



# Recognition and attitudes of Japanese hematologists on sperm banking before chemotherapy: present status from nationwide questionnaire survey

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Received: 22 March 2018 / Accepted: 6 August 2018 / Published online: 20 August 2018  
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## Abstract

**Background** Treatment advancements have improved young cancer patients' survival rate considerably. Fertility preservation has become a very important tool in the prevention of treatment-induced gonadal toxicity. This study aimed to examine hematologists' awareness of its necessity and importance.

**Methods** Questionnaires were mailed to the directors of 230 institutes that treated hematological malignancies in adults. The directors were asked to provide information regarding their institutes, collaboration with sperm banks, the number of patients treated per year, selection criteria for patients providing information, and their awareness of and attitudes toward sperm preservation.

**Results** The response rate was 40.0%. Municipal and private hospitals treated patients significantly less frequently relative to university hospitals ( $p = .002$ ). Of the 92 participating hematology institutions, 17 included sperm banks and 69 collaborated with sperm banks in neighboring institutions. Many participants stated that sperm preservation should be performed before chemotherapy; however, only 38% provided sperm preservation information to all patients. Participants in facilities without sperm banks exhibited significantly lower levels of knowledge regarding sperm preservation, relative to those from institutions with sperm banks, and found discussing fertility preservation burdensome. This trend was identical to that observed in a survey conducted 10 years earlier.

**Conclusion** Many hematologists did not appear to possess sufficient knowledge regarding fertility preservation. Moreover, few institutions included sperm banks, and a considerable burden was exerted on hematologists. The introduction of support systems is required to promote sperm preservation before cancer treatment.

**Keywords** Sperm preservation · Chemotherapy · Hematologist · Attitude · Recognition · Questionnaire

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## Introduction

Because of therapeutic advances, survival rates in young adults and adolescents with cancer have improved [1]. However, many types of therapy are toxic to germ cells, reduce spermatogenic potential, and cause infertility in male patients [2, 3]. In addition, abdominal and pelvic surgery obstructs the seminal tract, which could affect sexual function.

Infertility caused by cancer treatment should be addressed, and fertility preservation is currently the only tool available for achieving this. The American Society of Clinical Oncology 2006 guidelines (updated in 2013) recommend gamete cryopreservation before chemotherapy for young patients with cancer [4, 5]. Furthermore, in July 2017, the Japanese Society of Clinical Oncology published clinical practice guidelines for fertility preservation in cancer patients in childhood, adolescence, and young adulthood [6].

Pretreatment sperm cryopreservation is an established method for postpubescent men. However, many patients develop permanent azoospermia following cancer treatment and seek treatment for infertility without having been informed of options for pretreatment fertility preservation or understanding the information provided. Provision of information to patients depends on oncologists' knowledge and awareness of the importance of sperm cryopreservation.

We previously conducted a nationwide survey concerning sperm preservation before cancer treatment in Japan, and results indicated that sperm-banking rates for all disease groups, except the testicular tumor group, were lower relative to corresponding morbidity rates. One possible reason for this finding is that urologists who treat testicular tumors possess greater knowledge regarding testicular damage caused by anti-cancer drugs, relative to oncologists in other specialties [7].

Numerous studies have examined sperm preservation before cancer treatment [8–11], with the most common relevant diseases being testicular tumors, leukemia, and malignant lymphoma. Moreover, hematological malignancy, which is a combination of leukemia and lymphoma, was the disease for which sperm preservation was requested most frequently. Although hematologists make full use of chemotherapy and radiotherapy, it is unclear whether they possess sufficient knowledge regarding sperm preservation or the gonadotoxic effects of these treatments. Therefore, we examined Japanese hematologists' awareness of and attitudes toward sperm preservation before cancer treatment.

