BMC Palliative Care

RESEARCH

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# Availability of and factors related to interventional procedures for refractory pain in patients with cancer: a nationwide survey

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## Abstract

**Background:** Cancer pain may be refractory to standard pharmacological treatment. Interventional procedures are important for quality of analgesia. The aim of the present study was to clarify the availability of four interventional procedures (celiac plexus neurolysis/splanchnic nerve neurolysis, phenol saddle block, epidural analgesia, and intrathecal analgesia), the number of procedures performed by specialists, and their associated factors. In addition, we aimed to establish how familiar home hospice physicians and oncologists are with the different interventional procedures available to manage cancer pain.

**Methods:** A cross-sectional survey using a self-administered questionnaire was conducted. Subjects were certified pain specialists, interventional radiologists, home hospice physicians, and clinical oncologists.

**Results:** The numbers of valid responses/mails were 545/1,112 for pain specialists, 554/1,087 for interventional radiology specialists, 144/308 for home hospice physicians, and 412/800 for oncologists. Among pain specialists, depending on intervention, 40.9-75.2% indicated that they perform each procedure by themselves, and 47.5-79.8% had not performed any of the procedures in the past 3 years. Pain specialists had performed the four procedures 4,591 times in the past 3 years. Among interventional radiology specialists, 18.1% indicated that they conduct celiac plexus neurolysis/splanchnic nerve neurolysis by themselves. Interventional radiology specialists had performed celiac plexus neurolysis/splanchnic nerve neurolysis 202 times in the past 3 years. Multivariate analysis revealed that the number of patients seen for cancer pain and the perceived difficulty in gaining experience correlated with the implementation of procedures among pain specialists. Among home hospice physicians and oncologists, depending on intervention, 3.5-27.1% responded that they were unfamiliar with each procedure.

**Conclusions:** Although pain specialists responded that the implementation of each intervention was possible, the actual number of the interventions used was limited. As interventional procedures are well known, it is important to take measures to ensure that pain specialists and interventional radiology physicians are sufficiently utilized to manage refractory cancer pain.

**Keywords:** Refractory cancer pain, Interventional procedures, Availability, Related factors, Nationwide survey

## Background

Pain is a common symptom associated with cancer that needs to be controlled or reduced as much as possible. Cancer-related pain decreases the quality of life of patients [1, 2]. Pharmacological management is the

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basis of cancer pain treatment, and may adequately relieve cancer pain [3, 4]. However, a recent meta-analysis revealed that the proportion of patients with pain remains high, with 66.4% of patients with advanced terminal cancer having pain and 38% of those with cancer of any stage having moderate to severe pain [5].

The pharmacological management of cancer pain in some patients remains insufficient. Refractory cancer pain, which is defined as pain not responding to standard pharmacological treatments [6], may afflict some patients. The limitations of pharmacological therapy include its use for relief of breakthrough pain and side effects of analgesics. The use of individualized pharmacotherapy that considers the timing of treatment, individual characteristics, and non-pharmacological therapies is important for cancer-related pain. Among non-pharmacological therapies, the WHO guidelines [7] strongly recommend radiotherapy. Furthermore, authoritative guidelines [8–10] include non-pharmacological therapies such as neural blockade, neuraxial infusion, and cordotomy. Thus, in cancer pain management, an individualized multimodal approach is important [11, 12].

The degree to which interventional procedures for patients with cancer pain are available and utilized remains unclear. Some non-pharmacological therapies, including neural blockade and neuraxial infusion, are effective for cancer pain, and previous studies have reported that they are used to treat 3.8-8% of cancer patients [13–15]. However, as there are several barriers to the implementation of these therapies [16–21], their limited availability may explain refractory cancer-related pain in some patients with cancer.

Information on the status and availability of neural blockades and neuraxial infusions for cancer pain management or the factors associated with their use are currently limited [13–22]. Previous questionnaire surveys targeted palliative care physicians, referring physicians, and representatives of facilities at which treatment was provided [16–20, 23]; however, a national survey of the individual professionals who completed these surveys has not yet been performed.

The purpose of the present study was to clarify the availability and number performed by each specialist of four interventional procedures (celiac plexus neurolysis/splanchnic nerve neurolysis [CPN], subarachnoid neurolytic block for perineal pain [phenol saddle block], epidural infusions of local anesthetic combined with opioids [Epi], and intrathecal analgesia [IA] for refractory cancer pain) as well as factors related to their implementation using a nationwide survey of specialists. In addition, we aimed to clarify how familiar home hospice physicians (HHPs) and oncologists were with the different interventional procedures available to manage refractory cancer pain.

## Methods

### Study Design

A cross-sectional study on interventional procedures performed by pain specialists (PSs), interventional radiology (IVR) specialists, HHPs, and oncologists was conducted in Japan.

This survey was part of the "Research on the Construction of Systematic Pain Relief Methods in the Final Stage of Cancer Patients' Medical Care" program.

### Participants and procedures

Between February and March 2020, a questionnaire on interventional procedures for refractory cancer pain was sent to PSs, IVR specialists, HHPs, and oncologists. Eligibility criteria were certificated physicians of each academic society. Exclusion criteria were: 1) not living in Japan, 2) not working at a hospital (regarding PSs and oncologists), and 3) no contact information. To identify subjects, we used lists of certified physicians from websites or certifying societies. A questionnaire was mailed to all certified PSs, IVR specialists, and HHPs who met the eligibility criteria, and to 800 oncologists randomly selected based on prefecture-based population ratios. Double board-certified oncologists who were certified as PSs or palliative care physicians were excluded from the analysis of valid responses.

