その他の質問

質問１

医療と行政と医学従事者と患者との連携情報交換

回答 （手島先生）

国の委員会にはそれぞれの代表が参加できるようになってきています。

質問２

医療機関で末期癌と診断された場合、患者本人に告知説明するか否かはどのように判断していますか？何か条件規定はあるのですか？

回答 （手島先生）

担当医師は患者さんの意思、家族の意向、等多くの背景因子を総合して判断してきましたが、最近は徐々に欧米化してきており、これらの因子をあまり考慮せずに一方的に告知する場合もでてきています。

質問３

高等学校で「保健」の指導をしている者です。授業の教材研究のため参加を希望いたします。

回答 （手島先生）

本講座がお役に立てれば幸いです。講演のなかでも保健教育のなかで早期にがんに関する教育を行うことの重要性を強調しました。是非、積極的に取り入れていただければ幸いです。日本対がん協会では教育基金を設立しています。教材等も提供可能だと思います。ご相談ください。

質問４

１月３１日の東大でのシンポジウムに出席して大変勉強になりました。

回答 （手島先生）

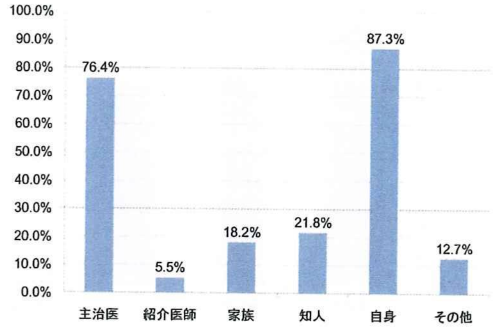
そのように評価していただきとても光栄です。今後ともよろしくお願いいたします。

# 市民公開講座アンケート結果

市民公開講座ホームページでの
アンケート結果

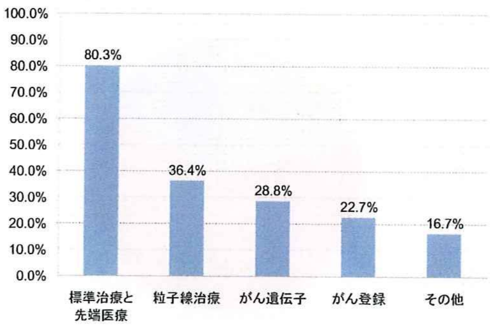
## がんに関する情報の入手方法

n=55（複数回答可能）



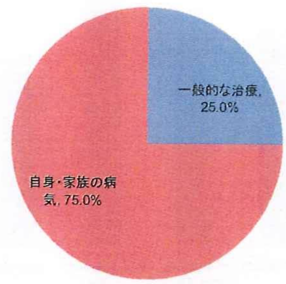

## 特に聴きたい講演

n=58（複数回答可能）



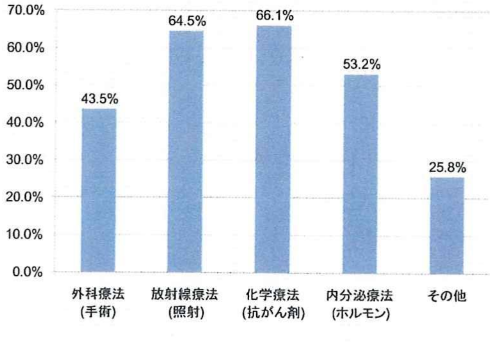

## 今回、お聞きになりたいこと

n=60



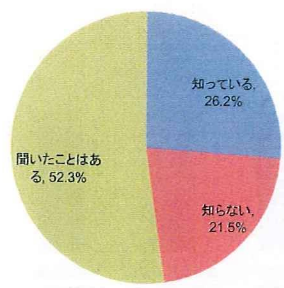

## 標準的ながん治療　知りたい治療法

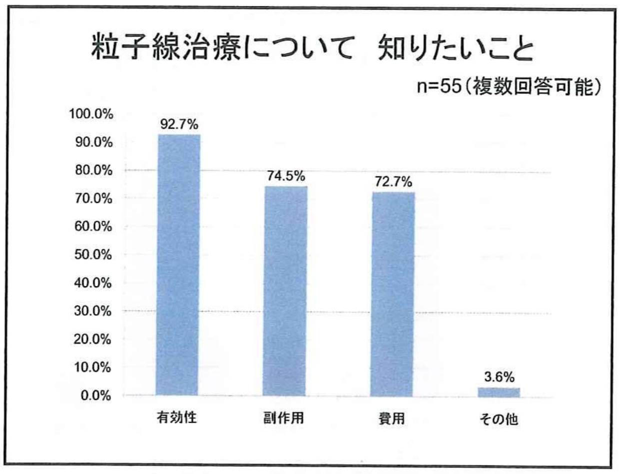
n=62（複数回答可能）

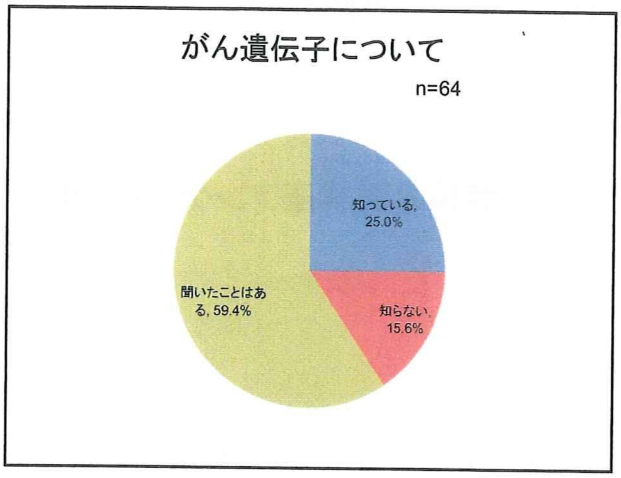


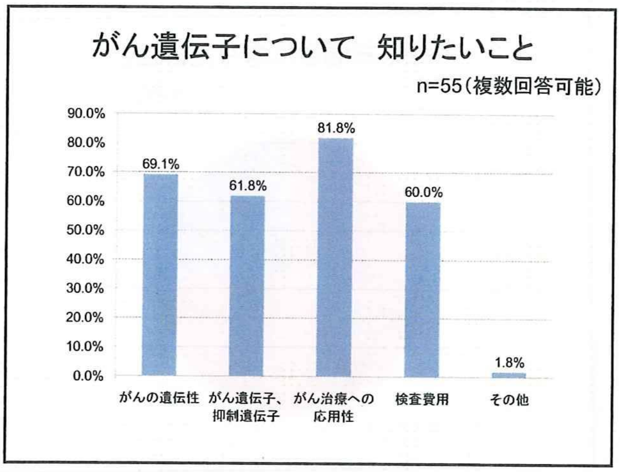

## 粒子線治療について

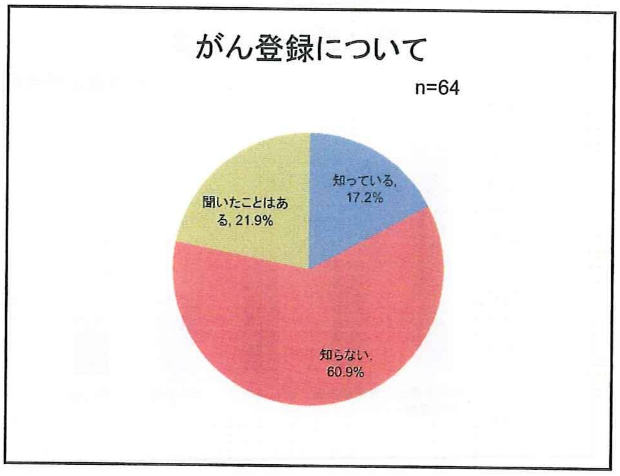
n=65

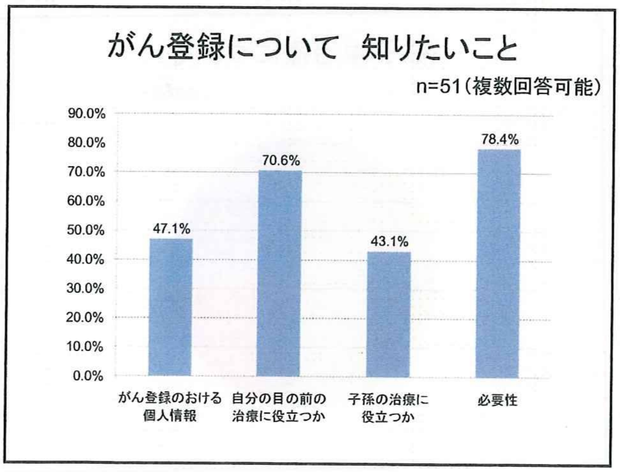



粒子線治療について　知りたいこと