## Materials and methods

### Participants

We conducted a national survey with the assistance of the Ministry of Health, Labour and Welfare in Japan. Questionnaires were mailed to the directors of 230 institutions that treated hematological malignancies in adults, which were selected from the “Hematopoietic Cell Transplantation in Japan Annual Report of Nationwide Survey 2013” on the Japan Society for Hematopoietic Cell Transplantation website [12].

### Survey

Participants received questionnaires via mail and provided information regarding their institutions, collaboration with sperm banks, the number of patients aged 15–45 years treated annually for hematological malignancies, the number of patients who attended consultations regarding sperm preservation (initiated by patients or doctors) between April 2015 and March 2016, and consultation timing.

Hematologists were asked to choose one of three responses to describe how they provided information to patients concerning sperm preservation before treatment (i.e., inform all patients, inform some patients, or do not inform any patients). These results were compared to the number of patients treated and the presence or absence of collaboration with sperm banks in neighboring institutions. Moreover, we examined the effects of nine factors that motivated doctors who did not inform all patients to recommend sperm preservation, using a 5-point scale ranging from a “strong effect” to “no effect.”

Participants indicated their agreement with 10 items pertaining to awareness of and attitudes toward sperm preservation, using a 5-point scale ranging from “strongly agree” to “strongly disagree.” Participants were classified according to the presence of cooperative institutions and the provision of information to patients, and item scores were compared.

### Data analysis

A chi-squared test was performed to confirm bias involving the number of patients, the existence of sperm banks, and the timing and limits to the provision of information concerning sperm preservation to patients, according to hospital type. Chi-squared tests were also performed to examine differences between participants' attitudes, the existence of sperm banks, and limits to the provision of information concerning sperm preservation. The significance level was set at  $p < .05$ .

All calculations were performed using IBM SPSS Version 22.0 for Macintosh (Chicago, IL, USA).

## Ethical considerations

Ethical approval for the study protocol was granted by St. Marianna University Nasu Red Cross Hospital and the Yokohama City University Review Board. We distributed anonymous questionnaires to participants and included documentation confirming that these ethics committees had approved the research. Participants' completion and return of the questionnaires signified consent to participate in the study.

## Results

### Participants' characteristics

A total of 92 institutions returned completed questionnaires (response rate: 40.0%). The number of patients aged 15–45 years treated in all participating institutions over the course of 1 year was 2,265. Table 1 presents participants' characteristics.

In terms of hospital classification, there were 38 university hospitals, 26 public hospitals, 27 private hospitals, and one hospital for which this information was not provided. The number of young people with hematologic malignancies treated at the institutions over the course of a year

**Table 1** Characteristics of participating hospitals ( $n=92$ )

Characteristics	Category	University hospital ( $n=38$ )	Municipal hospital ( $n=26$ )	Private hospital ( $n=27$ )	No response ( $n=1$ )	Overall	$p$ value
Number of male patients treated in participating hospitals (age: 15–45 years)	0–10	14	15	23	0	52	0.002
	11–20	9	5	1	0	15	
	21–50	7	3	2	0	12	
	≥51	5	3	1	1	10	
	No response	3	0	0	0	3	
	Overall	38	26	27	1	92	
Number of patients who underwent chemotherapy per year		1296	559	335	75	2265	0.576
Number of patients who underwent consultations at sperm banks per year		136	51	37	No statement	224	
Background to consulting to sperm bank	Recommended by doctor	120	46	34	No statement	200	0.938
	Requested by patient	16	5	3		24	
Presence of sperm bank in or near participating hospitals	Sperm bank in participating hospital	14	0	3	0	17	<0.001
	Sperm bank near participating hospital	23	23	22	1	69	
	No sperm bank in or near participating hospital	1	3	2	0	6	
	Overall	38	26	27	1	92	
Timing of the provision of sperm preservation information to patients	Before chemotherapy	34	20	22	0	76	0.300
	After one course of chemotherapy	0	2	0	0	2	
	After two or more courses of chemotherapy	0	0	0	0	0	
	Before hematopoietic stem cell transplantation	3	3	5	1	12	
	Upon recurrence	0	0	0	0	0	
	No response	1	1	0	0	2	
	Overall	38	26	27	1	92	
Limits to the provision of information to patients	No limits (all patients)	13	10	12	0	35	0.092
	Restricted (some patients)	24	14	14	1	53	
	No patients	1	1	0	0	2	
	No response	0	1	1	0	2	
	Overall	38	26	27	1	92	