A letter of purpose, questionnaire, and self-addressed envelope were enclosed and mailed, and a request was made in the letter of purpose to reply within one month of receipt of the questionnaire. A reminder by postcard was sent if when the questionnaire was not returned within this time.

### Measurements

In the present study, refractory pain was defined to participants as: pain that patients, family members, or nurses requested the physician to alleviate further, even with appropriate pharmacological therapy. All participants were asked about the following background factors: age, sex, the number of cancer patients seen annually, the number of cancer patients with pain seen annually, the number of cancer patients who died annually, other specialties, facilities at which they work, and their main workplace.

Self-administered questionnaires about the following interventional procedures for refractory cancer pain were conducted: CPN, phenol saddle block, Epi, and IA. We did not distinguish between celiac plexus neurolysis and splanchnic nerve neurolysis from the viewpoint of performing neural blockades for upper abdominal pain,

even though the techniques and injection sites of neurolytic agents differ. PSs reported whether they currently perform these four therapies (yes/no), whether they are willing to perform them in the future (a four-point Likert scale consisting of "will perform", "will probably perform", "will probably not perform", and "will never perform"), the number of procedures they performed in the past three years, and background factors and barriers related to the implementation of the four procedures. IVR specialists were asked about CPN only: whether they were currently performing CPN, whether they were willing to perform it in the future, and the number of procedures they had performed in the past 3 years.

Questions were based on those reported in previous studies [16–21, 23] and were developed through discussions among members of an expert group. The answers to potential barrier-related questions, such as experience, lack of time, communication with other departments, permission to perform at own facility, and availability of equipment at own facility, were recorded on a seven-point Likert scale with the following available responses: "strongly agree", "agree", "somewhat agree", "neither agree nor disagree (undecided)", "somewhat disagree", "disagree", and "strongly disagree"

Knowledge of these interventional procedures by HHPs and oncologists was also evaluated. HHPs and oncologists reported their knowledge and experience of interventional procedures for cancer pain management using one of four items: "I have performed the interventional procedure by myself"; "Some of my patients have received the interventional procedure from another physician"; "I know the interventional procedure, but have no experience with it"; and "I do not know the interventional procedure".

### Analysis

Analyses were performed on valid responses using descriptive statistics. Responses regarding willingness to perform were divided into two categories: "will perform" and "will perform probably" were categorized as "willing"; and "will probably not perform" and "will never perform" as "not willing". Responses expressed on a seven-point Likert scale were divided into two categories: "strongly agree" and "agree" were categorized as "agree"; and "somewhat agree", "neither agree nor disagree (undecided)", "somewhat disagree", "disagree", and "strongly disagree" as "other". A univariate analysis of the factors and barriers that contribute to the implementation of interventional procedures was conducted using chi-squared test. Multivariate analysis (binomial logistic regression analysis) was performed on variables with a P value of $\leq$ 0.1 in the univariate analysis. P values < 0.05 were considered to be significant due to the exploratory nature of the present study. Items with missing values of 10% or more were excluded from the analysis. All analyses were conducted using SPSS (version 25, SPSS Inc., Chicago, USA) and R version 4.0.3.

## Results

### Response rate

Questionnaires were sent to 1,112 out of 1,525 PSs; 1,087 IVR specialists; 308 HHPs; and 800 randomly selected physicians out of 16,717 oncologists. Valid responses were obtained from 545/587 PSs (49.0%) (Fig. 1), 554/572 IVR specialists (51.0%) (Fig. 2), 144/146 HHPs (46.8%), and 399/425 randomly selected physicians (49.9%).

### Characteristics

Participant characteristics are shown in Table 1. The mean ages of PSs, IVR specialists, HHPs, and oncologists were 53.1, 48.2, 47.2, and 46.7 years, respectively. The median numbers of the four types of specialists who saw cancer patients with pain annually were 10, 3, 20, and 10, respectively. The proportions of the four types of specialists working in a designated cancer hospital or university hospital were 59.4, 67.5, 6.3, and 56.1%, respectively.

### Implementation of and preferences for interventional procedures

Table 2 shows the implementation of and preferences for interventional procedures. The proportions of PSs who indicated "Currently performing" and "Willing to perform in the future" for the various interventional procedures were as follows: CPN, 49.5 and 60.0%; phenol saddle block, 55.2 and 63.1%; Epi, 75.2 and 67.7%; and IA, 40.9 and 55.2%, respectively. Regarding the frequency of these procedures performed by PSs in the past 3 years, median numbers (interquartile ranges) for the various interventional procedures were as follows: CPN, 0 (0-3); phenol saddle block, 0 (0-1); Epi, 0 (0-3); and IA, 0 (0-0). The numbers of PSs who performed 20 or more procedures were 20 (3.7%), 4 (0.7%), 25 (4.6%), and 4 (0.8%), respectively.

The proportions of IVR specialists who indicated "Currently performing CPN" and "Willing to perform CPN in the future" were 18.1 and 50.2%, respectively. Regarding the frequency of CPN performed by IVR specialists in the past 3 years, the median number (interquartile range) was 0 (0-0), with nearly 90% answering "0".