n=55（複数回答可能）
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
92.7%
74.5%
72.7%
3.6%
有効性
副作用
費用
その他


がん遺伝子について
n=64
知っている, 25.0%
知らない, 15.6%
聞いたことはある, 59.4%


がん遺伝子について　知りたいこと
n=55（複数回答可能）
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
69.1%
61.8%
81.8%
60.0%
1.8%
がんの遺伝性
がん遺伝子、抑制遺伝子
がん治療への応用性
検査費用
その他


がん登録について
n=64
知っている, 17.2%
聞いたことはある, 21.9%
知らない, 60.9%

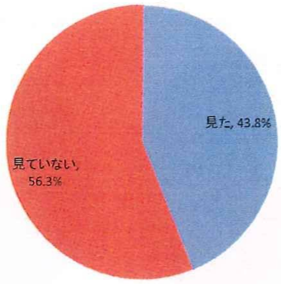

がん登録について　知りたいこと
n=51（複数回答可能）
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
47.1%
70.6%
43.1%
78.4%
がん登録のおける個人情報
自分の目の前の治療に役立つか
子孫の治療に役立つか
必要性

# がん登録アンケート結果

市民公開講座ホームページでの
事前アンケート結果

## アンケート 問題(n=16)

ホームページの「がん登録」に関する教育スライドをご覧になりましたか。

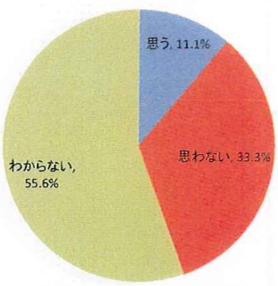



## アンケート 問1

市役所等から個別に検診受診の勧めが届いた場合、プライバシーの侵害と思いますか？

がん登録説明スライド閲覧(n=7)

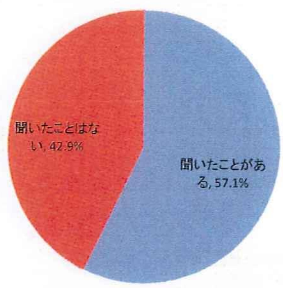

がん登録説明スライド未閲覧(n=9)



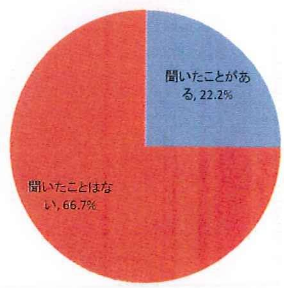

## アンケート 問2

地域がん登録の存在を聞いたことがある？

がん登録説明スライド閲覧(n=7)



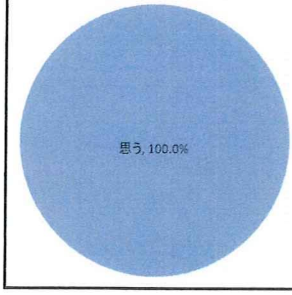

がん登録説明スライド未閲覧(n=9)



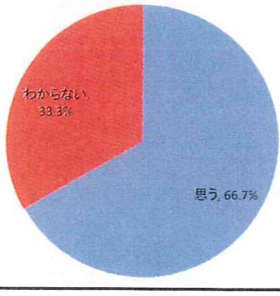

## アンケート 問3

地域がん登録は有益だと思う？

がん登録説明スライド閲覧(n=7)



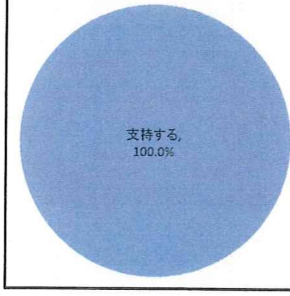

がん登録説明スライド未閲覧(n=9)



