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ORIGINAL RESEARCH

Clinical Utility of Integrated Multidisciplinary Patient-Centered Information in Breast Cancer Care: A Mixed Methods Study

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Purpose: The purpose of this study was to evaluate and assess the clinical utility of the integrated multidisciplinary patient-centered information (PCI) written by various healthcare professionals for promoting patient-centered care in the treatment and care of breast cancer patients.

Methods: This study employed a convergent mixed methods interventional design in which Control and Intervention were compared by integrating both quantitative and qualitative results obtained from questionnaires and verbatim transcripts. In three breast cancer cases, a multidisciplinary team meeting (MDTM) using a conventional electronic health record (EHR) viewer was designated Control, and a MDTM using a conventional EHR viewer plus the integrated multidisciplinary PCI was designated Intervention. Questionnaires, which consisted of questions about efficiency and patient-centeredness employing a 5-point Likert scale, were analyzed statistically using Wilcoxon rank test and summary statistics. Verbatim transcripts were analyzed using a thematic analysis hybrid approach.

Results: Three surgical oncologists and three nurses (ward, outpatient chemotherapy, and palliative care) participated in the MDTMs for both Control and Intervention. The quantitative data suggested that there were statistically significant differences between Control and Intervention ($p<0.05$), with Intervention superior to Control from the viewpoints of efficiency and patient-centeredness. The qualitative data suggested that the MDTM for Intervention involved more PCI and promoted shared understanding from early in the meeting. Synthesis of both the quantitative and qualitative results suggested that use of the integrated multidisciplinary PCI in MDTMs may facilitate the utilization of PCI and lead to more efficient and patient-centered discussions and decision-making to promote patient-centered care.

Conclusion: Integrating the PCI obtained from medical records of various healthcare specialists already documented in the hospital information system could prove to be helpful for supporting MDTMs and routine clinical practice without placing an additional burden on busy healthcare professionals while also promoting the digital transformation of healthcare.

Keywords: breast cancer multidisciplinary team, patient-centered care, patient preferences, psychosocial information

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Introduction

Patient-centered care is considered an essential component in improving the quality of care.[1] This approach coordinates and provides integrated treatment and care that considers research evidence, patients' clinical status and circumstances, and also respects patients' values, preferences, expressed needs, and social contexts (patient-centered information, PCI).[1–4] A multidisciplinary team approach is adopted to implement patient-centered care in oncology practice, especially the treatment and care of breast cancer patients.[3,5,6] Breast cancer treatments and care include a variety of reasonable options, such as breast-conserving treatment and mastectomy in early-stage surgery, systemic treatments administered orally, intravenously, or subcutaneously, and so on.[7–10] In addition, the number of new cases is one of the highest of all cancers, the 5-year survival rate exceeds 80% in many countries, and the time from diagnosis to treatment

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and care is relatively long.[11,12] Holistic interventions and supportive care tailored to each patient's circumstances and preferences should be considered for reducing the physical and psychosocial distress caused by surgery and the side effects of pharmacotherapy such as endocrine therapy, which can continue for 5–10 years after surgery.[13–16] Bringing all these considerations together for individual patients requires a wide range of clinical expertise,[4,17] and multidisciplinary team meetings (MDTMs) therefore play an important role in the patient-centered care of breast cancer patients.[18,19] The use of PCI is also known to improve the effectiveness and quality of MDTMs.[18,20–22] However, the use of PCI in MDTMs may be limited or absent because the information is fragmented, scattered across various healthcare professionals' medical records, written from different individual perspectives, and not stored in a standard location.[23–26] As a result, the exchange of such information in MDTMs is currently limited.[26–28] A lack of PCI is known to lead to inappropriate recommendations and is the main reason that multidisciplinary team (MDT) decisions are not implemented.[22,29,30] Moreover, MDTMs are considered demanding, expensive, and time-consuming due to excessive caseloads and the need for multiple healthcare specialists to attend and prepare beforehand.[30–33] It is also becoming increasingly difficult for multiple healthcare specialists to attend MDTMs at the same time due to workforce shortages throughout the field of clinical oncology.[34] Using the PCI that already exists in the hospital information system (HIS) could promote the utilization of PCI in MDTMs and lead to more patient-centered care without placing additional workload on busy healthcare professionals.

To promote patient-centered care in breast cancer management, potential facilitators of the use of PCI should be determined.

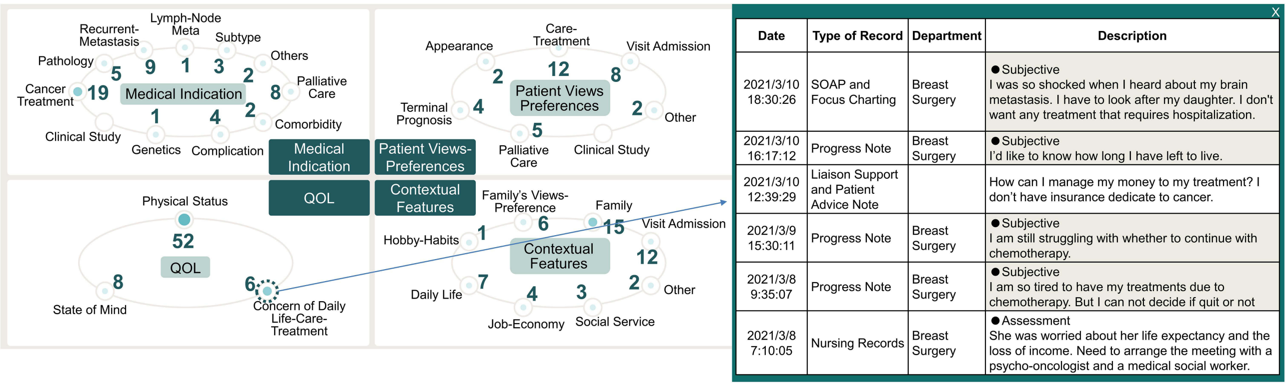
Few studies have examined how the integrated PCI of various healthcare professionals involved with breast cancer patients throughout their pathway can be employed in MDTMs and clinical decision-making.

The aim of this mixed methods study was to evaluate and assess "efficiency" and "patient-centeredness" as measures of the clinical utility of the PCI collected and retrieved from multidisciplinary healthcare professionals' medical records.