In the past 3 years, 545 PSs reported performing 4,591 of the four procedures (CPN, 1547; phenol saddle block, 706; Epi, 1746; and IA, 592), whereas 554 IVR specialists reported performing 202 CPN.

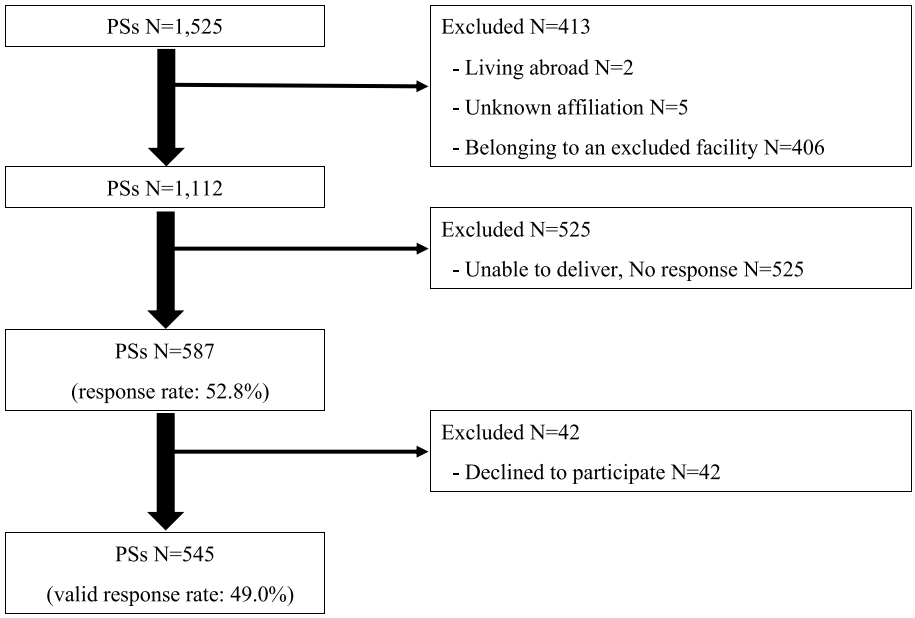


**Fig. 1** Participant flow (Pain specialist response rate). PSs: Pain specialists

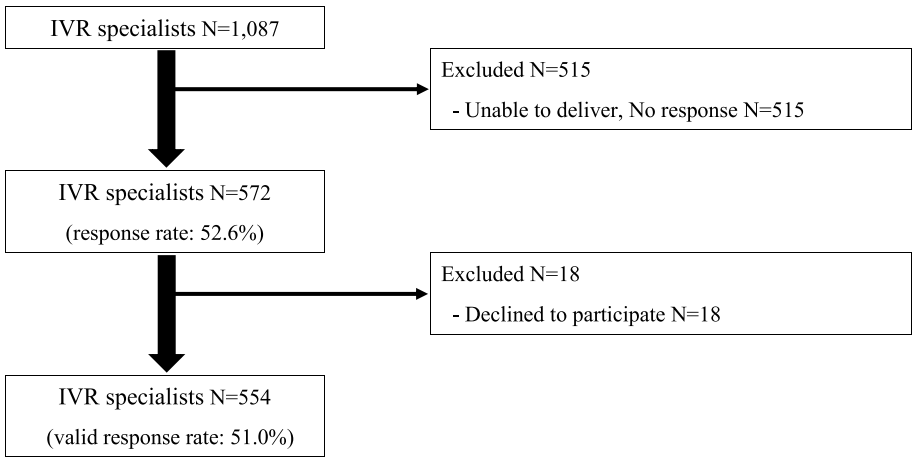


**Fig. 2** Participant flow (Interventional radiology specialist response rate). IVR: Interventional Radiology

### Factors related to the implementation of procedures by PSs

Univariate (Table 3) and multivariate analyses (Table 4) revealed that the number of cancer patients with pain seen annually and difficulty in gaining experience and acquiring skills due to the limited number of cases were associated with the implementation of all four interventional procedures for cancer pain management. Implementation not being permitted at the PSs' own facility was a barrier to the implementation of CPN, phenol saddle block, and IA. The difficulty of treating patients requiring the procedure due to a lack of time was a barrier to the implementation of CPN and phenol saddle block. Items regarding equipment were excluded from the analysis because they were missing values of 10% or more.

### Perceptions of interventional procedures by HHPs and oncologists

The proportions of HHPs and oncologists who responded that they did not know each of the four interventional procedures were as follows: CPN, 7.6 and 13.0%; phenol