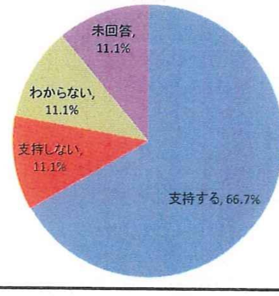

## アンケート 問4

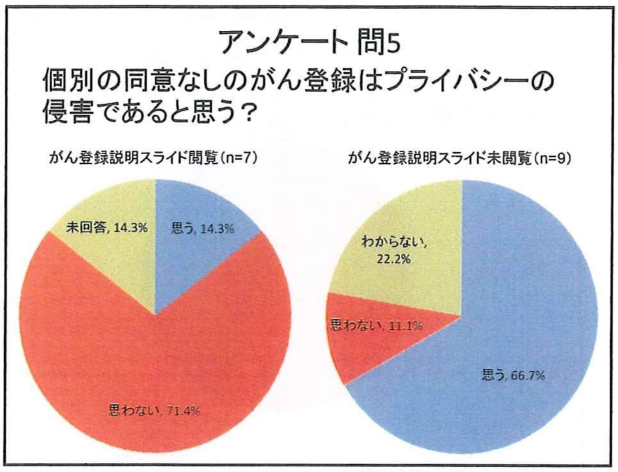
地域がん登録(制度)の法制化の法制化を支持する？

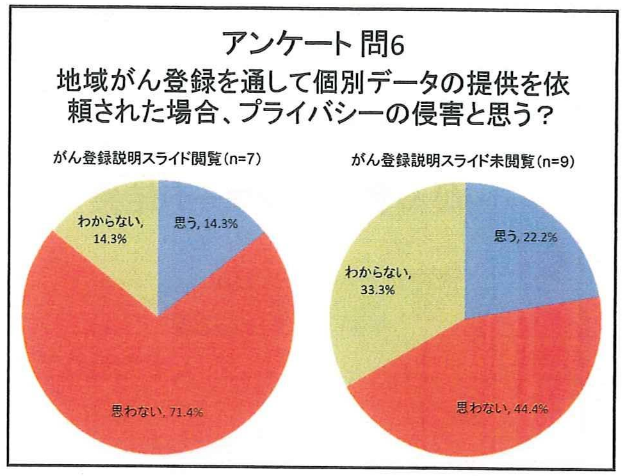
がん登録説明スライド閲覧(n=7)

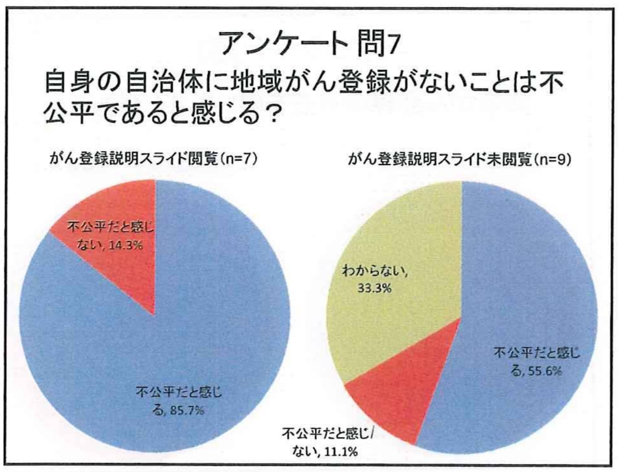


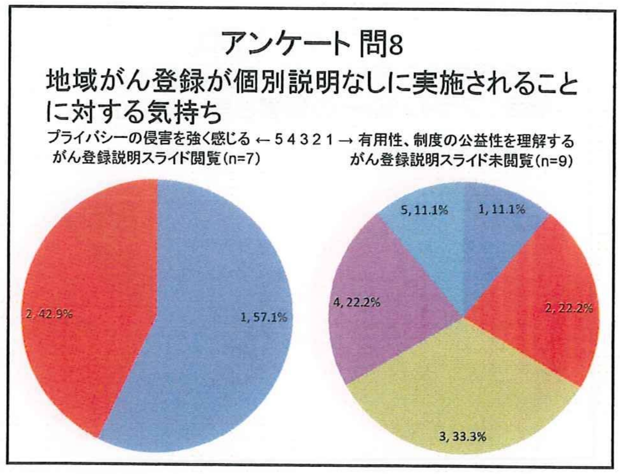

がん登録説明スライド未閲覧(n=9)




アンケート 問5
個別の同意なしのがん登録はプライバシーの侵害であると思う？
がん登録説明スライド閲覧(n=7)
未回答, 14.3%
思う, 14.3%
思わない, 71.4%
がん登録説明スライド未閲覧(n=9)
わからない, 22.2%
思わない, 11.1%
思う, 66.7%


アンケート 問6
地域がん登録を通して個別データの提供を依頼された場合、プライバシーの侵害と思う？
がん登録説明スライド閲覧(n=7)
わからない, 14.3%
思う, 14.3%
思わない, 71.4%
がん登録説明スライド未閲覧(n=9)
思う, 22.2%
わからない, 33.3%
思わない, 44.4%


アンケート 問7
自身の自治体に地域がん登録がないことは不公平であると感じる？
がん登録説明スライド閲覧(n=7)
不公平だと感じない, 14.3%
不公平だと感じる, 85.7%
がん登録説明スライド未閲覧(n=9)
わからない, 33.3%
不公平だと感じる, 55.6%
不公平だと感じない, 11.1%

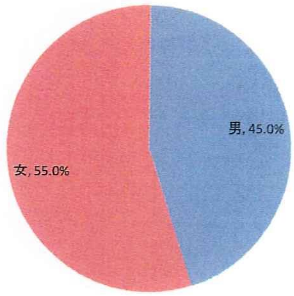

アンケート 問8
地域がん登録が個別説明なしに実施されることに対する気持ち
プライバシーの侵害を強く感じる ← 5 4 3 2 1 → 有用性、制度の公益性を理解する
がん登録説明スライド閲覧(n=7)
2, 42.9%
1, 57.1%
がん登録説明スライド未閲覧(n=9)
5, 11.1%
1, 11.1%
4, 22.2%
2, 22.2%
3, 33.3%