ranged from 1 to 250. Municipal hospitals (15/26) and private hospitals (20/27) were significantly more likely to treat 10 or fewer people, relative to university hospitals (13/38;  $p = .002$ ). Moreover, 224 patients in participating institutions received consultations regarding sperm preservation per year. Municipal hospitals provided consultations to their sperm bank departments in 9.1% (51/559) of chemotherapy cases, university hospitals provided consultations in 10.5% of cases, and private hospitals provided consultations in 11.0% (37/335) of private hospitals. There was no significant difference between the types of institutions ( $p = .576$ ). We surveyed the number of patients who consulted with the sperm banking department in this survey but did not investigate the number of patients who received information from the hematologists. In addition, 200 patients were advised to preserve their sperm by their attending doctors, and 24 received consultations upon their request. There was also no significant difference between the institutions in this regard. Of the 92 institutions, 17 included sperm banks and 69 collaborated with sperm banks in neighboring institutions. The proportion of university hospitals with sperm banks was significantly higher relative to those of the other two groups ( $p < .001$ ). In addition, 86 hospitals (93.5%) collaborated with sperm banks in neighboring institutions. Six participants reported that there were no sperm banks in or near their institutions.

When asked about the timing of sperm preservation recommendations, the most frequent response was before chemotherapy (76/92), followed by before hematopoietic stem cell transplantation (12/92). In two institutions, patients were informed after one chemotherapy cycle, and no institutions informed patients after more than two cycles of chemotherapy or the diagnosis of recurrence. Of 90 respondents, 35 (38.0%) informed all patients about sperm preservation before treatment, 53 (57.6%) informed some patients, and only two did not inform any patients. Responses to this item did not differ significantly between hospital groups.

## Factors that motivated participants to promote sperm preservation

We examined the factors that motivated the 53 participants who did not provide information to all patients (Table 2). One participant did not provide a response to this item. More than half of participants reported that all factors exerted either strong or weak effects. Of the nine factors examined, more than half of participants reported strong effects for “hematopoietic stem cell transplantation is scheduled” (43/52, 82.7%), “patient age” (40/52, 76.9%), “urgent treatment is necessary” (31/52, 59.6%), “disease stage” (29/52, 55.8%), and “disease type” (28/52, 53.8%).

## Participants' tendency to inform patients about sperm preservation according to the number of patients treated within a year and the existence of sperm banks

We divided participants into three groups according to their tendency to inform patients about sperm preservation before treatment. There was no significant difference between the number of patients treated over the course of the year and the number of participants who informed all patients ( $n = 35$ ), some patients ( $n = 53$ ), and no patients ( $n = 2$ ; Table 3). However, the proportion of participants with sperm banks in their institution who informed all patients was significantly higher relative to institutions without sperm banks ( $p = .002$ ; Table 4).

## Hematologists' awareness of and attitudes toward sperm preservation before chemotherapy

We examined participants' awareness of and attitudes toward fertility and sperm preservation. The proportion of participants who informed some patients about sperm preservation and agreed with the following statements

**Table 2** Factors promoting sperm preservation before treatment for young cancer patients

Factors	No effect	Weak effect	Do not know	Strong effect	Very strong effect
The patient already has children	1	3	13	26	9
The patient already has a partner	2	5	8	21	16
The patient has already begun treatment at another institution	0	4	18	21	9
Hematopoietic stem cell transplantation scheduled	0	0	2	7	43
Urgent treatment necessary	1	2	5	13	31
Patient age	0	1	1	10	40
Number of chemotherapy cycles	0	9	11	15	17
Disease type	0	4	5	15	28
Disease stage	1	4	5	13	29