**Table 1** Participant characteristics

| | Pain specialists (*N*=545) | IVR specialists (*N*=554) | Home hospice physicians (*N*=144) | Oncologists (*N*=399) |
|---|---|---|---|---|
| Age, years mean±SD | 53.1±9.3 | 48.2±9.5 | 47.2±9.2 | 46.7±7.7 |
| Sex N (%) | | | | |
| Male | 372 (68.3) | 510 (92.1) | 104 (72.2) | 333 (83.5) |
| Female | 167 (30.6) | 42 (7.6) | 38 (26.4) | 59 (14.8) |
| Cancer patients seen annually, median (IQR) | 10 (2-100) | 70 (20-200) | 30 (15-50) | 100 (35-200) |
| Cancer patients with pain seen annually, median (IQR) | 10 (2-55) | 3 (0-10) | 20 (9.25-40) | 10 (5-25) |
| Cancer patients who died annually, median (IQR) | 3 (0-20) | - | 20 (8.75-40) | 10 (4-15) |
| Other specialties N (%) | | | | |
| Internal medicine | 12 (2.2) | 22 (4.0) | 65 (45.1) | 85 (21.3) |
| Surgery | 2 (0.4) | 3 (0.5) | 11 (7.6) | 149 (37.3) |
| Anesthesiology | 463 (85.0) | 1 (0.2) | 5 (3.5) | 0 (0) |
| Family practice | 7 (1.3) | 3 (0.5) | 46 (31.9) | 2 (0.5) |
| Oncology | 1 (0.2) | 0 (0) | 0 (0) | 15 (3.8) |
| Radiology | 1 (0.2) | 503 (90.8) | 1 (0.7) | 20 (5.0) |
| Palliative medicine | 112 (20.6) | 0 (0) | 17 (11.8) | 5 (1.3) |
| Working facility N (%) | | | | |
| Designated cancer hospital/university hospital | 324 (59.4) | 374 (67.5) | 9 (6.3) | 224 (56.1) |
| Other | 221 (40.6) | 180 (32.5) | 135 (93.8) | 175 (43.9) |
| Main workplace N (%) | | | | |
| Ward/outpatient clinic | 222 (40.7) | - | - | - |
| Operating room | 294 (53.9) | - | - | - |
| Other | 12 (2.2) | - | - | - |

*IVR* Interventional radiology, *SD* Standard deviation, *IQR* Interquartile range

saddle block, 13.9 and 19.0%; Epi, 3.5 and 6.5%; and IA, 11.1 and 27.1%, respectively (Table 5).

## Discussion

The present results clarified the availability, status of implementation, and factors related to the implementation of interventional procedures for refractory pain in patients with cancer using a nationwide survey completed by specialists.

In the present study, the proportions of PSs who responded that they were able to perform CPN, phenol saddle block, Epi, and IA were 49.5, 55.2, 75.2, and 40.9%, respectively. In the past three years, almost 50% reported that they had not performed Epi; furthermore, most responded that they had not performed the three other procedures. Previous surveys on specialist pain services examined the availability of interventional procedures. In the UK, procedures were available at 24.5% (CPN), 24.5% (intrathecal neurolysis), and 85.8% (spinal analgesia; 22% for EPI only, 18% for IA only, and 45% for both) of facilities [16]. In Japan, procedures were available at 66% (CPN), 67.4% (intrathecal neurolysis), 88.2% (Epi), and 54.2% (IA) of facilities [23]. Thus, many pain specialist facilities provide interventional analgesia for cancer patients; however, PSs had few opportunities to perform these procedures.

Based on a previous Japanese study [15], we estimated that 3.3% of the 373,584 patients who died due to cancer in 2018 (approximately 12,000 patients) may have required interventional procedures for cancer pain management. Our survey revealed that 1,530 interventional procedures were performed annually by 545 PSs. Assuming that the 1,112 PSs that responded to our survey performed interventional procedures at the same frequency as the 545 PSs, the expected annual number of interventional procedures was 3,122, which is markedly less than the estimated demand. Thus, interventional procedures do not appear to be sufficiently utilized.

Factors related to the implementation of interventional procedures warrant further study. Previous studies reported the following barriers to the implementation of specialist pain management, such as neural blockade and neuraxial infusion: the underutilization of specialists [16, 17]; access issues/geographical issues [18, 19]; inter-facility issues [19]; inability to get appointments [20]; need for repeating procedures [20]; cost issues [17, 18, 21]; the short survival of patients following referral to palliative care services [21]; time