## がん登録アンケート結果

市民公開講座当日に回収した
事後アンケート結果

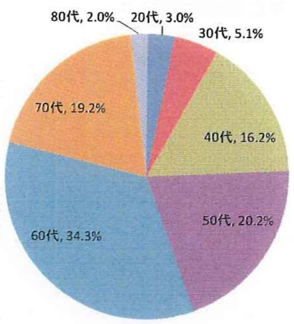
## アンケート回答者　背景

性別（n=100）



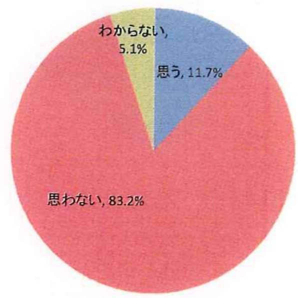

## アンケート回答者　背景

年代（n=99）



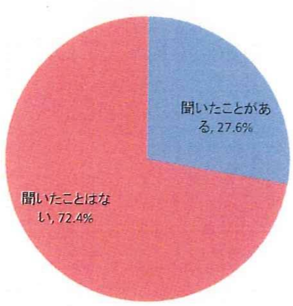

## アンケート 問1（n=196）

市役所から個別に検診受診の勧めが届いた場合、プライバシーの侵害と思う？



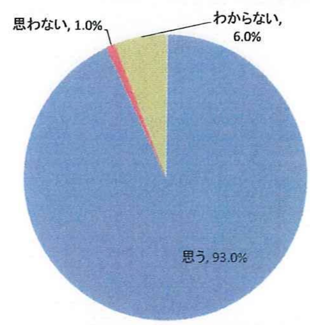

## アンケート 問2（n=199）

地域がん登録の存在を聞いたことがある？

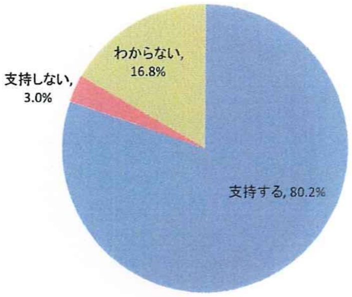



## アンケート 問3（n=199）

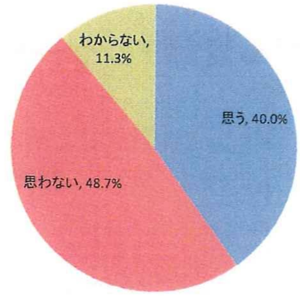
地域がん登録は有益だと思う？



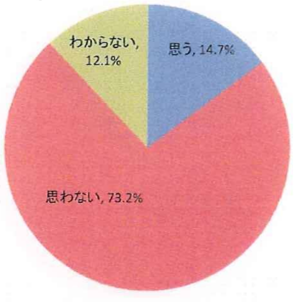
## アンケート 問4（n=197）
地域がん登録（制度）の法制化の法制化を支持する？



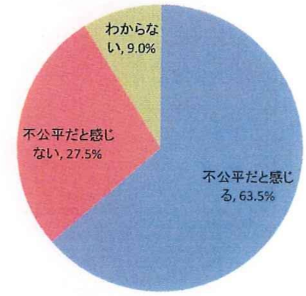

## アンケート 問5（n=195）
個別の同意なしのがん登録はプライバシーの侵害と思う？



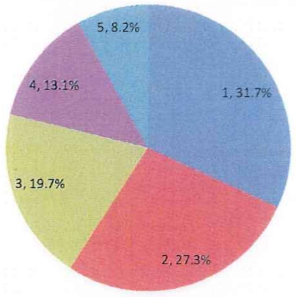

## アンケート 問6（n=190）
地域がん登録を通して個別データの提供を依頼された場合、プライバシーの侵害と思う？




## アンケート 問7（n=189）
自身の自治体に地域がん登録がないことは不公平であると感じる？




## アンケート 問8（n=183）
地域がん登録が個別説明なしに実施されることに対する気持ち




プライバシーの侵害を強く感じる ← 5 4 3 2 1 → 有用性、制度の公益性を理解する

# Ⅳ.　研究成果の刊行物・別刷

Int. J. Radiation Oncology Biol. Phys., Vol. ■, No. ■, pp. 1–11, 2010

0360-3016/09/$–see front matter

ELSEVIER

doi:10.1016/j.ijrobp.2009.10.019

**CLINICAL INVESTIGATION**

# JAPANESE STRUCTURE SURVEY OF RADIATION ONCOLOGY IN 2007 BASED ON INSTITUTIONAL STRATIFICATION OF PATTERNS OF CARE STUDY

Teruki Teshima, M.D.,[*] Hodaka Numasaki, Ph.D.,[*] Hitoshi Shibuya, M.D.,[†] Masamichi Nishio, M.D.,[‡] Hiroshi Ikeda, M.D.,[§] Kenji Sekiguchi, M.D.,[||] Norihiko Kamikonya, M.D.,[¶] Masahiko Koizumi, M.D.,[#] Masao Tago, M.D.,[**] Yutaka Ando, M.D.,[††] Nobuhito Tsukamoto, M.D.,[‡‡] Atsuro Terahara, M.D.,[§§] Katsumasa Nakamura, M.D.,[||||] Michihide Mitsumori, M.D.,[¶¶] Tetsuo Nishimura, M.D.,[##] and Masato Hareyama, M.D., [***] Japanese Society of Therapeutic Radiology and Oncology Database Committee.

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Q1 Kyoto, Japan; [##]Division of Radiation Oncology, Shizuoka Cancer Center, Shizuoka, Japan; and [***]Department of Radiology, Sapporo Medical University, Hokkaido, Japan

**Purpose: To evaluate the ongoing structure of radiation oncology in Japan in terms of equipment, personnel, patient load, and geographic distribution to identify and improve any deficiencies.**
**Methods and Materials: A questionnaire-based national structure survey was conducted from March to December 2008 by the Japanese Society of Therapeutic Radiology and Oncology (JASTRO). These data were analyzed in terms of the institutional stratification of the Patterns of Care Study.**
**Results: The total numbers of new cancer patients and total cancer patients (new and repeat) treated with radiation in**
Q3 **2007 were estimated at 181,000 and 218,000, respectively. There were 807 linear accelerator, 15 telecobalt, 46 Gamma Knife, 45 $^{60}$Co remote-controlled after-loading, and 123 $^{192}$Ir remote-controlled after-loading systems in actual use. The linear accelerator systems used dual-energy function in 539 units (66.8%), three-dimensional conformal radiation therapy in 555 (68.8%), and intensity-modulated radiation therapy in 235 (29.1%). There were 477 JASTRO-certified radiation oncologists, 826.3 full-time equivalent (FTE) radiation oncologists, 68.4 FTE medical physicists, and 1,634 FTE radiation therapists. The number of interstitial radiotherapy (RT) administrations for prostate, stereotactic body radiotherapy, and intensity-modulated radiation therapy increased significantly. Patterns of Care Study stratification can clearly identify the maturity of structures based on their academic nature and caseload. Geographically, the more JASTRO-certified physicians there were in a given area, the more RT tended to be used for cancer patients.**
Q4 **Conclusions: The Japanese structure has clearly improved during the past 17 years in terms of equipment and its use, although a shortage of personnel and variations in maturity disclosed by Patterns of Care Study stratification were still problematic in 2007.** © 2010 Elsevier Inc.

