG PS: Eastern Cooperative Oncology Group performance status; RT: radiotherapy.

Results

As indicated in Table I, the study included 21 female and 27 male patients (56%), whose median age was 63 years (range=42-84 years). More than half had ECOG PS 3-4 (52%) and 81% were inpatients. As shown in Table II, a wide range of malignancies was treated, including hematological diagnoses (12%) such as multiple myeloma (10%). Most patients were irradiated for bone metastases from solid primary tumors (73%), others for painful pelvic tumors.

Commonly, 3- or 4-Gy fractions were employed (Table III). Some patients received additional radiotherapy for non-pain indications, *e.g.*, brain or skin metastases, in the same course. Four patients (8%) were unable to complete the prescribed course of radiotherapy, all with ECOG PS 3-4. Deviation from routine ESAS utilization before radiotherapy was observed in 21 patients. Only a small subgroup of 11 patients had ESAS data available during follow-up (Table IV). Based on 27 patients with baseline ESAS, median pain score was 4 (resting) and 6 (activity), respectively. A reduction after radiotherapy was observed (after 4-6 weeks median 1 and 3, respectively).

Overall, 31 patients (65%) had journal notes available allowing for evaluation of pain relief, even if not documented by ESAS and therefore not always quantifiable. Several patients were discharged to nursing homes or home without documented pain status. Twenty-six of 31 experienced some degree of pain relief (54% in the intention-to-treat population of 48 study patients), and 17 (35%) had less pain for at least one month. Twelve patients (25%) stopped interventional pain therapy by pump and were converted to transdermal or oral drugs.

Table II. *Tumor characteristics for 48 patients.*

Parameter	N	%
Cancer type		
Prostate	1	2
Breast	5	10
Lung (small cell)	1	2
Colorectal	7	15
Bladder	4	8
Lymphoma	1	2
Multiple myeloma	5	10
Lung (non-small cell)	9	19
Malignant melanoma	3	6
Kidney	2	4
Unknown primary	1	2
Others	9	19
Metastatic sites		
Brain	9	19
Liver	18	38
Lung	25	52
Adrenal gland	12	25
Bone	35	73

Table III. *Radiation treatment characteristics for 48 patients.*

Parameter	N	%
Number of target volumes		
1	30	63
2	13	27
3	5	10
Dose per fraction (Gy)		
0-2	2	4
2.1-2.9	1	2
3	21	44
4	17	35
4.1-5.6	3	6
More than 5.6	4	8
Number of fractions		
1-4	7	15
5-9	19	40
10	15	31
11-15	5	10
More than 15	2	4
Type of target volume		
Bone	39	81
Lymph node	3	6
Brain	3	6
Lung	2	4
Skin	3	6
Others	3	6
Previous radiotherapy		
No	18	38
One course	15	31
Two or more courses	15	31
Re-irradiation	5	10
Incomplete radiotherapy		
Yes	4	8
No	44	92

Median survival was 1.6 months (95% confidence interval=0.3-3.1; Figure 1). After 6 months, 17% were still alive. Thirty-three percent died within 30 days of last radiation treatment. Forty-four percent had received radiotherapy during the last month of life. Interestingly, 64% of patients with ECOG PS 3-4 had received radiotherapy during the last month of life, compared to 22% of those with PS <3, p=0.004. None of the other baseline parameters displayed in the Tables correlated significantly with this endpoint. Patients scheduled to receive at least 10 fractions survived for a median of 1.6 months and those scheduled to receive fewer fractions survived for a median of 1.9 months, p=0.5. Patients with ECOG PS 3-4 survived for a median of 1.0 months and those with better PS for a median of 3.0 months, p=0.03. Survival was longest in patients with multiple myeloma (median 6.9 months) and breast cancer (median 4.4 months) and shortest in those with lung cancer (median 1.5 months) and colorectal cancer (median 1.2 months), p=0.09.