**Table 3** Participating hospitals' tendency to provide sperm preservation information according to the number of patients treated per year

Factor	Provision of sperm preservation information before cancer treatment			
	To all patients ( <i>n</i> = 35)	To some patients ( <i>n</i> = 53)	To no patients ( <i>n</i> = 2)	No response
Number of male patients treated in participating hospital (age: 15–45 years)				
0–10 ( <i>n</i> = 52)	20	28	2	2
11–20 ( <i>n</i> = 15)	8	7	0	0
21–50 ( <i>n</i> = 12)	4	8	0	0
≥ 51 ( <i>n</i> = 10)	2	8	0	0
No response	1	2	0	0

**Table 4** Participating Hospitals' tendency to provide sperm preservation information according to the presence of a sperm bank

	Provision of sperm preservation information before cancer treatment			
	To all patients ( <i>n</i> = 35)	To some patients ( <i>n</i> = 53)	To no patients ( <i>n</i> = 2)	No response
Presence of sperm bank in or near participating hospital				
Sperm bank in participating hospital ( <i>n</i> = 17)	9	8	0	0
Sperm bank near the participating hospital ( <i>n</i> = 69)	26	42	0	1
No sperm bank in or near the participating hospital ( <i>n</i> = 6)	0	3	2	1

*p* = .002

items was significantly higher relative to participants who informed all patients: “Information regarding fertility deterioration due to cancer treatment is lacking” (*p* = .018); “The provision of information regarding sperm preservation before cancer treatment is lacking” (*p* < .001); “Because hematological malignancy is a life-threatening disease, patients are not concerned about infertility” (*p* = .007); “Because my daily workload is heavy, I cannot take time to talk to patients about fertility problems” (*p* = .005); and “I think the priority of infertility problems is low for patients before cancer treatment” (*p* = .003). In contrast, the proportion of participants who disagreed with the “It is the attending physician’s duty to provide consultations regarding patients’ fertility” (*p* = .002) item was low (Table 5).

Of the 17 participants with sperm banks in their institutions, the proportion who did not agree with the following items was significantly lower relative to participants without sperm banks or with sperm banks in neighboring institutions: “Information regarding fertility deterioration due to cancer treatment is lacking” (*p* = .014); “The provision of information regarding sperm preservation before cancer treatment is lacking” (*p* = .027); and “Because my daily workload is heavy, I cannot take time to talk to patients about fertility problems” (*p* < .001; Table 6).

## Discussion

The American Society of Clinical Oncology published guidelines recommending gamete cryopreservation before chemotherapy for young patients with cancer in 2006 (updated in 2013) [4, 5]. Furthermore, the Japanese Society of Clinical Oncology published clinical practice guidelines for fertility preservation in cancer patients in childhood, adolescence, and young adulthood [6]. However, because of these guidelines, there is no immediate sense of a deepening awareness of fertility preservation. In a previous survey, we speculated that patients with testicular tumors exhibited higher sperm preservation rates relative to incidence rates [7]. Tantiana et al. reported that of the various cancer types, the period from diagnosis to sperm preservation was shortest for testicular tumors [13]. A possible reason for this is that urologists possess greater knowledge of the gonadotoxic effects of chemotherapy relative to oncologists in other specialties. To determine the extent of knowledge and awareness oncologists other than urologists possessed about fertility preservation, we examined awareness levels in hematologists, who had the greatest opportunity to request sperm preservation.