**Structure survey, Radiotherapy facility, Radiotherapy personnel, Radiotherapy equipment, Caseload.**

Reprint requests to: Teruki Teshima, M.D., Department of Medical Physics & Engineering, Osaka University Graduate School of Medicine, 1-7 Yamadaoka, Suita, Osaka 565-0871, Japan. Tel: (+81) 6-6879-2570; Fax: (+81) 6-6879-2570; E-mail: teshima@sahs.med.osaka-u.ac.jp

Supported by the Japanese Society of Therapeutic Radiology and Oncology. This study was also supported by Grants-in-Aid for Cancer Research (Nos. 18–4 and H19–3rd Term Cancer Control–General–038) from the Ministry of Health, Labor and Welfare of Japan and by a Grant-in-Aid for Scientific Research from the Japan Society for the Promotion of Sciences (No. 19390320).

Conflict of interest: none.

*Acknowledgment*—We thank all radiation oncologists and technologists throughout Japan who participated in this survey for their efforts in providing us with information to make this study possible. We also appreciate the continual encouragement and support by Gerald E. Hanks, M.D., former Principal Investigator of the Patterns of Care Study; J. Frank Wilson, M.D., current Principal Investigator; Jean B. Owen, Ph.D., Director; and all other Patterns of Care Study members in the United States and Japan. Q2

Received July 23, 2009, and in revised form Sept 29, 2009. Accepted for publication Oct 6, 2009.

## INTRODUCTION

The medical care systems of the United States and Japan have very different backgrounds. In 1990 the Patterns of Care Study (PCS) conducted a survey of the structure of radiation oncology facilities in 1989 for the entire census of facilities in the United States (1). In 1991 the Japanese Society of Therapeutic Radiology and Oncology (JASTRO) conducted the first national survey of the structure of radiotherapy (RT) facilities in Japan based on their status in 1990, with the results reported by Tsunemoto (2). The first comparison of these two national structure surveys to illustrate and identify similarities and differences in 1989–1990 was conducted by Teshima *et al.* (3) and reported in 1996. The resultant international exchange of information proved especially valuable for Japan, because we could improve our own structure of radiation oncology based on those data.

The Japanese structure has gradually improved in terms of a greater number of cancer patients who are treated with radiation as well as public awareness of the importance of RT. The Japanese Society of Therapeutic Radiology and Oncology has conducted national structure surveys every 2 years since 1990 (4), and in 2006 an anticancer law was enacted in Japan, which strongly advocates the promotion of RT and an increase in the number of radiation oncologists (ROs) and medical physicists. The Japanese Ministry of Education, Sciences, and Sports is supporting the education of these specialists at university medical hospitals. Findings of international comparisons and the consecutive structural data gathered and published by JASTRO have been useful for an understanding of our current position and future direction (4, 5). In this report the recent structure of radiation oncology in Japan is analyzed and compared with the data of 2005 (5).

## METHODS AND MATERIALS

From March to December 2008, JASTRO conducted a questionnaire based on the national structure survey of radiation oncology in 2007. The questionnaire dealt with the number of treatment machines by type, number of personnel by category, and number of patients by type, site, and treatment modality. To measure variables over a longer period of time, data for the calendar year 2007 were also requested. The response rate was 721 of 765 active facilities (94.2%). The data from 573 institutions (79.5%) were registered in the International Directory of Radiotherapy Centres in Vienna, Austria, in October 2008.

The PCS was introduced in Japan in 1996 (6–15). The Japanese PCS used methods similar to those of the American version, which used structural stratification to analyze national averages for the data in each survey item by means of two-stage cluster sampling. We stratified RT facilities throughout the country into four categories for the regular structure surveys. This stratification was based on academic conditions and the annual number of patients treated with radiation at each institution, because academic institutions require and have access to more resources for education and training whereas the annual caseload also constitutes essential information related to structure. For the study reported here, the following institutional Q5 stratification was used: A1, university hospitals/cancer centers treating 440 patients or more per year; A2, university hospitals/cancer centers treating 439 patients or fewer per year; B1, other national/public hospitals treating 140 patients or more per year; and B2, other national hospital/public hospitals treating 139 patients or fewer per year.

We used SAS 8.02 (SAS Institute, Cary, NC) (16) for statistical analyses, and statistical significance was tested by means of chi-square test, Student *t* test, or analysis of variance.

## RESULTS

*Current situation of radiation oncology in Japan*

Table 1 shows that the numbers of new patients and total patients (new plus repeat) undergoing radiation in 2007 were estimated at 181,000 and 218,000, respectively, showing a 7.3% increase over 2005 (5). According to the PCS stratification of institutions, 40.1% of the patients were treated at academic institutions (Categories A1 and A2), even though these academic institutions constituted only 18.6% of the 765 RT facilities nationwide.

Table 1. Patterns of Care Study stratification of radiotherapy facilities in Japan

| Institution category | Description | Facilities (*n*) | New patients (*n*) | Average new patients/ facility* (*n*) | Total patients (new + repeat) (*n*) | Comparison with data of 2005† (%) | Average total patients/ facility* (*n*) | Comparison with data of 2005† (%) |
|---|---|---|---|---|---|---|---|---|
| A1 | UH and CC (≥440 patients/y) | 71 | 49,866 | 702.3 | 60,398 | 10.0 | 850.7 | 2.3 |
| A2 | UH and CC (<440 patients/y) | 71 | 17,974 | 253.2 | 21,867 | 2.1 | 308.0 | −3.6 |
| B1 | Other (≥140 patients/y) | 288 | 78,154 | 271.4 | 94,188 | 6.1 | 327.0 | 6.8 |
| B2 | Other (<140 patients/y) | 291 | 24,235 | 83.3 | 28,634 | 9.6 | 98.4 | 8.8 |
| Total | | 721 | 170,229‡ | 236.1 | 205,087‡ | 7.3 | 284.4 | 5.9 |

*Abbreviations:* UH = university hospital; CC = cancer center hospital; Other = other national, city, or public hospital.

* $p < 0.0001$.

† Rate of increase compared with data of 2005. The calculating formula was as follows: $\frac{\text{data of 2007 } (n) - \text{data of 2005 } (n)}{\text{data of 2005 } (n)} \times 100$ (%). Q18

‡ The number of radiotherapy institutions was 765 in 2007, and the number of new patients was estimated at approximately 181,000; the corresponding number of total patients (new plus repeat) was 218,000.