Discussion

Even in prospective clinical trials, many patients with painful bone metastases could not be assessed for pain response [2,000 out of 6,775 (30%) in a recent meta-analysis (11)]. We were aware of this challenge and expected an equal or bigger drop-out rate in a retrospective setting like the present one, and indeed only 65% of our patients had journal notes available allowing for evaluation of pain relief, although quantification of this endpoint was elusive. Ideally, the international consensus pain response endpoints should be reported (20), however limited information could be abstracted from the electronic health records, *e.g.*, regarding longitudinal drug dose titration. A disappointingly low percentage of patients had serial ESAS pain scores documented. Despite anticipating challenges with missing data and limited follow-up consistency, we decided to perform this study, because the previous literature gives little if any guidance on what to expect when irradiating patients with advanced/interventional pain therapy.

Our retrospective study included 48 patients with a very heterogeneous status at baseline before radiotherapy, ranging from newly diagnosed multiple myeloma with excellent systemic treatment options to chemotherapy-resistant widely metastasized colorectal cancer with poor ECOG PS. Also, type of pain therapy varied widely (subcutaneous continuous opioids *via* pump, spinal anesthesia *etc.*). Due to the small size of the study, we could not account for these different scenarios by looking into subgroups. Given that Odell *et al.* already have reported that radiotherapy can be administered

Table IV. *Pain and management characteristics for 48 patients.*

Parameter	N	% or median (range)
Days with pump in place		38 (4-374)
Co-analgesics		
None	31	65
Oral drugs	11	23
Intravenous drugs	1	2
Plexus blockade	1	2
Transdermal drugs	3	6
Not documented	1	2
ESAS before radiotherapy	27	56
Pain at rest	27	4 (0-8)
Pain in activity	27	6 (0-10)
ESAS after radiotherapy	11	23
Pain at rest	11	1 (0-8)
Pain in activity	10	3 (0-10)
Improvement after radiotherapy	31	65
Yes	26	54
No	5	10
Days with improved pain*	29	30 (0-3,000)
Improved for at least 30 days	24	50
Yes	17	35
No	7	15
Pump discontinued		
No	35	73
Yes	12	25
Not documented	1	2

*After last radiotherapy session. ESAS: Edmonton Symptom Assessment System.

safely to patients with intrathecal drug delivery systems without malfunction [total measured dose to the device ranged from 0 to 18 Gy (median 0.2 Gy) with a median dose of 0.04 Gy/fraction (range=0-3.2 Gy/fraction)] (21), the main research questions were related to efficacy and prognosis. Reassuringly, malfunction was not reported and the fact that 8% of patients did not complete radiotherapy could be explained by adverse baseline characteristics such as poor ECOG PS, leading to rapid clinical deterioration and short survival. The rate of 8% is not unusual in the palliative radiotherapy literature (16, 22, 23).

The record review identified several patients who experienced worthwhile pain relief that would have been classified as response according to the international consensus pain response endpoints, sometimes leading to conversion of pain therapy back to non-invasive oral or transdermal application. Durable relief was sometimes observed, but only 17% survived for at least six months. The rate of 35% who had less pain for at least one month (intention-to-treat) is not tremendously different from the reported response rate of 45% of intent-to-treat patients in the bone metastases meta-analysis (nota bene: different patient populations, different assessments) (11). It would thus not be justified to advice against palliative radiotherapy in all patients with interventional pain therapy. However, improved selection appears necessary, given that 33% died within 30 days of last radiation treatment. In a recent large meta-analysis (24), 16% of patients with advanced cancer who had received palliative radiotherapy died within 30 days of treatment. In the present study, ECOG PS 3-4 was the only statistically significant predictor of death within 30 days. The clinical picture is too complex to base decision making on PS alone, although PS is a well-known, robust predictor identified in numerous studies (16, 24, 25). Ideally, prediction of survival would be complemented by prediction of pain response. Much larger studies than ours are needed to decipher factors predicting pain response. In theory, a well-responding, initially bedridden inpatient may regain an ECOG PS <3 and qualify for initiation of life-prolonging systemic therapy. In the light of sometimes disappointing record quality and variable PCT involvement during follow-up in this retrospective study, we can only advocate for prospective clarification of response rates and predictors.