**Table 2** Implementation of and preferences for interventional procedures

| | Pain specialists | | | IVR specialists | | |
|---|---|---|---|---|---|---|
| | **N** | **%** | **95% CI** | **N** | **%** | **95% CI** |
| Celiac plexus neurolysis/splanchnic nerve neurolysis | | | | | | |
| Currently performing | | | | | | |
| yes | 270 | 49.5 | 45.3-53.8 | 100 | 18.1 | 14.9-21.5 |
| no | 267 | 49.0 | 44.7-53.3 | 444 | 80.1 | 76.6-83.4 |
| missing | 8 | 1.5 | - | 10 | 1.8 | - |
| Willing to perform in the future | | | | | | |
| willing | 327 | 60.0 | 55.8-64.1 | 278 | 50.2 | 45.9-54.4 |
| not willing | 207 | 38.0 | 33.9-42.2 | 260 | 46.9 | 42.7-51.2 |
| missing | 11 | 2.0 | - | 16 | 2.9 | - |
| Number of implementations in the past 3 years | | | | | | |
| Median (IQR) | 0 (0-3) | | | 0 (0-0) | | |
| 0 | 322 | 59.1 | | 487 | 87.9 | |
| 1-4 | 125 | 22.9 | | 35 | 6.3 | |
| 5-9 | 42 | 7.7 | | 8 | 1.4 | |
| 10-19 | 27 | 5.0 | | 6 | 1.1 | |
| 20-49 | 18 | 3.3 | | 1 | 0.2 | |
| ≥50 | 2 | 0.4 | | 0 | 0 | |
| Subarachnoid neurolytic block for perineal pain (phenol saddle block) | | | | | | |
| Currently performing | | | | | - | |
| yes | 301 | 55.2 | 50.9-59.5 | | | |
| no | 238 | 43.7 | 39.5-48.0 | | | |
| missing | 6 | 1.1 | - | | | |
| Willing to perform in the future | | | | | - | |
| willing | 344 | 63.1 | 58.9-67.2 | | | |
| not willing | 193 | 35.4 | 31.4-39.6 | | | |
| missing | 8 | 1.5 | - | | | |
| Number of implementations in the past 3 years | | | | | | |
| Median (IQR) | 0 (0-1) | | | | | |
| 0 | 342 | 62.8 | | | - | |
| 1-4 | 150 | 27.5 | | | - | |
| 5-9 | 24 | 4.4 | | | - | |
| 10-19 | 16 | 2.9 | | | - | |
| 20-49 | 4 | 0.7 | | | - | |
| ≥50 | 0 | 0 | | | - | |
| Epidural infusions of local anesthetic combined with opioids | | | | | | |
| Currently performing | | | | | - | |
| yes | 410 | 75.2 | 71.4-78.8 | | | |
| no | 107 | 19.6 | 16.4-23.2 | | | |
| missing | 28 | 5.1 | - | | | |
| Willing to perform in the future | | | | | - | |
| willing | 369 | 67.7 | 63.6-71.6 | | | |
| not willing | 151 | 27.7 | 24.0-31.7 | | | |
| missing | 25 | 4.6 | - | | | |
| Number of implementations in the past 3 years | | | | | | |
| Median (IQR) | 0 (0-3) | | | | | |
| 0 | 259 | 47.5 | | | - | |
| 1-4 | 144 | 26.4 | | | - | |
| 5-9 | 43 | 7.9 | | | - | |

**Table 2** (continued)

| | Pain specialists | | | IVR specialists | | |
|---|---|---|---|---|---|---|
| | N | % | 95% CI | N | % | 95% CI |
| 10-19 | 45 | 8.3 | | | - | |
| 20-49 | 22 | 4.0 | | | - | |
| ≥50 | 3 | 0.6 | | | - | |
| Intrathecal analgesia | | | | | | |
| Currently performing | | | | | - | |
| yes | 223 | 40.9 | 36.8-45.2 | | | |
| no | 321 | 58.9 | 54.6-63.1 | | | |
| missing | 1 | 0.2 | - | | | |
| Willing to perform in the future | | | | | - | |
| willing | 301 | 55.2 | 50.9-59.5 | | | |
| not willing | 240 | 44.0 | 39.8-48.3 | | | |
| missing | 4 | 0.7 | - | | | |
| Number of implementations in the past 3 years | | | | | | |
| Median (IQR) | 0 (0-0) | | | | | |
| 0 | 435 | 79.8 | | | - | |
| 1-4 | 81 | 14.9 | | | - | |
| 5-9 | 10 | 1.8 | | | - | |
| 10-19 | 9 | 1.7 | | | - | |
| 20-49 | 2 | 0.4 | | | - | |
| ≥50 | 2 | 0.4 | | | - | |

*IVR* Interventional radiology, *IQR* Interquartile range, *CI* Confidence interval

on the part of the specialist for evaluation and discussion [16, 21]; complexity [21]; continuity issues, such as the handling of pumps and catheters, creating a pump, procurement of drugs, and management at home [21]; the inexperience of palliative care physicians [18]; perception issues among palliative care physicians (interest or lack of awareness of potential benefits) [18, 21]; and the lack of training for specialists [21]. In the present study, the number of cancer patients with pain seen annually, difficulty in gaining experience, lack of time, and lack of institutional acceptance were associated with the implementation of procedures, with the first three factors being consistent with previously reported associated factors (involvement of specialists in palliative care [16], time on the part of the specialist for evaluation and discussion [16], and the lack of training for specialists [21]). These factors are important because the results of the present study support previous findings.

The following measures may increase the number of interventional procedures being performed. First, in the present survey, the number of cancer patients with pain seen annually (contributing factor) and difficulty in gaining experience and acquiring skills due to the limited number of cases (barrier) were identified as factors related to implementation. Moreover, previous studies reported the lack of training of experts as a barrier to implementation [21]. Thus, PSs need to increase their experience treating such patients. To increase the experience of PSs, several strategies may be effective, including further specialization for the treatment of cancer pain, a region-wide networking system for identifying potential candidates for interventional procedures, and establishing designated teaching facilities. Second, the effective use of time by PSs to practice palliative medicine may increase the implementation of procedures. In the present study, lack of time was associated with the implementation of two procedures: CPN and phenol saddle block. Moreover, increasing the time spent in palliative medicine practice may compensate for lack of experience. In a 2007 survey of lead anesthetists in UK pain clinics [16], joint consulting arrangements were rare, and only 25% of anesthetists' job plans had time allocated for palliative medicine referrals; however, there was a positive correlation with the number of referrals. Therefore, promoting opportunities for PSs to be involved in palliative medicine may, in turn, increase the number of interventional procedures performed. Third, efforts are needed to educate palliative care physicians who will serve as bridges. The present survey of HHPs and oncologists revealed that they had knowledge of the implementation of procedures, but no experience or may not be