The cancer incidence in Japan in 2007 was estimated at 692,502 (17), with approximately 26.1% of all newly diagnosed patients treated with radiation. This number has increased steadily during the last 17 years and is expected to increase further (12). In 1990 the rate was estimated to be approximately 15% (3). The corresponding rates were 16%, 17%, 20%, 22%, 23.3% (4), 24.5% (5), and 26.1% in 1995, 1997, 1999, 2001, 2003, 2005, and 2007, respectively.

*Facility and equipment patterns*

Table 2 shows an overview of RT equipment and related Q6 functions. There were 807 linear accelerator (linac) systems, 15 telecobalt systems, 46 Gamma Knife systems, 45 $^{60}$Co remote-controlled after-loading systems (RALSs), and 123 $^{192}$Ir RALSs in actual use. The linac system used dual-energy function in 539 units (66.8%), three-dimensional (3D) conformal radiation therapy (CRT) in 555 (68.8%), and intensity-modulated radiation therapy (IMRT) in 235 (29.1%). The IMRT function was used more frequently in the equipment of academic institutions (A1, 61.6%; A2, 31.9%) than that of nonacademic institutions (B1, 26.4%; B2, 13.0%). However, 3D CRT functions were disseminated widely in both academic and nonacademic institutions, with more than 50% even in B2 institutions. Image-guided radiation therapy functions have been gradually spreading from A1 institutions (28.5%) to the other types of institutions (8.2% to 11.1%), although the rate of expansion has remained low. The annual numbers of patients per linac were 400 for A1 institutions, 238.6 for A2, 296.2 for B1, and 98.4 for B2. The number of institutions with telecobalt in actual use showed a major decrease to 15, and Gamma Knife was installed more frequently in B1 and B2 institutions. A significant replacement of $^{60}$Co RALSs with $^{192}$Ir RALSs was observed especially in academic institutions, whereas the number of new-type $^{60}$Co RALSs in use did not increase. Six particle machines were registered in this survey, two with carbon beam and five with proton beam irradiation. One machine at Hyogo is delivering either carbon or proton. Although HI-Q7 MAC at Chiba has two synchrotrons, it was registered as one machine in the 2007 survey. The total number of new cancer patients treated at these six institutions was estimated at 1,643 (0.9% of all new patients in Japan). Twenty-one advanced institutions were included in the A1 Category and treated more than 800 patients per year. They were equipped with linac with dual-energy function (77.6% of the institutions), 3D CRT function (91.4%), and IMRT function (65.5%), as well as with $^{192}$Ir RALS (85.7%) and a computed tomography (CT) simulator (95.2%).

Table 3 shows an overview of RT planning and other equipment. X-ray simulators were installed in 60.9% of all institutions and CT simulators in 65.6%, with the latter exceeding the former for the first time in 2007. There was a significant difference in the rate of CT simulators installed by institutional stratification, from 93% in A1 institutions to 52.6% in B2 institutions. Very few institutions used magnetic resonance imaging for RT only, whereas computer use for RT recording was pervasive.

*Staffing patterns and patient loads*

Table 4 shows the staffing patterns and patient loads by institutional stratification. "Full time or part time" indicates the style of employment. Even full-time ROs must share the diagnosis in a week in smaller institutions like B2 institutions. We considered that these numbers were not sufficient Q8 for accurate evaluation of personnel. Therefore full-time equivalent (FTE) (40 hours/week only for radiation oncology service) data were surveyed depending on clinical working hours for RT of each person. For example, FTE of a person who has 4 days working is 0.8 and that of 1 day is 0.2. The FTE of an institution that has 3 persons with 0.8, 0.2, and 0.4 is calculated as 1.4 in total. This is a measure to represent actual personnel at each institution. The total number of FTE ROs in Japan was 826.3, whereas the average numbers were 4.3 for A1 institutions, 1.4 for A2, 1.0 for B1, and 0.5 for B2. The number in B1 institutions improved by 12.1% compared with 2005 (5). The overall patient load per FTE RO in Japan was 248.2, and the numbers for A1, A2, B1, and B2 institutions were 200.1, 218.2, 327.3, and 209.9, respectively, with the patient load for B1 institutions being by far the highest. The increase in the rate of FTE ROs was 6.7% over 2005 (5). In Japan 39% of the institutions providing RT have their own designated beds, where ROs must also take care of their inpatients. The percentage distribution of institutions by patient load per FTE RO is shown in Fig. 1, indicating that the largest number of facilities featured a patient/FTE staff level in the 101 to 150 range and the second largest number was in the 151 to 200 range. The blue areas of the bars show that 56% of the institutions (405 of 721) had fewer than 1 FTE RO. Compared with the data of 2005 (5), the patient load is shifting to a larger volume.

A similar trend was observed for RT technologists and their patient load by institutional stratification. The percentage distribution of institutions by patient load per radiation technologist is shown in Fig. 2. The largest number of facilities had a patient–per–RT technologist level in the 101 to 120 range, with the second largest number showing a range of 61 to 80 and the third largest showing a range of 121 to 140. There were 68.4 FTE medical physicists and 106.6 RT quality assurance (QA) staff. For this survey, personnel numbers were checked for duplicate reporting by individual identification on staffing data, and these data will be analyzed in detail in another report. Finally, there were 494.4 FTE nurses.

*Distribution of primary sites, specific treatment, and palliative treatment*

Table 5 shows the distribution of primary sites by institutional stratification. The most common disease site was breast, followed by lung/bronchus/mediastinum and genitourinary sites. In Japan the number of patients with prostate cancer undergoing RT was 16,225 in 2007, an increase of 22.7% over 2005 (5). By disease site, the rate of increase was the highest for prostate cancer, at 22.7%; the second highest was for breast cancer, at 20.1%; and the third highest was for lung cancer, at 14.9%. Stratification of institutions