In the absence of better selection criteria, administration of 10 or more fractions in patients with median survival of 1.6 months appears to violate the principles of Choosing Wisely. Based on the knowledge generated by our retrospective analysis, we are now trying to complete radiotherapy in a shorter time frame, prioritizing single fraction and 4-5 fraction regimens. Besides the number of patients (suboptimal statistical power), limitations of the present work include its retrospective single-institution design and selection bias, because a proportion of poor-prognosis patients referred to palliative radiotherapy may have died before the planned start of treatment or opted out of treatment due to discomfort during treatment planning. A stringent definition of pain response at narrowly defined follow-up time points could not be applied. Endpoints such as pain flare, nausea, and other side-effects were not assessable. Nevertheless, the study cohort represents an understudied real-world patient population of cancer patients who may have been excluded from many clinical trials due to survival expectation <3 months and/or poor PS.

Despite recent progress in prognostic stratification, survival predictions in oncology tend to be overly optimistic (16, 17, 22, 24-28). Not all patients initially thought to represent suitable candidates for palliative radiotherapy are able to complete their treatment and derive net benefit. The large meta-analysis by Kutzko *et al.* identified multiple treatment sites, hepatobiliary primary, inpatient status, and ECOG PS 3-4 as predictors of 30-day mortality (24). In contrast to these results, Wu *et al.* performed a multivariate analysis suggesting that breast or prostate primary tumor, ECOG PS, body mass index, liver metastases, more than five active metastases (dichotomized, radiographically identified), albumin level, and hospitalization within three months of radiotherapy consult were associated with 30-day survival (22). Tools preferred by palliative care providers