**Table 3** Factors related to the implementation of procedures by pain specialists (univariate analysis)

| Variables | Celiac plexus neurolysis/splanchnic nerve neurolysis | | | Phenol saddle block | | | Epidural infusions of local anesthetic combined with opioids | | | Intrathecal analgesia | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Currently implementing | Not currently implementing | *p*-value | Currently implementing | Not currently implementing | *p*-value | Currently implementing | Not currently implementing | *p*-value | Currently implementing | Not currently implementing | *p*-value |
| **Background** | | | | | | | | | | | | |
| Age N (%) | | | | | | | | | | | | |
| -39 | 19 (47.5) | 21 (52.5) | 0.526 | 24 (58.5) | 17 (41.5) | 0.933 | 33 (86.8) | 5 (13.2) | 0.426 | 17 (41.5) | 24 (58.5) | 0.915 |
| 40-59 | 173 (49.4) | 177 (50.6) | | 196 (55.7) | 156 (44.3) | | 269 (79.4) | 70 (20.6) | | 143 (40.4) | 211 (59.6) | |
| ≥60 | 75 (54.7) | 62 (45.3) | | 77 (56.6) | 59 (43.4) | | 101 (77.1) | 30 (22.9) | | 59 (42.4) | 80 (57.6) | |
| Sex N (%) | | | | | | | | | | | | |
| Male | 196 (53.4) | 171 (46.6) | 0.043* | 211 (57.5) | 156 (42.5) | 0.274 | 279 (79.5) | 72 (20.5) | 0.875 | 155 (41.8) | 216 (58.2) | 0.622 |
| Female | 72 (43.9) | 92 (56.1) | | 87 (52.4) | 79 (47.6) | | 127 (78.9) | 34 (21.1) | | 66 (39.5) | 101 (60.5) | |
| Number of cancer patients with pain treated annually N (%) | | | | | | | | | | | | |
| 0 | 14 (16.7) | 70 (83.3) | <0.001* | 18 (21.4) | 66 (78.6) | <0.001* | 42 (50.6) | 41 (49.4) | <0.001* | 14(16.7) | 70 (83.3) | <0.001* |
| 1-9 | 74 (44.8) | 91 (55.2) | | 86 (52.4) | 78 (47.6) | | 132 (84.1) | 25 (15.9) | | 59(35.3) | 108 (64.7) | |
| 10-49 | 79 (64.2) | 44 (35.8) | | 85 (68.5) | 39 (31.5) | | 106 (87.6) | 15 (12.4) | | 70(56.0) | 55 (44.0) | |
| ≥50 | 98 (67.6) | 47 (32.4) | | 102 (69.4) | 45 (30.6) | | 117 (84.8) | 21 (15.2) | | 73(49.3) | 75 (50.7) | |
| Working facility N (%) | | | | | | | | | | | | |
| Designated cancer hospital/ university hospital | 176 (55.2) | 143 (44.8) | 0.006* | 196 (60.9) | 126 (39.1) | 0.004* | 249 (80.8) | 59 (19.2) | 0.294 | 137 (42.3) | 187 (57.7) | 0.457 |
| Other | 94 (43.1) | 124 (56.9) | | 105 (48.4) | 112 (51.6) | | 161 (77.0) | 48 (23.0) | | 86 (39.1) | 134 (60.9) | |
| Main workplace N (%) | | | | | | | | | | | | |
| Ward/outpatient clinic | 143 (65.0) | 77 (35.0) | <0.001* | 140 (63.3) | 81 (36.7) | 0.015* | 170 (82.9) | 35 (17.1) | 0.016* | 110 (49.5) | 112 (50.5) | 0.004* |
| Operating room | 114 (39.3) | 176 (60.7) | | 147 (50.7) | 143 (49.3) | | 222 (77.9) | 63 (22.1) | | 103 (35.0) | 191 (65.0) | |
| Other | 4 (36.4) | 7 (63.6) | | 6 (50.0) | 6 (50.0) | | 6 (50.0) | 6 (50.0) | | 5 (41.7) | 7 (58.3) | |
| **Barriers** | | | | | | | | | | | | |
| Difficult to gain experience and acquire skills due to the limited number of cases N (%) | | | | | | | | | | | | |
| Agree | 109 (38.0) | 178 (62.0) | <0.001* | 68 (36.2) | 120 (63.8) | <0.001* | 17 (47.2) | 19 (52.8) | <0.001* | 43 (25.0) | 129 (75.0) | <0.001* |
| Other | 160 (65.6) | 84 (34.4) | | 232 (67.2) | 113 (32.8) | | 391 (82.1) | 85 (17.9) | | 176 (48.6) | 186 (51.4) | |
| Difficult to treat patients who require the procedure due to a lack of time N (%) | | | | | | | | | | | | |
| Agree | 39 (28.3) | 99 (71.7) | <0.001* | 25 (25.3) | 74 (74.7) | <0.001* | 38 (55.9) | 30 (44.1) | <0.001* | 22 (22.7) | 75 (77.3) | <0.001* |
| Other | 229 (58.4) | 163 (41.6) | | 275 (63.2) | 160 (36.8) | | 369 (83.5) | 73 (16.5) | | 199 (45.4) | 239 (54.6) | |
| Difficult to communicate with other departments when implementing the procedure N (%) | | | | | | | | | | | | |
| Agree | 27 (38.6) | 43 (61.4) | <0.001* | 17 (32.1) | 36 (67.9) | <0.001* | 22 (56.4) | 17 (43.6) | <0.001* | 18 (26.1) | 51 (73.9) | 0.006* |
| Other | 242 (52.5) | 219 (47.5) | | 284 (59.0) | 197 (41.0) | | 385 (81.6) | 87 (18.4) | | 203 (43.4) | 265 (56.6) | |