Methods

Design

The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist and Standards for Reporting Qualitative Research (SRQR) items were followed to ensure reporting rigor.[35,36] A mixed methods approach was employed, and both quantitative and qualitative data were collected, analyzed, and integrated to combine the strengths of both datasets.[37] In this convergent mixed methods interventional design, both quantitative and qualitative data derived from questionnaires and verbatim transcripts were integrated and compared between Control and Intervention. Two simulated multidisciplinary team meetings (MDTMs) were held with the same participants, the same cases, and the same discussion topics. These two MDTMs were held with different equipment conditions and at different times, with a 3-month interval between meetings to reduce recall bias. One MDTM which was conducted using a conventional electronic health record (EHR) viewer was designated Control, and the other MDTM which was conducted using a conventional EHR viewer plus the integrated multidisciplinary healthcare professionals' medical records which we prototyped (hereinafter referred to as "the prototype") was designated Intervention (Figure 1). The quantitative analysis involved comparison of the 5-point Likert scale data obtained by a questionnaire (Questionnaire A). Participants completed this questionnaire at the end of the MDTM for each case. They also completed a second questionnaire consisting of 5-point Likert scale questions and open-ended questions concerning Intervention after the second MDTM (Questionnaire B), which was an explanatory sequential design.[38] The qualitative analysis was based on comparison of verbatim transcripts of the audio recordings made during the MDTMs and the answers to the questionnaire concerning Intervention. The results of the quantitative and qualitative analyses were integrated to evaluate and assess the clinical utility of Intervention, with special efforts made to understand the reasons and context of the evaluation and assessment results. A procedural diagram of the study is shown in Figure 2. First, quantitative data derived from Questionnaire A were compared between Control and Intervention using a non-parametric test (Figure 2 (1)). Second, qualitative data derived from verbatim transcripts were compared between Control and Intervention (Figure 2 (2)). Then, the quantitative analysis results of Questionnaire A and Questionnaire B and the quantitative



Date	Type of Record	Department	Description
2021/3/10 18:30:26	SOAP and Focus Charting	Breast Surgery	● Subjective I was so shocked when I heard about my brain metastasis. I have to look after my daughter. I don't want any treatment that requires hospitalization.
2021/3/10 16:17:12	Progress Note	Breast Surgery	● Subjective I'd like to know how long I have left to live.
2021/3/10 12:39:29	Liaison Support and Patient Advice Note		How can I manage my money to my treatment? I don't have insurance dedicate to cancer.
2021/3/9 15:30:11	Progress Note	Breast Surgery	● Subjective I am still struggling with whether to continue with chemotherapy.
2021/3/8 9:35:07	Progress Note	Breast Surgery	● Subjective I am so tired to have my treatments due to chemotherapy. But I can not decide if quit or not
2021/3/8 7:10:05	Nursing Records	Breast Surgery	● Assessment She was worried about her life expectancy and the loss of income. Need to arrange the meeting with a psycho-oncologist and a medical social worker.

Figure 1 Prototype for integrating multidisciplinary patient-centered information.

Notes: As an example of the prototype's functions, when the Concerns of Daily Life-Care-Treatment tag is selected, the descriptions with that tag are listed along with the date, type of record, and department.

Abbreviations: QOL, quality of life; SOAP, subjective, objective, assessment, and plan.

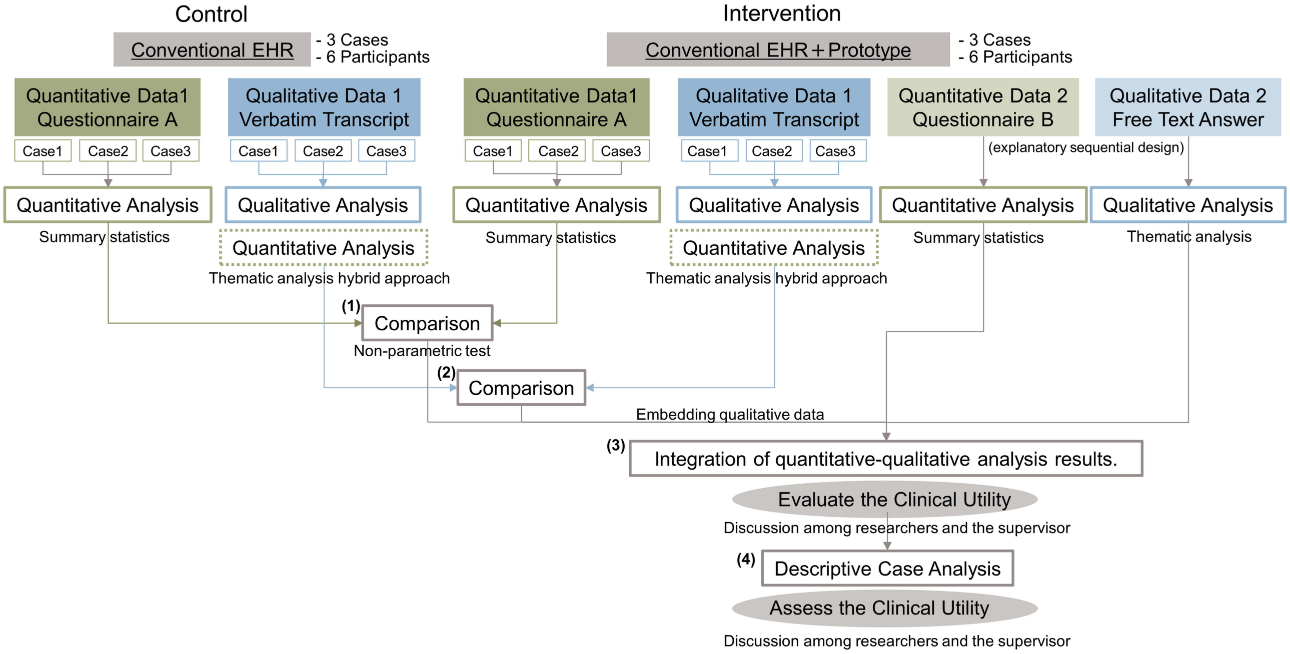


Figure 2 Procedural diagram of the study.

Notes: (1) Comparison of quantitative analysis of Questionnaire A results between Control and Intervention. (2) Comparison of qualitative analysis of verbatim transcripts between Control and Intervention. (3) Integration of both quantitative and qualitative analysis results to evaluate clinical utility. (4) Descriptive case analysis to assess clinical utility.

analysis results of verbatim transcripts and Free text answers were integrated to evaluate clinical utility (Figure 2 (3)). Finally, descriptive case analysis was performed to assess clinical utility (Figure 2 (4)).