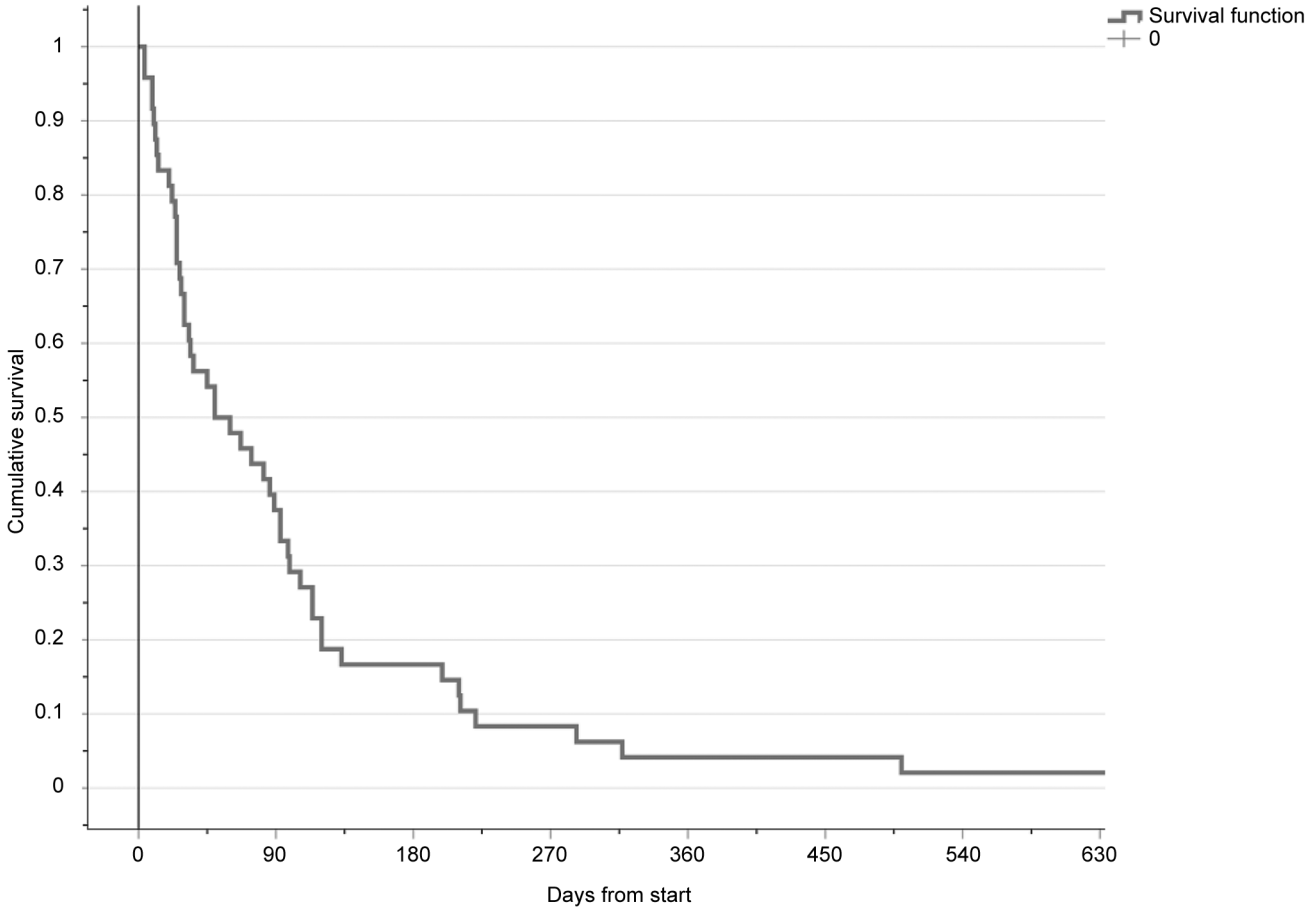

Figure 1. *Overall survival after start of palliative radiotherapy.*

(29) may be relevant in a setting like ours, where inpatient care, PCT involvement, and short survival were common.

Conclusion

Palliative radiotherapy was feasible in this setting, but given the short median survival and high likelihood of treatment during the last month of life, patient selection and choice of fractionation regimen should be optimized. The record review identified several patients who experienced worthwhile pain relief, sometimes leading to conversion of pain therapy back to non-invasive oral or transdermal application.

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Conflicts of Interest

The Authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Authors' Contributions

SMJ and SN: Collected the related data, contributed to analysis of the data, investigated the study results. CN and ECH: Interpreted data and wrote the manuscript. All Authors contributed to the article and approved the submitted version.

References

1 Ito K, Saito T, Nakamura N, Imano N, Hoskin P: Stereotactic body radiotherapy *versus* conventional radiotherapy for painful bone metastases: a systematic review and meta-analysis of randomised controlled trials. Radiat Oncol 17(1): 156, 2022. DOI: 10.1186/s13014-022-02128-w

2 Pielkenrood BJ, Gal R, Kasperts N, Verhoeff JJC, Bartels MMTJ, Seravalli E, van der Linden YM, Monninkhof EM, Verlaan JJ, van der Velden JM, Verkooijen HM: Quality of life after stereotactic body radiation therapy *versus* conventional radiation therapy in patients with bone metastases. Int J Radiat Oncol Biol Phys 112(5): 1203-1215, 2022. DOI: 10.1016/j.ijrobp.2021.12.163

3 Tsang RW, Campbell BA, Goda JS, Kelsey CR, Kirova YM, Parikh RR, Ng AK, Ricardi U, Suh C, Mauch PM, Specht L,

Yahalom J: Radiation therapy for solitary plasmacytoma and multiple myeloma: Guidelines from the International Lymphoma Radiation Oncology Group. Int J Radiat Oncol Biol Phys 101(4): 794-808, 2018. DOI: 10.1016/j.ijrobp.2018.05.009

4 Aoshika T, Abe T, Iino M, Saito S, Ryuno Y, Ohta T, Igari M, Hirai R, Kumazaki Y, Noda SE, Kato S: Safety and efficacy of palliative radiotherapy (25 Gy×5 fractions) for symptomatic pelvic tumors. Anticancer Res 42(12): 6099-6103, 2022. DOI: 10.21873/anticanres.16122

5 Cameron MG, Kersten C, Vistad I, Van Helvoirt R, Weyde K, Undseth C, Mjaaland I, Skovlund E, Fosså SD, Guren MG: Palliative pelvic radiotherapy for symptomatic rectal cancer – a prospective multicenter study. Acta Oncol 55(12): 1400-1407, 2016. DOI: 10.1080/0284186X.2016.1191666