Table 2. Equipment and its function and patient load per equipment type by Patterns of Care Study institutional stratification

| Radiotherapy equipment and its function | A1 ($n = 71$) | | A2 ($n = 71$) | | B1 ($n = 288$) | | B2 ($n = 291$) | | Total ($n = 721$) | | Comparison with data of 2005 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $n$ | % | $n$ | % | $n$ | % | $n$ | % | $n$ | % | |
| Linear accelerator | 151 | | 91 | | 296 | | 269 | | 807 | | 5.5* |
| With dual-energy function | 116 | 76.8† | 64 | 70.3† | 216 | 73.0† | 143 | 53.2† | 539 | 66.8† | 1.7‡ |
| With 3D CRT function (MLC width ≤1.0 cm) | 136 | 90.1† | 63 | 69.2† | 214 | 72.3† | 142 | 52.8† | 555 | 68.8† | 8.4‡ |
| With IMRT function | 93 | 61.6† | 29 | 31.9† | 78 | 26.4† | 35 | 13.0† | 235 | 29.1† | 6.9‡ |
| With IGRT function | 43 | 28.5† | 10 | 11.0† | 33 | 11.1† | 22 | 8.2† | 108 | 13.4† | |
| With CT on rail | 7 | 4.6† | 6 | 6.6† | 17 | 5.7† | 17 | 6.3† | 47 | 5.8† | |
| With treatment position verification system | 42 | 27.8† | 18 | 19.8† | 36 | 12.2† | 14 | 5.2† | 110 | 13.6† | |
| Annual No. patients/linac | 400.0§ | | 238.6§ | | 296.2* | | 98.4§ | | 243.2§ | | 3.7* |
| Particle | 4 | | 0 | | 1 | | 1 | | 6 | | |
| Q19 Betatron | 0 | | 0 | | 0 | | 0 | | 0 | | |
| Microtoron | 4 | | 2 | | 4 | | 3 | | 13 | | |
| Telecobalt (actual use) | 6 (4) | | 2 (0) | | 7 (2) | | 13 (9) | | 28 (15) | | |
| Gamma Knife | 3 | | 2 | | 31 | | 10 | | 46 | | |
| Other accelerator | 1 | | 1 | | 2 | | 5 | | 9 | | |
| Other external irradiation device | 1 | | 2 | | 2 | | 1 | | 6 | | |
| New-type $^{60}$Co RALS (actual use) | 3 (3) | 4.2‖ (4.2) | 1 (1) | 1.4‖ (1.4) | 10 (10) | 3.5‖ (3.5) | 2 (2) | 0.7‖ (0.7) | 16 (16) | 2.2‖ (2.2) | |
| Old-type $^{60}$Co RALS (actual use) | 6 (5) | 8.5‖ (7.0) | 5 (2) | 7.0‖ (2.8) | 24 (20) | 8.3‖ (6.9) | 4 (2) | 1.4‖ (0.7) | 39 (29) | 5.4‖ (4.0) | |
| $^{192}$Ir RALS (actual use) | 56 (55) | 78.9‖ (77.5) | 31 (29) | 43.7‖ (40.8) | 35 (35) | 12.2‖ (12.2) | 5 (4) | 1.7‖ (1.4) | 127 (123) | 17.6‖ (17.1) | |
| $^{137}$Cs RALS (actual use) | 1 (1) | | 1 (1) | | 2 (1) | | 0 (0) | | 4 (3) | | |

*Abbreviations:* A1 = university hospitals/cancer centers treating 440 patients or more per year; A2 = university hospitals/cancer centers treating 439 patients or fewer per year; B1 = other national/public hospitals treating 140 patients or more per year; B2 = other national hospital/public hospitals treating 139 patients or fewer per year; 3D CRT = three-dimensional conformal radiotherapy; MLC = multileaf collimator; IMRT = intensity-modulated radiotherapy; IGRT = image-guided radiation therapy; CT = computed tomography; linac = linear accelerator; RALS = remote-controlled after-loading system.

* Rate of increase compared with data of 2005. The calculating formula was as follows: $\frac{\text{data of 2007 (n)} - \text{data of 2005 (n)}}{\text{data of 2005 (n)}} \times 100$ (%)

† Percentage calculated from number of systems by use of this function and the total number of linear accelerator systems.

‡ Comparison with data of 2005. The calculating formula was as follows: Data of 2007 (%) – Data of 2005 (%).

§ Number of patients over number of linear accelerators; institutions without linear accelerators excluded from calculation.

‖ Rate of institutions that have this equipment (≥2 pieces of equipment per institution).

Table 3. Radiotherapy planning and other equipments by Patterns of Care Study institutional stratification

| RT planning and other equipment | A1 ($n = 71$) | | A2 ($n = 71$) | | B1 ($n = 288$) | | B2 ($n = 291$) | | Total ($n = 721$) | | Comparison with data of 2005† (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *n* | %* | *n* | %* | *n* | %* | *n* | %* | *n* | %* | |
| X-ray simulator | 55 | 76.1 | 52 | 69.0 | 165 | 56.6 | 173 | 59.5 | 445 | 60.9 | −8.8 |
| CT simulator | 74 | 93.0 | 58 | 77.5 | 210 | 69.1 | 155 | 52.6 | 497 | 65.6 | 10.3 |
| RTP computer (≥2) | 277 (60) | 100 (84.5) | 117 (26) | 100 (36.6) | 370 (57) | 97.2 (19.8) | 306 (25) | 91.1 (8.6) | 1070 (168) | 95.3 (23.3) | 2.2 (2.8) |
| MRI (≥2) | 201 (60) | 95.8 (84.5) | 137 (54) | 93.0 (76.1) | 502 (185) | 97.2 (64.2) | 349 (71) | 95.2 (24.4) | 1189 (370) | 95.8 (51.3) | 1.1 (3.8) |
| For RT only | 1 | 1.4 | 3 | 4.2 | 7 | 2.4 | 0 | 0 | 13 | 1.5 | — |
| Computer use for RT recording | 63 | 88.7 | 64 | 90.1 | 268 | 93.1 | 245 | 84.2 | 640 | 88.8 | 0.9 |

*Abbreviations:* A1 = university hospitals/cancer centers treating 440 patients or more per year; A2 = university hospitals/cancer centers treating 439 patients or fewer per year; B1 = other national/public hospitals treating 140 patients or more per year; B2 = other national hospital/public hospitals treating 139 patients or fewer per year; RT = radiotherapy; CT = computed tomography; RTP = radiotherapy planning; MRI = magnetic resonance imaging.

* Ratio of institutions that have equipment (≥2 pieces of equipment per institution).

† Comparison with data of 2005. The calculating formula was as follows: data of 2007 (%) − data of 2005 (%).

indicates that the rate of increase was notable for lung at A1, B1, and B2 and the corresponding rates for prostate cancer were high at A1, A2, and B1, from 24.7% to 26.2%. On the other hand, the corresponding rate for breast was the lowest (15.6%) at A1, whereas those at A2, B1, and B2 ranged from 20.7% to 22.5%.