**Table 3** (continued)

| Variables | Celiac plexus neurolysis/splanchnic nerve neurolysis | | | Phenol saddle block | | | Epidural infusions of local anesthetic combined with opioids | | | Intrathecal analgesia | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Currently implementing | Not currently implementing | *p*-value | Currently implementing | Not currently implementing | *p*-value | Currently implementing | Not currently implementing | *p*-value | Currently implementing | Not currently implementing | *p*-value |
| Implementation at our facility is not permitted N (%) | | | | | | | | | | | | |
| Agree | 6 (16.7) | 30 (83.3) | <0.001* | 7 (17.1) | 34 (82.9) | <0.001* | 7 (38.9) | 11 (61.1) | <0.001* | 3 (6.8) | 41 (93.2) | <0.001* |
| Other | 261 (53.3) | 229 (46.7) | | 292 (49.5) | 298 (50.5) | | 400 (81.1) | 93 (18.9) | | 218 (44.3) | 274 (55.7) | |
| Dispensing and using phenol glycerin are not permitted by the Ethics Committee or Regulatory Committee in our facility N (%) | | | | | | | | | | | | |
| Agree | - | - | | 43 (40.2) | 64 (59.8) | <0.001* | - | - | | - | - | |
| Other | - | - | | 255 (60.3) | 168 (39.7) | | - | - | | - | - | |
| The facilities to which patients may be referred after implementation are limited N (%) | | | | | | | | | | | | |
| Agree | - | - | | - | - | | - | - | | 105 (39.6) | 160 (60.4) | 0.446 |
| Other | - | - | | - | - | | - | - | | 117 (42.9) | 156 (57.1) | |

*significantly different

**Table 4** Factors related to the implementation of procedures by pain specialists (multivariate analysis)

| | Celiac plexus neurolysis/splanchnic nerve neurolysis | | | Phenol saddle block | | | Epidural infusions of local anesthetic combined with opioids | | | Intrathecal analgesia | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **OR** | **95% CI** | ***p*-value** | **OR** | **95% CI** | ***p*-value** | **OR** | **95% CI** | ***p*-value** | **OR** | **95% CI** | ***p*-value** |
| **Background** | | | | | | | | | | | | |
| Sex | | | | | | | | | | | | |
| Male | REFERENCE | | 0.066 | - | | - | - | | - | - | | - |
| Female | 0.658 | 0.42-1.03 | | - | - | | - | - | | - | - | |
| Number of cancer patients with pain treated annually | | | | | | | | | | | | |
| 0 | REFERENCE | | <0.001* | REFERENCE | | <0.001* | REFERENCE | | <0.001* | REFERENCE | | <0.001* |
| 1-9 | 3.72 | 1.84-7.51 | | 4.14 | 2.15-7.97 | | 4.94 | 2.54-9.60 | | 2.74 | 1.38-5.44 | |
| 10-49 | 5.92 | 2.84-12.32 | | 7.03 | 3.47-14.23 | | 5.65 | 2.71-11.82 | | 6.09 | 2.99-12.41 | |
| ≥50 | 5.77 | 2.68-12.42 | | 8.02 | 3.80-16.92 | | 5.13 | 2.38-11.08 | | 4.11 | 1.98-8.52 | |
| Working facility | | | | | | | | | | | | |
| Designated cancer hospital/ university hospital | REFERENCE | | 0.599 | REFERENCE | | 0.04* | - | | - | - | | - |
| Other | 1.12 | 0.73-1.74 | | 1.58 | 1.02-2.43 | | - | - | | - | - | |
| Main workplace | | | | | | | | | | | | |
| Ward/outpatient clinic | REFERENCE | | 0.035* | REFERENCE | | 0.959 | REFERENCE | | 0.199 | REFERENCE | | 0.387 |
| Operating room | 0.57 | 0.36-0.90 | | 1.05 | 0.65-1.70 | | 1.12 | 0.62-2.02 | | 0.77 | 0.50-1.20 | |
| Other | 0.37 | 0.09-1.49 | | 1.18 | 0.31-4.49 | | 0.34 | 0.09-1.28 | | 1.51 | 0.35-6.49 | |
| **Barriers** | | | | | | | | | | | | |
| Difficult to gain experience and acquire skills due to the limited number of cases | | | | | | | | | | | | |
| Agree | REFERENCE | | <0.001* | REFERENCE | | <0.001* | REFERENCE | | 0.006* | REFERENCE | | <0.001* |
| Other | 2.67 | 1.76-4.05 | | 2.71 | 1.72-4.27 | | 3.29 | 1.41-7.66 | | 2.31 | 1.47-3.63 | |
| Difficult to treat patients who require the procedure due to a lack of time | | | | | | | | | | | | |
| Agree | REFERENCE | | 0.004* | REFERENCE | | 0.01* | REFERENCE | | 0.139 | REFERENCE | | 0.318 |
| Other | 2.13 | 1.28-3.55 | | 2.22 | 1.21-4.10 | | 1.74 | 0.84-3.63 | | 1.37 | 0.740-2.54 | |
| Difficult to communicate with other departments when implementing the procedure | | | | | | | | | | | | |
| Agree | REFERENCE | | 0.455 | REFERENCE | | 0.956 | REFERENCE | | 0.343 | REFERENCE | | 0.96 |
| Other | 0.77 | 0.39-1.52 | | 0.98 | 0.43-2.24 | | 1.62 | 0.60-4.38 | | 0.98 | 0.48-2.01 | |
| Implementation at our facility is not permitted | | | | | | | | | | | | |
| Agree | REFERENCE | | 0.009* | REFERENCE | | 0.002* | REFERENCE | | 0.193 | REFERENCE | | 0.001* |
| Other | 4.20 | 1.44-12.25 | | 5.53 | 1.84-16.63 | | 2.38 | 0.64-8.79 | | 7.77 | 2.22-27.11 | |
| Dispensing and using phenol glycerin are not permitted by the Ethics Committee or Regulatory Committee in our facility | | | | | | | | | | | | |
| Agree | - | - | | REFERENCE | | 0.402 | - | | - | - | | - |
| Other | - | - | | 1.28 | 0.72-2.25 | | - | - | | - | - | |