6 Tello Valverde CP, Ebrahimi G, Sprangers MA, Pateras K, Bruynzeel AM, Jacobs M, Wilmink JW, Besselink MG, Crezee H, Van Tienhoven G, Versteijne E: Impact of short-course palliative radiation therapy on pancreatic cancer-related pain: Prospective phase 2 nonrandomized PAINPANC trial. Int J Radiat Oncol Biol Phys 118(2): 352-361, 2024. DOI: 10.1016/j.ijrobp.2023.08.055

7 Donati CM, Macchia G, Siepe G, Zamagni A, Benini A, Cellini F, Buwenge M, Cilla S, Cammelli S, Rizzo S, Caravatta L, Wondemagegnhu T, Uddin AFMK, Deressa BT, Sumon MA, Lodi Rizzini E, Bazzocchi A, Morganti AG, Deodato F, Farina E: Short course palliative radiotherapy in advanced solid tumors: a pooled analysis (the SHARON project). Sci Rep 12(1): 20978, 2022. DOI: 10.1038/s41598-022-25602-7

8 Kombathula SH, Cree A, Joshi PV, Akturk N, Barraclough LH, Haslett K, Choudhury A, Hoskin P: Palliative radiotherapy in cancers of female genital tract: Outcomes and prognostic factors. Radiother Oncol 175: 42-46, 2022. DOI: 10.1016/j.radonc.2022.07.023

9 Shahid Iqbal M, Kelly C, Kovarik J, Goranov B, Shaikh G, Morgan D, Dobrowsky W, Paleri V: Palliative radiotherapy for locally advanced non-metastatic head and neck cancer: A systematic review. Radiother Oncol 126(3): 558-567, 2018. DOI: 10.1016/j.radonc.2017.12.011

10 Skarf LM, Jones KF, Meyerson JL, Abrahm JL: Pharmacologic pain management: What radiation oncologists should know. Semin Radiat Oncol 33(2): 93-103, 2023. DOI: 10.1016/j.semradonc.2023.01.002

11 Imano N, Saito T, Hoskin P, Nakamura N, Ito K, Yorozu A, Nishibuchi I, Murakami Y, Nagata Y: Pain response rates after conventional radiation therapy for bone metastases assessed using international consensus pain response endpoints: a systematic review and meta-analysis of initial radiation therapy and reirradiation. Int J Radiat Oncol Biol Phys 116(4): 739-746, 2023. DOI: 10.1016/j.ijrobp.2023.01.050

12 Perruchoud C, Dupoiron D, Papi B, Calabrese A, Brogan SE: Management of cancer-related pain with intrathecal drug delivery: a systematic review and meta-analysis of clinical studies. Neuromodulation 26(6): 1142-1152, 2023. DOI: 10.1016/j.neurom.2021.12.004

13 Aman MM, Mahmoud A, Deer T, Sayed D, Hagedorn JM, Brogan SE, Singh V, Gulati A, Strand N, Weisbein J, Goree JH, Xing F, Valimahomed A, Pak DJ, El Helou A, Ghosh P, Shah K, Patel V, Escobar A, Schmidt K, Shah J, Varshney V, Rosenberg W, Narang S: The American Society of Pain and Neuroscience (ASPN) best practices and guidelines for the interventional management of cancer-associated pain. J Pain Res 14: 2139-2164, 2021. DOI: 10.2147/JPR.S315585

14 Nieder C, Pawinski A, Haukland E, Dokmo R, Phillipi I, Dalhaug A: Estimating need for palliative external beam radiotherapy in adult cancer patients. Int J Radiat Oncol Biol Phys 76(1): 207-211, 2010. DOI: 10.1016/j.ijrobp.2009.01.028

15 Nieder C, Dalhaug A, Pawinski A, Haukland E, Mannsåker B, Engljähringer K: Palliative radiotherapy with or without additional care by a multidisciplinary palliative care team in patients with newly diagnosed cancer: a retrospective matched pairs comparison. Radiat Oncol 10: 61, 2015. DOI: 10.1186/13014-015-0365-0

16 Nieder C, Haukland EC, Mannsåker B, Dalhaug A: Palliative appropriateness criteria: external validation of a new method to evaluate the suitability of palliative radiotherapy fractionation. Strahlenther Onkol 199(3): 278-283, 2023. DOI: 10.1007/s00066-022-02040-y

17 Nieder C, Imingen KS: Palliative radiotherapy for non-metastatic non-small-cell lung cancer: Impact of blood test results on survival. In Vivo 37(2): 771-776, 2023. DOI: 10.21873/invivo.13140

18 Bruera E, Kuehn N, Miller MJ, Selmser P, Macmillan K: The Edmonton Symptom Assessment System (ESAS): a simple method for the assessment of palliative care patients. J Palliat Care 7(2): 6-9, 1991.