This study was approved by The University of Tsukuba Institutional Ethical Review Committee. Informed consent was obtained from all participants. Informed consent was obtained from the patients and all case descriptions have been pseudonymized in the previous study.[23]

Setting

The first MDTM was held using a conventional EHR viewer in January 2024 in a conference room at an academic hospital in Japan, and the second MDTM was held using a conventional EHR viewer plus the prototype 3 months later in April 2024 at the same location. The conference room is a room that is regularly used for MDTMs. Three EHR viewers

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were employed in Control and Intervention. Each participant used their own prototype in Intervention. Physicians and nurses sat facing each other. The researchers observed from a location that minimized visibility to the participants as much as possible. A physician was assigned to the moderator for each case. Each case was discussed for 15 minutes. The audio during MDTMs was recorded.

Participants

Six healthcare professionals at a university hospital in Japan were recruited between December 2023 and January 2024. The principal investigator (HB) recruited physicians and nurses from the Breast-Thyroid-Endocrine Surgery Department and the Nursing Department at the university hospital. Among the physicians and nurses who voluntarily agreed to participate, those who were able to participate in both MDTMs were selected. Three physicians and three nurses who satisfied both of the following eligibility criteria were enrolled in the study.

1. Physicians or nurses who were involved in breast cancer care
2. Physicians or nurses who gave voluntary written informed consent after receiving an explanation of the study

Cases

Data from a pilot study which investigated the feasibility of integrating multidisciplinary medical records employing purposeful sampling was used for secondary analysis.[23] Patients who visited the department of breast surgery at a university hospital in Japan between January 2018 and June 2022 and who satisfied either of the following eligibility criteria were enrolled (Table 1).

1. Patients with breast cancer who underwent surgery and received pharmacotherapy
2. Patients with advanced metastatic breast cancer who received pharmacotherapy

The reason for these eligibility criteria was that a variety of healthcare professionals would be involved with the patients if they received at least pharmacotherapy or surgery.

Twenty types of medical records for the three cases from various healthcare professionals such as physicians, nurses, and allied healthcare professionals (AHPs) were aggregated and pseudonymized (Supplementary Table 1). All pseudonymized data were annotated using the tag-sets that were identified in the previous study using a thematic analysis hybrid approach (Supplementary Figure 1).[6] The tag-sets consisted of 54 items in 4 categories, which were *Medical Indications, Patient Views and Preferences, Contextual Features*, and *Quality of Life*, referring to Jonsen's Four Topics Chart (Supplementary Table 2).[39] *Quality of Life* was divided into three subcategories, which were *Physical Status, Concerns of Daily Life-Care-Treatment*, and *State of Mind*, obtained by the inductive analysis.[23]

Table 1 Overview of the Patients (N=3)

Category	Case 1	Case 2	Case 3
Sex	Female	Female	Female
Age at cancer diagnosis	40s	40s	40s
Stage	Stage II	Stage III	Stage IV
Data duration	1 year	10 years	9 years
Treatment summary	Neoadjuvant therapy, surgery, adjuvant therapy, hormone therapy, and radiotherapy as primary treatment. Treatment ongoing.	Neoadjuvant therapy, surgery, adjuvant therapy, and radiotherapy as both primary and metastasis treatment. Deceased.	Chemotherapy, hormone therapy, and radiotherapy as metastasis treatment. Deceased.

Notes: These cases were selected for the pilot study. They were then used for secondary analysis.[23]

Intervention

In the second MDTM, the participants used the prototype in addition to a conventional EHR viewer. The prototype was used to integrate the multidisciplinary healthcare professionals' medical records and to display a list of descriptions when a tag of interest was selected on a desktop computer (Figure 1). Each participant used one prototype. They received instructions on how to use the prototype for 10 minutes before the start of the second MDTM. As in the first MDTM (Control), participants discussed the set topics for each of the three cases. Each participant used the three EHR viewers and their own prototypes as much as they desired during the discussions.

Measures and Data Collection

Measures

The items "efficiency" and "patient-centeredness" were used to evaluates and assess clinical utility in this study. These two items correspond to the key dimensions "efficient" and "patient-centered" for the healthcare system described in *Crossing the Quality Chasm: A New Health System for the 21st Century* (2001).[1] The questions related to efficiency were based on Donabedian's model, consisting of structure, process, and outcome, while the questions related to patient-centeredness were based on the conceptual framework for the dimensions of patient-centered care described by Gerteis et al (1993).[2,40] First, one researcher extracted sentences from chapters 2 and 3 of *Crossing the Quality Chasm: A New Health System for the 21st Century* (2001) that were considered important for efficiency and patient-centeredness and mapped them onto the efficiency framework (structure, process, and outcome) and the patient-centeredness framework.[1,2,40] The three researchers then reviewed and revised the mapped sentences. Next, the three researchers developed questions to incorporate each framework element, which were finalized after review by the supervisor.

Questionnaire

Questionnaire A consisted of 10 questions related to efficiency and 13 questions related to patient-centeredness to be answered on a five-point Likert scale: disagree, slightly disagree, neutral, slightly agree, and agree (Supplementary Figure 2). Questionnaire B, which focused on Intervention, consisted of 8 questions related to efficiency and 7 questions related to patient-centeredness to be answered on a five-point Likert scale (Supplementary Figure 3) and 2 questions each related to efficiency and patient-centeredness to be answered as free text (Supplementary Figure 4).

Data Collection

All participants completed Questionnaire A after attending the MDTM for each case. They also completed Questionnaire B only after attending the second MDTMs of all cases.

The purpose, data duration, timing, and topics were set for each case's MDTM. Case 1 focused on treatment and care support, taking into consideration the patient characteristics. Case 2 focused on advanced care planning when the disease was exacerbated by distant metastasis. Case 3 focused on advanced care planning in the terminal phase. The details of each case's MDTM are shown in Supplementary Table 3.

Two researchers created verbatim transcripts of the audio recordings made during the MDTMs and performed consensus reading to ensure accuracy. The transcripts were anonymized.