**Table 5** Attitudes toward sperm preservation in 92 hematologists according to whether they informed all patients about preservation

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	<i>p</i> value
Information regarding fertility deterioration due to cancer treatment is lacking						
All patients informed	1	9	6	14	5	0.018
Some patients informed	0	4	8	38	3	
The provision of information regarding sperm preservation before cancer treatment is lacking						
All patients informed	1	9	8	12	5	<0.001
Some patients informed	0	1	8	40	4	
It is the attending physician's duty to provide consultations concerning patients' fertility						
All patients informed	0	0	4	17	14	0.002
Some patients informed	0	2	8	39	4	
Because hematological malignancy is a life-threatening disease, patients are not concerned about infertility						
All patients informed	8	17	9	1	0	0.007
Some patients informed	2	25	16	10	0	
Because my daily workload is heavy, I cannot take time to talk to patients about fertility problems						
All patients informed	8	15	3	9	0	0.005
Some patients informed	2	17	13	17	4	
It is difficult to talk about sperm preservation to patients who are in shock because they are being informed that they have cancer						
All patients informed	7	12	8	7	1	0.762
Some patients informed	5	26	10	12	0	
It is hard to talk to the patient about the problem of fertility						
All patients informed	12	18	3	1	0	0.503
Some patients informed	9	30	8	6	0	
Sperm preservation should be done before chemotherapy						
All patients informed	1	0	5	21	8	0.978
Some patients informed	1	2	8	30	12	
Infertility problems are of low priority for patients before cancer treatment						
All patients informed	5	20	7	3	0	0.003
Some patients informed	1	17	26	9	0	
Sperm preservation motivates patients to undergo cancer treatment						
All patients informed	1	8	13	10	3	0.501
Some patients informed	2	5	30	14	2	

Results showed that the number of male patients aged 15–45 years with hematological malignancies in the entire country was 2,265, of whom 224 (9.9%) had visited a sperm bank. According to 2012 data, there were 2,593 male patients aged 10–40 years with lymphoma or leukemia. During the designated period, 383 patients with hematological malignancies, including leukemia and lymphoma, received sperm cryopreservation consultations [7]. In countries that manage sperm preservation on a national scale, such as France, preservation rates are almost 80% [10]. In contrast, in countries in which sperm preservation management is performed in facilities, such as the United States and Japan, preservation

rates are approximately 10%. However, sperm preservation rates differ according to disease, and the rate for testicular tumors is high in the United States [14]. The current results were almost identical to those observed almost 10 years ago, indicating no change in sperm preservation rates according to patient numbers during this period. Schover et al. posited that the observation of lower sperm-banking rates, relative to morbidity rates, occurred because of inadequate information [15]. In the current study, the proportion of patients who initiated sperm preservation themselves was 10.7% ( $n=24$ ), suggesting that the importance of sperm preservation has not penetrated Japanese society.