19 Nieder C, Kämpe TA: Symptom burden in patients with reduced performance status at the start of palliative radiotherapy. In Vivo 34(2): 735-738, 2020. DOI: 10.21873/invivo.11832

20 Chow E, Hoskin P, Mitera G, Zeng L, Lutz S, Roos D, Hahn C, van der Linden Y, Hartsell W, Kumar E: Update of the international consensus on palliative radiotherapy endpoints for future clinical trials in bone metastases. Int J Radiat Oncol Biol Phys 82(5): 1730-1737, 2012. DOI: 10.1016/j.ijrobp.2011.02.008

21 Odell DW, Albrechtsen RD, Sindt JE, Gole R, Brown S, Parsons MW, Paxton AB, Sarkar V, Lloyd S, Brogan SE, Tao R: The effect of measured radiotherapy dose on intrathecal drug delivery system function. Neuromodulation 24(7): 1204-1208, 2021. DOI: 10.1111/ner.13372

22 Wu SY, Yee E, Vasudevan HN, Fogh SE, Boreta L, Braunstein SE, Hong JC: Risk stratification for imminent risk of death at the time of palliative radiotherapy consultation. JAMA Netw Open 4(7): e2115641, 2021. DOI: 10.1001/jamanetworkopen.2021.15641

23 Ali A, Song YP, Mehta S, Mistry H, Conroy R, Coyle C, Logue J, Tran A, Wylie J, Janjua T, Joseph L, Joseph J, Choudhury A: Palliative radiation therapy in bladder cancer—importance of patient selection: a retrospective multicenter study. Int J Radiat Oncol Biol Phys 105(2): 389-393, 2019. DOI: 10.1016/j.ijrobp.2019.06.2541

24 Kutzko JH, Dadwal P, Holt T, Rahman MA, Zahir SF, Hickey B: Defining the expected 30-day mortality for patients undergoing palliative radiotherapy: A meta-analysis. Radiother Oncol 168: 147-210, 2022. DOI: 10.1016/j.radonc.2022.01.030

25 Vázquez M, Altabas M, Moreno DC, Geng AA, Pérez-Hoyos S, Giralt J: 30-day mortality following palliative radiotherapy. Front Oncol 11: 668481, 2021. DOI: 10.3389/fonc.2021.668481

26 Gripp S, Moeller S, Bölke E, Schmitt G, Matuschek C, Asgari S, Asgharzadeh F, Roth S, Budach W, Franz M, Willers R: Survival prediction in terminally ill cancer patients by clinical estimates, laboratory tests, and self-rated anxiety and

depression. J Clin Oncol 25(22): 3313-3320, 2007. DOI: 10.1200/JCO.2006.10.5411

27 Chow E, Abdolell M, Panzarella T, Harris K, Bezjak A, Warde P, Tannock I: Predictive model for survival in patients with advanced cancer. J Clin Oncol 26(36): 5863-5869, 2008. DOI: 10.1200/JCO.2008.17.1363

28 Pobar I, Job M, Holt T, Hargrave C, Hickey B: Prognostic tools for survival prediction in advanced cancer patients: A systematic review. J Med Imaging Radiat Oncol 65(6): 806-816, 2021. DOI: 10.1111/1754-9485.13185

29 Stone P, White N, Oostendorp LJ, Llewellyn H, Vickerstaff V: Comparing the performance of the palliative prognostic (PaP) score with clinical predictions of survival: A systematic review. Eur J Cancer 158: 27-35, 2021. DOI: 10.1016/j.ejca.2021.08.049

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