Data Analysis

Quantitative Analysis

Questionnaire analysis was performed using a Likert scale as an ordinal scale: disagree (1 point), slightly disagree (2 points), neutral (3 points), slightly agree (4 points), and agree (5 points). Summary statistics were calculated and nonparametric tests (Brunner-Munzel test for comparison of unpaired groups, Wilcoxon rank test for comparison of paired groups) were used to test for differences between Control and Intervention. Statistical analysis was performed using Python 3.11.5 and SciPy 1.10.0.

Qualitative Analysis

The verbatim transcripts were analyzed and compared between Control and Intervention both quantitatively and qualitatively for each case. All verbatim transcripts were analyzed using a thematic analysis hybrid approach which

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incorporated both a deductive a priori template of codes (tags) approach and a data-driven inductive approach.[40,41] The procedure for qualitative analysis of the verbatim transcripts was as follows (Supplementary Figure 5). Three researchers (AS, KU, KF) annotated the transcripts individually for a priori template analysis using Jonsen's Four Topics Chart.[39,42] They then conducted consensus reading to establish the results of the deductive analysis for each case.[43] A data-driven inductive thematic analysis was also applied to Case 1. Case 2 was analyzed using Case 1's code book, and the code book (second code book) was revised. Case 3 was analyzed using the second code book and revised to create the third code book. The three researchers mutually reviewed and revised the deductive and inductive results. These processes were applied to both the Control and Intervention transcripts individually. The Control and Intervention code books were then mutually reviewed and revised, after which they were compared both quantitatively and qualitatively. The free text obtained from Questionnaire B was analyzed using thematic analysis.[44] The coder (first author) met regularly with the other researchers to discuss the tentative output during the iterative coding process, and a final meeting was held to finalize the code results to ensure methodological rigor.

There is no standard definition of patient-centered care or patient-centered information. We therefore defined patient-centered information as *Patient Views and Preferences, Contextual Features, Concerns of Daily Life-Care-Treatment*, and *State of Mind*, which affect decision-making or recommendations from various psychosocial aspects, while *Medical Indications* and *Physical Status* designate biomedical information.

Integration of the Datasets

The results of the quantitative and qualitative analyses were integrated using joint displays and then evaluated and assessed to determine whether and why Intervention was or was not useful in terms of clinical utility.[43]

Results

Participant Overview

Table 2 shows an overview of the participants. This study involved three surgical oncologists and three nurses (ward, outpatient chemotherapy, and palliative care) working at an academic hospital in Japan.

Quantitative Results

Questionnaire A: The quantitative data showed that Intervention was rated higher than Control for all questions, both those related to efficiency and those related to patient-centeredness. The differences were statistically significant ($p<0.05$) (Table 3). Internal consistency was calculated based on Cronbach's alpha using a statistical package Pingouin of Python (efficiency: 0.81, patient-centeredness: 0.80).

Questionnaire B on a five-point Likert scale: The participants expressed a preference for Intervention (Figure 3). Internal consistency was calculated based on Cronbach's alpha using a statistical package Pingouin of Python (efficiency: 0.91, patient-centeredness: 0.95).

Table 2 Overview of the Participants (N=6)

Occupation	Specialty	Sex	Experience (years)
Physician	Surgical oncologist	Female	15
	Surgical oncologist	Female	7
	Surgical oncologist	Female	5
Nurse	Ward	Female	15
	Outpatient chemotherapy	Female	15
	Palliative care	Male	13

Table 3 Comparison of Control and Intervention in Questionnaire A

	Control		Intervention		*p*-value
	M	**SD**	**M**	**SD**	
All questions	3	1.0	4	1.0	<0.001
Questions on efficiency	3	0.9	4	1.0	<0.001
Questions on patient-centeredness	3	0.7	4	0.5	<0.001

Notes: A Likert scale was used as an ordinal scale: disagree (1 point), slightly disagree (2 points), neutral (3 points), slightly agree (4 points), and agree (5 points).
Abbreviations: M, median; SD, standard deviation.

Qualitative Results

Verbatim transcripts: The thematic analysis of the verbatim transcripts resulted in a total of 35 items (subthemes) in six categories (themes).[41,42] The frequency of each subtheme in all cases is shown in Supplementary Table 4. Subthemes unique to Control were “supplemental items on treatment” such as the identity of the attending physician and “biomedical characteristics” such as the patient’s gene mutation status. Subthemes unique to Intervention were “economic situation”, “events” such as planning a trip, “personality traits”, “psychiatric symptoms”, and “feelings”. The frequency of the subthemes in the PCI category of the a priori template was 30% for Control and 35% for Intervention as the average of all cases.

All MDTMs were initiated by confirming the medical condition and the history of present illness, after which the discussions followed the order of the set topics.

In Case 1, of the six topics set, two were discussed for Control and all were discussed for Intervention. The total number of agreed contents was 14 for Control and 14 for Intervention. The discussion time, excluding confirmation of the medical condition and the history of present illness and any other topics (such as mutual confirmation of the discussion topics and so on), was 13’14” for Control and 10’53” for Intervention. As a result, the number of agreed contents per minute was 1.1 for Control and 1.3 for Intervention. With regard to “What symptoms of discomfort and distress does the patient have?” which was the first of the set topics, tumor growth, change of the attending physician, and physical pain were considered the patient’s symptoms of discomfort and distress in Control. In Intervention, physical pain, condition, and “She is always thinking about dying” (C1) were considered the patient’s symptoms of discomfort and distress. With regard to “What are the action plans and conclusions of this MDTM?”, there was no discussion in Control. In Intervention, the participants agreed to monitor the patient’s mental state during hospitalization in order to arrange for appropriate consultation and support her acceptance of surgical options (Table 4a).

In Case 2, of the six topics set, all topics were discussed in Control and five topics were discussed in Intervention. The total number of agreed contents was 17 for Control and 23 for Intervention. The discussion time, excluding confirmation

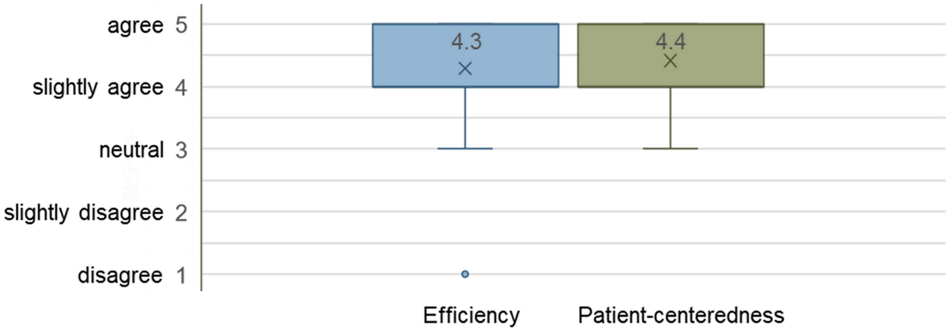

Figure 3 Box plot of the results from Questionnaire B (5-point Likert scale part).
Notes: The blue box plot shows the results for “Efficiency”. The green box plot represents the results for “Patient-centeredness” in Questionnaire B (5-point Likert scale part). The X in the box plot shows the average value.