*OR* Odds ratio, *CI* Confidence interval; * significantly different

**Table 5** Number of home hospice physicians and oncologists who responded that they did not know interventional procedures

| | Home hospice physicians (*N*=144) | | | Oncologists (*N*=399) | | |
|---|---|---|---|---|---|---|
| | N | % | 95% CI | N | % | 95% CI |
| Celiac plexus neurolysis/splanchnic nerve neurolysis | 11 | 7.6 | 3.9-13.3 | 52 | 13.0 | 3.9-13.3 |
| Subarachnoid neurolytic block for perineal pain (phenol saddle block) | 20 | 13.9 | 8.7-20.6 | 76 | 19.0 | 15.3-23.3 |
| Epidural infusions of local anesthetic combined with opioids | 5 | 3.5 | 1.1-7.9 | 26 | 6.5 | 4.3-9.4 |
| Intrathecal analgesia | 16 | 11.1 | 6.5-17.4 | 108 | 27.1 | 22.8-31.7 |

*CI* Confidence interval

able to refer patients to specialists. Palliative care physicians need to act as a bridge to connect patients to specialists who perform these procedures. Previous studies also reported a lack of experience and awareness among palliative care physicians [18, 21]; thus, further education and awareness on indications for and effects of interventional therapies among palliative care physicians are needed. Fourth, the education of IVR specialists may be important for promoting the implementation of CPN because even though many IVR specialists responded that they are willing to perform CPN, actual implementation rates were low.

Since there are few evidence-based interventional procedures, it may be difficult for specialists to provide a rationale for the procedure; furthermore, palliative care physicians who act as bridges may not be able to propose a procedure with confidence and obtain approval from institutions. Further studies to evaluate the efficacy of these interventional procedures are needed.

### Limitations

There are several limitations to the present study. First, although the status of implementation by specialists nationwide was surveyed, we did not obtain information on the implementation status of each facility. A survey of facilities, including designated cancer hospitals, hospitals without designated cancer departments, and home hospices is warranted to obtain more detailed data on interventional procedures for cancer pain management. Second, the valid response rate for each expert, which ranged between 46.8 and 51.5%, may not reflect the overall situation. However, the response rate was sufficient for a survey of individual experts. Third, as Japan has a universal health insurance system, no restrictions on access to medical facilities, and a small geographical area, we considered it unnecessary to ask about geographical distance and cost issues.

## Conclusion

PSs surveyed in the present study responded that they implement each of the four procedures to treat patients with cancer pain; however, the actual number appears to be limited and may not meet demands. It is important to take measures to ensure that PSs and IVR physicians are sufficiently utilized to manage refractory cancer pain.

#### Abbreviations

CPN: Celiac plexus neurolysis/splanchnic nerve neurolysis; PSs: Pain specialists; IVR: Interventional radiology; HHPs: Home hospice physicians; Epi: Epidural infusions of local anesthetic combined with opioids; IA: Intrathecal analgesia.

#### Acknowledgements

We would like to express our gratitude to Dr. Masashi Kato for providing insightful comments and suggestions.

#### Authors' contributions

YU, YM, TM, and ES were responsible for the conception and design of the study. YU, YM, and AM were involved in the preparation of the questionnaire and were responsible for drafting of the manuscript. All authors reviewed and made critical revisions to the manuscript. MM, TM, and TY supervised the study.

#### Funding

The present study was funded by the Ministry of Health, Labour and Welfare (Grant Number 19EA1011).

#### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Declarations

#### Ethics approval and consent to participate

The study was approved by the Institutional Review Board of the National Cancer Center, Japan (6000-021). Formal approval of the study protocol by an ethics committee was not required according to the Japanese national policies. All procedures were performed in accordance with the Declaration of Helsinki. We enclosed a letter explaining the purpose of the survey and explained that responses were voluntary. If the survey was filled out and returned, it was considered as consent.

#### Consent for publication

Not applicable.

#### Competing interests

The authors declare that they have no competing interests.

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Received: 16 August 2021 Accepted: 15 September 2022
Published online: 26 September 2022

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## Publisher's Note