**Table 6** Attitudes toward sperm preservation in 92 hematologists according to the presence of a sperm bank

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	<i>P</i> value
Information regarding fertility deterioration due to cancer treatment is lacking						
Sperm bank present in participating hospital	1	6	4	4	2	0.014
Sperm bank present near participating hospital	0	6	10	47	6	
No sperm bank present in or near participating hospital	0	1	0	3	2	
The provision of information regarding sperm preservation before cancer treatment is lacking						
Sperm bank present in participating hospital	1	5	5	6	0	0.027
Sperm bank present near participating hospital	0	5	10	45	9	
No sperm bank present in or near participating hospital	0	0	1	4	1	
It is the duty of the attending doctor to receive consultation on the patient's fertility						
Sperm bank present in participating hospital	0	0	2	9	6	0.645
Sperm bank present near participating hospital	0	2	9	46	12	
No sperm bank present in or near participating hospital	0	0	3	2	1	
Because hematological malignancy is a life-threatening disease, patients are not concerned about infertility						
Sperm bank present in participating hospital	1	8	5	3	0	0.997
Sperm bank present near participating hospital	7	34	21	7	0	
No sperm bank present in or near participating hospital	0	2	2	2	0	
Because my daily workload is heavy, I cannot take time to talk to patients about fertility problems						
Sperm bank present in participating hospital	4	12	0	2	1	<0.001
Sperm bank present near participating hospital	6	22	15	23	3	
No sperm bank present in or near participating hospital	0	0	0	3	3	
It is difficult to talk about sperm preservation to patients who are in shock because they are being informed that they have cancer						
Sperm bank present in participating hospital	2	8	5	2	0	0.276
Sperm bank present near participating hospital	10	29	24	15	1	
No sperm bank present in or near the participating hospital	0	2	0	4	0	
It is hard to talk to patients about fertility problems						
Sperm bank present in participating hospital	5	11	1	0	0	0.934
Sperm bank present near participating hospital	16	37	9	6	0	
No sperm bank present in or near the participating hospital	1	3	1	1	0	
Sperm preservation should be performed before chemotherapy						
Sperm bank present in participating hospital	0	0	3	12	2	0.999
Sperm bank present near participating hospital	2	2	10	38	17	
No sperm bank present in or near the participating hospital	0	0	3	2	1	
Infertility problems are of low priority for patients before cancer treatment						
Sperm bank present in participating hospital	1	8	5	3	0	0.807
Sperm bank present near participating hospital	5	30	27	7	0	
No sperm bank present in or near the participating hospital	0	1	2	3	0	
Sperm preservation motivates patients to undergo cancer treatment						
Sperm bank present in participating hospital	0	4	9	3	1	0.975
Sperm bank present near participating hospital	3	8	33	21	4	
No sperm bank present in or near the participating hospital	0	1	4	1	0	

In Japan, Watanabe et al. [16] and Kobayashi et al. [17] examined hematologists' awareness of fertility preservation, and we compared their results with those of the current study. Although our response rate (40.0%, 92/230) was lower than 50.0%, we considered it sufficient, as we collected data from more than 90 institutions. Schover et al. suggest that low response rates [15] indicate that respondents have not considered cancer-related infertility comprehensively. The proportion of participants who informed all patients about sperm preservation was 38.0% (35/92), and more than half of participants (53/92) informed some patients. The following were cited as factors that ensured explanation: scheduled hematopoietic stem cell transplantation, patient age, the need for urgent treatment, disease stage, and disease type. In addition, Schover et al. reported that oncologists were less likely to offer sperm preservation to male patients who were homosexual or HIV positive and those with a poor prognosis or aggressive tumors, relative to other patients [15]. Participants appeared to understand that spermatogenesis undergoes considerable damage after aggressive chemotherapy for hematopoietic stem cell transplantation. Moreover, refractory disease requires strong chemotherapy, and participants tended to inform patients about sperm preservation in response to their estimation of the damage to spermatogenesis.

Furthermore, participants tended to encourage sperm preservation in younger patients because of the possibility of future fatherhood. However, these results were almost identical to those of a survey conducted by Watanabe et al. in 2007 [16], and hematologists' awareness of and attitudes toward sperm preservation have not changed since then.

When asked about timing for sperm preservation recommendations, the most common response was before chemotherapy initiation (76/92). However, 12 and 2 participants recommend sperm preservation before hematopoietic stem cell transplantation and after one cycle of chemotherapy, respectively. Prior to bone marrow transplantation, many patients undergo multiple chemotherapy cycles, and although the regimen is classified as an intermediate risk in the guidelines, multiple regimens exert adverse effects on spermatogenesis. According to Kobayashi's survey, 12 of 22 (57.1%) hematologists stated that sperm preservation was performed before chemotherapy, and 3 (14.3%) stated that enforcement after chemotherapy had been introduced. In addition, almost 29% (6/21) were unsure about the appropriate timing for banking [17]. These results indicate that some hematologists lack sufficient knowledge regarding gonadal toxicity in anticancer drugs.