Table 4 Summary of Qualitative Analysis of the MDTM Verbatim Transcript for Each Case

a. Case 1

		What symptoms of discomfort and distress does the patient have?	What are the patient’s preferences and thoughts on surgery?	Who is the key decision-maker?	What kinds of information should healthcare professionals have as shared understanding?	What kinds of information do the patient and her family need to know?	What are the action plans and conclusions of this MDTM?
Discussion time (number of agreed contents)	Control	6’55” (11)	3’11” (3)	ND	ND	ND	ND
	Intervention	2’11” (5)	2’49” (2)	1’05” (1)	1’32” (2)	0’30” (1)	1’52” (3)
Examples of agreed contents	Control	- Growth of cancer - Change of attending physician - Who will perform surgery - MSK pain	- Mastectomy, but also considering breast-conserving therapy - Breast-conserving therapy would be better (husband) - Hard to decide	ND	ND	ND	ND
	Intervention	- MSK pain - Reduction of body weight - Always thinking about dying	- Also considering breast-conserving therapy - Hard to decide	-Her husband	- Used to thinking about dying - Agonizing over surgical options	- Benefits and harms of the two surgical procedures	- Continue monitoring her mental state during hospitalization - Provide support to perform surgery with her acceptance

b. Case 2

		What symptoms of discomfort and distress does the patient have?	What are the patient’s preferences and thoughts on treatment and care?	Who is the key decision-maker?	What kinds of information should healthcare professionals have as shared understanding?	What kinds of information do the patient and her family need to know?	What are the action plans and conclusions of this MDTM?
Discussion time (number of agreed contents)	Control	2’06” (7)	0’27” (2)	1’41” (1)	1’03”“ (5)	0’07” (0)	4’44” (2)
	Intervention	3’10” (10)	4’13” (5)	2’19” (1)	3’19” (7)	0’06” (0)	ND

Examples of agreed contents	Control	- Numbness - Abdominal pain - Fatigue	- Still deciding - At home as much as possible	- Her daughter who lives with her	- Subsequent plan - Her preference as to where to receive care - Support her preference if she wants to stay at home - Family relationships not bad	NA	- Do ACP in finding brain metastasis -Being devastated
	Intervention	- Being devastated - Getting better - Fatigue	- Dislikes painful or burdensome treatments - Uncertain about what she recognizes as the goal of treatment - Prefers to stay in her home - Does not want to be hospitalized - Spending time with her family is important	- Her daughter who lives with her	- Her thoughts on treatment and care - Her understanding of her prognosis was longer than her actual prognosis - Her family’s understanding was the actual prognosis - Consider the gap in understanding her prognosis - Her daughter’s acceptance is insufficient - How much communication has there been?	NA	ND
c. Case 3 purpose 1							
		What are the patient’s preferences and thoughts on her treatment and care?	Who is the key decision-maker?	What kinds of information should healthcare professionals have as shared understanding?	What kinds of information do the patient and her family need to know?	What are the action plans and conclusions of this MDTM?	
Discussion time (number of agreed contents)	Control	3’08” (1)	3’27” (1)	ND	ND	4’16” (3)	
	Intervention	3’02” (4)	2’18” (1)	1’33” (6)	1’39” (2)	1’05” (0)	

(*Continued*)

Table 4 (Continued).

Examples of agreed contents	Control	- DNAR - BSC	- Her older sister	ND	ND	- Both the patient and her family recognize that they can hardly take care of her at home - Explore one-night stay at home - Consider the cost of her recuperation
	Intervention	- Very picky - Childish - It was not that the patient did not want treatment - Dislikes distressful treatments	- Her older sister	- Her personality - Her preferences and thoughts on treatment - Relationships with her family - Her support networks - Her economic situation - Not possible to recuperate at home	- Available options for her recuperation site - Cost of each option	NA

Notes: This table excludes confirmation of the medical condition and the history of present illness and other discussion such as mutual confirmation of the discussion topics and so on.

Abbreviations: MDTM, multidisciplinary team meeting; ACP, advanced care planning; ND, not discussed; MSK, musculoskeletal; NA, no agreed contents; DNAR, do not attempt resuscitation; BSC, best supportive care.

of the medical condition and the history of present illness and any other topics, was 11’56” for Control and 13’41” for Intervention. As a result, the number of agreed contents per minute was 1.4 for Control and 1.7 for Intervention. With regard to “What symptoms of discomfort and distress does the patient have?”, in Control, physical symptoms were shared and agreed. In Intervention, physical condition and “She was devastated” (C2) were shared and agreed. With regard to “What kinds of information should healthcare professionals have as shared understanding?”, the participants agreed with the subsequent plan, supporting the patient’s preferences in Control. In Intervention, they agreed with the patient’s thoughts on treatment and care: “She dislikes painful or burdensome treatments” (C3). They also recognized and considered the gap in perceptions of her prognosis. With regard to “What are the action plans and conclusions of this MDTM?” which was the last of the set topics, the participants shared and agreed with “She was devastated” (C4) in Control. There was no discussion in Intervention (Table 4b).

In Case 3, of the five topics set for discussion purpose 1 (Supplementary Table 3), three topics were discussed in Control and five topics in Intervention. The total number of agreed contents was 5 for Control and 10 for Intervention. The discussion time, excluding confirmation of the medical condition and the history of present illness and any other topics, was 11’18” for Control and 9’50” for Intervention. As a result, the number of agreed contents per minute was 0.45 for Control and 1.0 for Intervention. Three topics were set for discussion purpose 2. Neither Control nor Intervention discussed purpose 2. With regard to “What are the patient’s preferences and thoughts on her treatment and care?”, the participants agreed with “DNAR (do not attempt resuscitation) and BSC (best supportive care, focusing on palliative care with no further anticancer therapies)” (C5) in Control. In Intervention, they mutually agreed that “it wasn’t that the patient didn’t want treatment, she just didn’t like distressful treatments” (C6). With regard to “What kinds of information should healthcare professionals have as shared understanding?”, there was no discussion in Control. In Intervention, the participants agreed that the patient had a unique personality: “She has a unique personality and has a clear preference for various things (very picky)” (C7) which should be considered during her treatment and care, as included in the first topic. They also reached consensus regarding the patient’s preferences and thoughts on treatment. In addition, they recognized and considered the complexity of her support networks, and her and her family’s economic situations. With regard to “What kinds of information do the patient and her family need to know?”, there was no discussion in Control. In Intervention, the participants agreed that the patient’s family needed to know the available options for her recuperation site as well as the costs. With regard to “What are the action plans and conclusions of this MDTM?”, the participants mutually agreed that both the patient and her family recognized that they could hardly take care of her at home. However, they explored the possibility of a one-night stay at home and the need to consider the cost of her recuperation in Control. There was no discussion in Intervention (Table 4c).

Qualitative analysis of Questionnaire B (free text part): For efficiency, the thematic analysis resulted in three themes: “use scenarios of the prototype”, “effects of the prototype”, and “suggestions for the prototype”.[41] The “effects of the prototype” were further divided into three subthemes: “time”, “understanding”, and “utilization” (Table 5). Most of the participants discussed the clinical scenarios in which they would like to use the prototype. They expressed a desire to use the prototype in a variety of clinical scenarios, such as daily practice, treatment planning, MDTMs, etc. For example, one surgical oncologist commented as follows: “Even when a patient is initially assigned in the emergency room or admitted as an emergency case, understanding the patient’s prior treatment history and thoughts on treatment can lead to greater efficiency in informed consent and decision-making situations, such as determining the appropriate care site, rather than just treatment options”.

Several participants also commented that they would expect to be more efficient in terms of the time needed to gather and share information. One surgical oncologist commented on obtaining a clearer idea of sequential changes in psychosocial information as follows: “It is easy to identify the changes in psychological aspects over time that cannot be expressed by test scores.” One nurse commented on utilization as follows: “Integrated information can help share mutual goal and decide on the best treatment and care from a multidisciplinary point of view.”

For patient-centeredness, the analysis resulted in three themes: “useful”, “useless”, and “how to use” (Table 6). The theme “useful” was divided into two subthemes: “understanding” and “utilization”. One surgical oncologist commented on “useful” as follows: “There are sometimes patients whose emotional expressions and statements differ depending on the particular member of the medical staff, such as doctors, nurses, social workers, and rehabilitation staff. So I think it is very useful to be able to easily grasp the information obtained by staff members involved in other aspects of patient care”.

Table 5 Themes and Short Descriptions for Efficiency in Questionnaire B (Free Text Part)

Theme	Subtheme	Short Description (Occupation)
Use scenarios of the prototype		- Informed consent and decision-making situations such as determining the care site rather than treatment options (Surgical oncologist) - When a patient is initially assigned in the emergency room or admitted as an emergency case (Surgical oncologist) - When treating the patient (Surgical oncologist) - MDTMs (Surgical oncologist, Nurse) - When formulating the subsequent plan (Surgical oncologist) - Daily information gathering (Nurse)
Effects of the prototype	Time	- Improved efficiency of information sharing time in multidisciplinary conferences (Surgical oncologist, Nurse) - Reduction of preparation (information gathering and consolidation) time in MDTMs (Nurse) - Time-consuming to find the required information when a huge amount of information is integrated (Nurse).
	Understanding	- Easy understanding of treatments by other departments (Surgical oncologist) - Understanding of psychological changes over time that could not be expressed by test values (Surgical oncologist)
	Utilization	- Increased shared understanding (Surgical oncologist) - Better planning of subsequent treatment and care (Physician) - Helpful when considering the best treatment and care for the patient from a multidisciplinary viewpoint (Nurse) - Easier to collect information on a daily basis (Nurse) - Getting into the habit of collecting information not only recently but also over time (Nurse)
Suggestions for the prototype		- Individual time series according to department, nurse, and SW could be retrieved more efficiently (Surgical oncologist)

Abbreviations: MDTM, multidisciplinary team meeting; SW, social worker.

Table 6 Themes and Descriptions for Patient-Centeredness in Questionnaire B (Free Text Part)

Theme	Subtheme	Description (Occupation)
Useful	Understanding	- It was useful for understanding the information obtained by various healthcare professionals because the contents of what the patient said sometimes differed depending on who they were talking to. (Surgical oncologist) - It was easy to search for information on the patient's family and social background. (Surgical oncologist) - It eliminated the need to repeatedly ask the patient for the same information. (Surgical oncologist)
	Utilization	- It was useful for reviewing the patient's information retrospectively because the items were classified from various perspectives. (Surgical oncologist) - It was helpful to have a shared understanding. (Nurse) - A smooth exchange of the patient's background information could make it easier to identify missing support for the patient. (Surgical oncologist) - The integrated information allowed multiple healthcare professionals to provide medical care and other care focusing on the same patient goals. (Nurse)
Useless		- I was unable to make effective use of this tool for biomedical information because I was accustomed to using a conventional EHR viewer. (Surgical oncologist)
How to use		- I used the "select all items" function instead of selecting each item because I was afraid that I might not be able to see all the information. (Surgical oncologist)

Abbreviation: EHR, electronic health record.

Table 7 Joint Display of Questionnaire A and the Verbatim Transcript for Each Case

			Case 1	**Case 2**	**Case 3**
Questionnaire A *p*-value	Efficiency		<0.01	<0.01	0.19
	Patient-centeredness		<0.01	<0.01	<0.05 (0.026)
Verbatim transcript	Change in the number of agreed contents (Control to Intervention)		14 to 14	17 to 23	5 to 10
	Change in the number of agreed contents per minute (Control to Intervention)		1.1 to 1.3	1.4 to 1.7	0.4 to 1.0
	Number of tags of a priori template	PCI	129 to 135	128 to 174	164 to 192
		BMI	19 to 58	79 to 58	62 to 44
	Subthemes unique to Control		-Supplemental items on treatments -Physical characteristics	-Supplemental items on treatments	NS
	Subthemes unique to Intervention		-Psychiatric symptoms -Feelings	-Events	-Personality traits -Economic status -Feelings

Notes: A Likert scale was used as an ordinal scale: disagree (1 point), slightly disagree (2 points), neutral (3 points), slightly agree (4 points), and agree (5 points).
Abbreviations: PCI, patient-centered information; BMI, biomedical information; NS, no subtheme.