The proportion of participants who did not have sperm banks or inform all patients and agreed that patients received insufficient information regarding fertility deterioration following cancer treatment and sperm preservation before cancer treatment was significantly higher relative to those who

had sperm banks and informed all patients. In addition, the proportion of participants who did not have sperm banks or inform all patients and agreed that they had insufficient time to discuss fertility problems with patients was significantly higher relative to participants who had sperm banks and informed all patients. Furthermore, the proportion of participants who did not inform all patients and agreed that it was difficult to talk to patients about fertility problems was significantly higher relative to those who informed all patients. Table 4 shows the correlation between the decision to explain sperm preservation to all patients and the location of sperm banks. Hematologists who did not have sperm banks or collaborate with neighboring institutions tended not to provide fertility preservation information to all patients. The number of patients treated was unrelated to the decision to explain sperm preservation to all patients.

Although the questionnaire did not collect information regarding the number of doctors in each institution, we speculate that high numbers of patients were treated in institutions with high numbers of staff members. Therefore, the number of patients treated was likely to be unrelated to the provision of information regarding sperm preservation. Hematologists in institutions with sperm banks could acquire knowledge regarding sperm preservation but did not feel responsible for providing this information to patients, as this was the responsibility of doctors in charge of sperm preservation. The current results also showed that university hospitals were significantly more likely to have sperm banks in their own institutions; however, there are only 17 such hospitals in Japan. Hematologists at institutions without sperm banks received poor information regarding sperm preservation, which increased the difficulty in explaining this to patients. Furthermore, they believed that fertility preservation was of low priority among treatment options. The opinions of doctors and staff members in cancer treatment exert strong effects on patients' decision-making. Achille et al. listed the following factors that influenced sperm preservation from the perspective of survivors: healthcare professionals' role in discussing infertility, the importance of fatherhood, fatherhood status, the influence of parents or partners, attitudes toward survival at diagnosis, cost, perception of complexity, and the efficacy of sperm preservation [18]. It is important to avoid restricting young patients' opportunities because of doctors' lack of knowledge and their own ideas.

However, Japanese hematologists are very busy [17], and acquiring new knowledge concerning sperm preservation, making time to explain sperm preservation to patients, and contacting sperm banks is burdensome for them. Oncologists' attitudes toward sperm preservation emphasized the fact that sperm preservation is unpopular because of lack of information and systematization [15, 17]. Guidelines on fertility preservation have been published in Japan, but

disseminating knowledge to all oncologists is time consuming. To eliminate the burden on hematologists, professionals should be hired to explain sperm preservation and create systems that introduce patients to sperm banks. In the future, sperm preservation will become an important supportive tool for young patients who receive cancer treatment. We believe that it is necessary to ascertain patients' desire for sperm cryopreservation prior to cancer treatment and incorporate this into treatment plans.

In conclusion, Japanese hematologists possessed some fertility preservation knowledge. Some institutions understood the importance of sperm preservation and actively endeavored to introduce it. However, the proportion of institutions that provided sperm preservation information to all patients has not changed for 10 years, and many hematologists did not appear to possess sufficient knowledge regarding fertility preservation. Owing to this lack of knowledge and cooperation, discussing fertility preservation with patients is overly burdensome for hematologists. It is important to provide counseling to support physicians and patients, employ specialized nurses, and establish systems to ensure smooth communication with reproductive medical specialists and provide information. Furthermore, sperm preservation information should be communicated to oncologists and citizens.

The inclusion of only hematologists was a limitation of this study. Although we included hematologists because they requested sperm banking most frequently, the questionnaire should be completed by oncologists and other specialists (e.g., orthopedic and brain surgeons) who do not know about sperm preservation because of low numbers of patients. Additionally, urologists, who are familiar with gonadal toxicity, should be recruited and their responses should be compared with those of hematologists. Additionally, we were unable to examine the specific conditions under which hematologists recommended sperm preservation to patients. Once these conditions are satisfied, the survey should be replicated.

**Acknowledgements** This national survey was conducted with the assistance of the Ministry of Health, Labour and Welfare in Japan. We thank Editage (<http://www.editage.jp>) for English language editing.

### Compliance with ethical standards

**Conflict of interest** All authors have no competing financial interests to declare.

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