Integration of the Qualitative and Qualitative Results

The results of the quantitative and qualitative analyses were integrated using joint displays.[44] The quantitative results from Questionnaire A showed that Intervention was useful for both efficiency and patient-centeredness, with the exception of efficiency in Case 3 (Table 7). The quantitative results from Questionnaire B (5-point Likert scale part) also showed positive responses to Intervention, with one outlier of efficiency in Case 3 (Figure 3). The qualitative results from the verbatim transcripts and Questionnaire B (free text part) clarified the reasons and context for the quantitative results. In terms of efficiency, Intervention had a higher number of agreed contents per minute than Control (Table 7). Regarding efficiency in Case 3, one nurse commented on the difficulty of finding the required information when there was too much information as follows: "In cases with a large amount of information, it sometimes took time to find the required information due to the integrated information." In terms of patient-centeredness, there were more PCIs in Intervention than in Control. The subthemes unique to Control consisted of biomedical aspects, which were "Supplemental items on treatment" and "Physical characteristics", and the subthemes unique to Intervention consisted of psychosocial aspects, which were "Psychiatric symptoms", "Feelings", "Personality traits", and "Economic status" (Table 7).

Discussion

Whether and why Intervention was useful in terms of clinical utility was evaluated and assessed from the viewpoints of efficiency and patient-centeredness.[1,2] Our analysis resulted in three key findings. First, it was found that Intervention can be useful in terms of both efficiency and patient-centeredness by integrating the quantitative and qualitative results. Second, it was also found that integrating large amounts of information can lead to inefficiencies. Finally, it was found that Intervention is likely to support patient-centered care due to sharing PCI and discussing not only biosocial aspects but also psychosocial aspects in MDTMs.

Previous studies have reported that current EHR viewers present difficulties in collecting and utilizing PCI, such as patient narratives and psychosocial information.[24,45] Discussions concerning "What are the patient's preferences and thoughts on treatment and care?" in the MDTM for Control on advanced care planning in the terminal phase were limited to collecting information on biomedical aspects such as DNAR and BSC (C5, Control). This is consistent with previous findings that meaningful PCI is difficult to collect and use during MDTMs because MDTs have not yet optimized the use of health information systems and technology.[24,25] However, in the MDTM for Intervention, PCI, which healthcare professionals need to be aware of when providing treatment and care, was addressed early in the meeting, and a patient-centered conference was held based on this shared understanding. For example, "She is always thinking about dying" (C1, Intervention) was shared in the first topic of Intervention but not shared in Control. In addition, information concerning the patient's preferences and thoughts, such as "She doesn't like painful or burdensome treatments" (C3, Intervention) or "She has a unique personality and has a clear preference for various things (very picky)" (C7, Intervention) or "It wasn't that the patient didn't want treatment, she just didn't like distressful treatments." (C6, Intervention), was used to achieve shared understanding during the MDTM and when discussing action plans. Moreover, regarding the agreed content: "She was devastated" (C2, Intervention. C4, Control) was agreed in the first topic of Intervention and in the last topic of Control. A previous study suggested that EHRs may impede the sharing of patient data interpretation and compromise the time-efficient delivery of care.[45] However, the use of integrated multidisciplinary PCI (the prototype) in MDTMs made it easier to share and interpret patient data and to efficiently obtain patient-centered agreed contents to deliver individualized patient-centered care. Our findings suggest that sharing PCI, which is important for patient-centered decision-making, early in MDTMs could promote patient-centered decision-making and facilitate patient-centered care.

It is known that an excess of medical information increases the cognitive load on healthcare professionals and makes decision-making more difficult.[46–48] Case 3 had a much higher number of tags assigned to the medical records for the set data period than the other cases (total number of tags for Case 1, Case 2 and Case 3: 444, 2096, and 7601, respectively), and the number of agreed contents was lowest (14, 17, and 5 for Control and 14, 23, and 10 for Intervention in Case 1, Case 2, and Case 3, respectively) and the number of words spoken per minute was also lowest (205, 204, and 200 for Control and 260, 273, and 227 for Intervention in Case 1, Case 2, and Case 3, respectively). An excessive amount of information, as in Case 3, may have adversely affected operability and searchability, making it difficult to retrieve the required information, increasing the cognitive load on healthcare professionals, and making decision-making more difficult. Our findings suggest that the number of medical records themselves may have had an effect rather than the effect of integrating the medical records because the same trend was seen in Control. This is consistent with previous findings that information overload leads to limited information search and suboptimal decisions.[46,47]

Breast cancer has a relatively high 5-year survival rate compared to other malignant tumors, and even after recurrence, patients may receive long-term treatment, so the volume of medical records may become very large.[12,49,50] In such cases, providing an appropriate amount of information in MDTMs and in daily practice may be essential. However, it was also confirmed that there is consistent and important information that should be considered in treatment and care from the initial visit to the present, such as the patient's personality. Therefore, it would be important to retain this type of information when adjusting the total amount of information.

On the other hand, it is also known that patients may change the contents of their conversations, such as their preferences, thoughts, and so on, depending on where, when, and with whom they are conversing. It is also known that each healthcare professional has a different perspective on their patients because they have different roles in medical treatment and care.[25,51–53] One physician commented that the integrated multidisciplinary PCI facilitated a clearer understanding of sequential psychosocial changes over time. These integrated multidisciplinary medical records could integrate the fragmented information from different perspectives and times obtained by various healthcare professionals to create multifaceted PCI and clearly show any changes in it. The holistic biopsychosocial PCI could also facilitate use of the patient's and family's narratives, including their preferences and thoughts, during MDTMs.

Lack of PCI, time constraints, and low attendance are known factors that can affect the quality of the clinical decisions made in MDTMs.[22,27,32,54] Moreover, given the increase in the number of cancer patients and changes in the healthcare environment, it is widely recognized that MDTMs are becoming more difficult to organize due to the difficulty of bringing together multiple healthcare professionals at the same time and the increases in time and cost pressures.[55–58]

One nurse commented that integrated information enables the sharing of common goals and supports decision-making for optimal treatment and care from a multidisciplinary perspective. Integrated multidisciplinary medical records would enable various healthcare professionals to utilize the perspectives of different specialties more efficiently and effectively, even if they are all in different places at different times. It would also support not only MDTMs but also individual healthcare professionals in making more patient-centered clinical decisions.

We believe that the use of integrated multidisciplinary medical records would improve accessibility to PCI and that the utilization of this multifaceted and holistic PCI could support and facilitate patient-centered care not only in MDTMs but also in routine clinical practice.

Our findings highlight potential implications for clinical practice. In order to integrate and utilize PCI in MDTMs and clinical practice, it is important that each healthcare professional documents PCI appropriately in the HIS. Therefore, it is necessary to develop technologies for collecting PCI without creating additional workload in daily practice. However, current research and development has mainly focused on collecting and structuring biomedical information. There has been remarkable development in large-scale natural language processing technology for medical use, such as generative AI.[59,60] To ensure that PCI also focuses on collecting and structuring data using these technologies, further studies are needed to clarify the PCI that is actually needed in clinical practice. Moreover, further research is needed to evaluate the impact of applying technology that enables the use of PCI in MDTMs and daily practice on interactions between healthcare professionals and between healthcare professionals and patients.

Early in MDTMs, encouraging participants to share the PCI they have gathered in their daily practice and found in EHRs may contribute to more patient-centered discussions and decisions in MDTMs. When preparing for MDTMs, collecting as much PCI as possible that is already stored in the HIS may lead to the greater use of PCI in MDTMs. However, previous studies suggested that it is difficult to search for and retrieve PCI because PCI is fragmented, scattered across the HIS, and not stored in a standard location.[23–26] Data standardization, consolidation, and interoperability, such as HL7 (Healthcare Level 7) FIRE® (Fast Healthcare Interoperability Resources), are driving progress all over the world.[61–63] We therefore anticipate that further feasibility studies will become available in the near future.

We also believe that further research is needed to investigate the usability of the user interface to present the appropriate amount of PCI in various clinical use case scenarios.[47,48,60]

Strengths and Limitations

This study has several limitations. The first is the Hawthorne effect, in which people change their behavior because they are being observed, which is an inherent limitation of all observational studies.[64] To minimize this effect, the researchers conducted their observations from a location that was as far out of the participants' field of view as possible. Thematic analysis is potentially subjective. Therefore, the three researchers conducted their analyses individually. Consensus readings were then used to reach mutual agreement, which is likely to strengthen the validity of our results by reducing subjectivity bias.

The department where this research was conducted usually employs two EHR viewers during MDTMs. However, three viewers were employed in this research. This may have affected the accessibility of the medical records as compared to usual MDTMs. Furthermore, the participants might have had greater access to the PCI than in Control because each participant was able to use their own prototype. This may have led to greater sharing of PCI than in Control, allowing them to reach consensus and conclusions while deepening their understanding of the patient. On the other hand, although Intervention was defined as "the conventional EHR viewer plus the prototype", the participants rarely used the conventional EHR viewers, and only one physician briefly used them once in each of Cases 1 and 3. As a result, this study was effectively a comparison between the conventional EHR viewer and the prototype. This is presumably because each person was able to use a prototype and therefore enjoyed better operability and accessibility to the PCI compared to a conventional EHR viewer.

In Intervention, the input data to the prototype was pseudonymized not only with regard to the patients' personal information but also the names of the medical staff and facilities. This made it difficult to use specific information, such as the patient experiencing intense anxiety due to the possibility of changing her attending physician, the fact that the senior physician had to deal with the patient's telephone calls instead of an on-call physician, the patient's preference for a certain type of facility (such as a hospice, her home, or a rehabilitation facility) after discharge from the current hospital, and so on. Despite this limitation, we found that using the prototype could facilitate more patient-centered discussions in Intervention. However, further studies of the integrated multidisciplinary EHR should be conducted using un-anonymized data.

This study involved three cases of breast cancer from a single university hospital in Japan. The MDTMs included only surgical oncologists and nurses. Other healthcare professionals such as pathologists, radiologists, and medical oncologists were not included.[18,65] Further studies of patients undergoing treatment are needed, with larger numbers of cases, a wider variety of healthcare professionals, other types of cancer, and more facilities in order to obtain more generalizable results.

This study also has several strengths. Previous studies have suggested that not all relevant information in the EHR can be easily shared across specialties.[66,67] It is also known that studies using full free text are limited due to anonymization costs.[59] In addition, PCI is usually documented in free text format and a narrative form, and not stored in a standard location.[23–25,47] However, we aggregated, pseudonymized, and integrated unstructured data of 20 types of medical records from the first visit to the set date for up to 10 years across the entire HIS and evaluated and assessed the clinical usefulness of the integrated data.

Conclusion

The use of the integrated PCI obtained by multiple healthcare professionals could improve the accessibility of PCI and may help to make MDTMs more efficient and patient-centered. Sharing and utilizing the integrated PCI at MDTMs could lead to a more holistic understanding of the patient, including what kind of pain and distress they are experiencing or have experienced, what their personal preferences are, what their individual personality is like, and so on. The integrated PCI could promote a shared understanding among MDTM participants and has the potential to lead to more patient-centered clinical decision-making, treatment, and care based on the expertise of each healthcare specialist.

As the workload on healthcare professionals increases, a digital transformation with the implementation of disruptive technologies in healthcare is also being promoted. Integrating the PCI obtained from various healthcare specialists that is already documented in the HIS and providing the appropriate amount of information can be expected to improve MDTMs and support routine clinical practice without placing an additional burden on busy healthcare professionals.

Data Sharing Statement

The data supporting this study's findings are not publicly available due to privacy/ethical restrictions.

Ethics Approval

This study complies with the Declaration of Helsinki, the Ethical Guidelines for Medical and Biological Research Involving Human Subjects (Japan) and the Act on the Protection of Personal Information (Japan). All case descriptions have been pseudonymized based on these guidelines. This study was conducted according to ethics committee guidelines. The University of Tsukuba Institutional Ethical Review Committee (ERC) approved the study on November 28, 2023 (ERC Management Number; R05-151).

Informed Consent

Informed consent was obtained from all participants. Informed consent was obtained from the patients. These consents complied with the Ethical Guidelines for Medical and Biological Research Involving Human Subjects (Japan), and the Act on the Protection of Personal Information (Japan). The institutional ethics committee approved this consent process.

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