Table 6 shows the distribution of usage of specific treatments and the number of patients treated with these modalities by PCS stratification of institutions. Use of interstitial irradiation, radioactive iodine therapy for prostate cancer, stereotactic body RT, and IMRT increased significantly by 19.0%, 52.4%, 50.2%, and 270.7%, respectively, over 2005 (5). On the other hand, the use of intraoperative RT decreased significantly by 35.1% and that of hyperthermia decreased by 41.5%. Institutional stratification shows that there was a dramatic increase of 623.6% in the use of IMRT in B1 (5). In 2007, 58 institutions (8%) actually used IMRT. This percentage was significantly lower than 235 linac systems with IMRT function (29.1%) as shown in Table 2.

Table 7 shows the number of patients with brain or bone metastasis treated with radiation according to the same institutional stratification. The B1 institutions treated more patients with brain metastasis (13.9% of all patients) than other types of institutions, whereas usage of radiation for bone metastasis ranged from 11.4% for A1 to 17.4% for B2. Overall, more patients with bone metastasis were treated with radiation at nonacademic than at academic institutions. Compared with the data of 2005 (5), the number of patients with brain metastasis increased by 38.6%.

### *Geographic patterns*

Figure 3 shows the geographic distributions for 47 prefectures of the annual number of patients (new plus repeat) per 1,000 population arranged in order of increasing number of JASTRO-certified ROs per 1,000,000 population (18). There were significant differences in the use of RT, from 0.9 patients per 1,000 population (Saitama and Okinawa) to 2.1 (Miyagi). The average number of patients per 1,000 population per quarter ranged from 1.42 to 1.69 ($p = 0.0996$). The more JASTRO-certified physicians there were in a given area, the more RT tended to be used for cancer patients, although the correlation was of borderline significance. A similar trend was observed in 2005 (5). The utilization rate of RT in every prefecture increased in 2007 compared with 2005. However, the rate in 2007 was not related to a prefecture's population density, as we also observed in the data for 1990 (3).

## DISCUSSION

In 1990 there were fewer facilities for radiation treatment and patients treated with radiation in Japan than in the United States. However, the numbers of patients in Japan increased significantly during the next 17 years by a factor of 2.8 compared with the number in 1990 (3). However, the

Table 4. Structure and personnel by Patterns of Care Study institutional stratification

| | Structure and personnel | | | | | |
|---|---|---|---|---|---|---|
| | A1 ($n = 71$) | A2 ($n = 71$) | B1 ($n = 288$) | B2 ($n = 291$) | Total ($n = 721$) | Comparison with data of 2005* (%) |
| Institutions/total institutions (%) | 9.8 | 9.8 | 39.9 | 40.4 | 100 | — |
| Institutions with RT bed ($n$) | 59 (83.1) | 35 (49.3) | 120 (41.2) | 67 (23.3) | 281 (39.0) | −2.1 (−1.3†) |
| Average RT beds/ institution ($n$) | 12.9 | 3.2 | 2.8 | 1.0 | 3.1 | −13.9 |
| No. of ROs (full time + part time) | 350 + 47 | 142 + 35 | 336 + 188 | 179 + 264 | 1007 + 534 | 6.1 |
| JASTRO*-certified ROs* (full time) | 198 | 64 | 169 | 46 | 477 | 12.0 |
| Average JASTRO-certified ROs/institution | 2.8 | 0.9 | 0.6 | 0.2 | 0.7 | 16.7 |
| Total (full time and part time) RO FTE* | 301.9 | 100.2 | 287.8 | 136.4 | 826.3 | 6.7 |
| Average FTE ROs/ institution | 4.3 | 1.4 | 1.0 | 0.5 | 1.1 | 0.9 |
| Patient load/FTE RO | 200.1 | 218.2 | 327.3 | 209.9 | 248.2 | 0.6 |
| No. of RT technologists (full time + part time) | 471 + 24 | 267 + 7 | 1046 + 31 | 833 + 3 | 2617 + 65 | — |
| Total (full time and part time) RT* technologists FTE | 375.8 | 178.7 | 648.9 | 430.7 | 1634.1 | — |
| Average FTE RT technologists/institution | 5.3 | 2.5 | 2.3 | 1.5 | 2.3 | — |
| Patient load/FTE RT technologist | 160.7 | 122.4 | 145.2 | 66.5 | 125.5 | — |
| No. of nurses (full time + part time) | 162 + 16 | 129 + 11 | 454 + 72 | 319 + 38 | 1064 + 137 | 68.9 |
| Total (full time and part time) nurses FTE | 118.5 | 57.7 | 220.9 | 97.3 | 494.4 | — |
| No. of medical physicists (full time + part time) | 80 + 2 | 37 + 2 | 104 + 6 | 47 + 1 | 268 + 11 | 129.1 |
| Total (full time and part time) medical physicists FTE | 26.2 | 6.3 | 27.4 | 8.5 | 68.4 | — |
| No. of RT QA staff (full time + part time) | 132 + 1 | 70 + 2 | 222 + 5 | 104 + 0 | 528 + 8 | 105.6 |
| Total (full time and part time) RT QA staff FTE | 31.5 | 12.1 | 46.4 | 16.6 | 106.6 | — |

*Abbreviations:* A1 = university hospitals/cancer centers treating 440 patients or more per year; A2 = university hospitals/cancer centers treating 439 patients or fewer per year; B1 = other national/public hospitals treating 140 patients or more per year; B2 = other national hospital/public hospitals treating 139 patients or fewer per year; RT = radiotherapy; RO = radiation oncologist; JASTRO = Japanese Society of Therapeutic Radiology and Oncology; FTE = full-time equivalent (40 hours/week only for RT practice); QA = quality assurance.

Data in parentheses are percentages. "Full time or part time" means only the style of employment at each institution. However, FTE data were surveyed depending on clinical working hours for RT of each person. This is a measure to represent actual personnel at each institution.

* Rate of increase compared with data of 2005. The calculating formula was as follows: $\frac{\text{data of 2007 }(n) - \text{data of 2005 }(n)}{\text{data of 2005 }(n)} \times 100$ (%)

† Comparison with data of 2005. The calculating formula was as follows: Data of 2007 (%) − Data of 2005 (%).

utilization rate of radiation for new cancer patients remained at 26.1%, less than half that recorded in the United States and European countries, although the rate increased slightly, by 0.8% per year between 2005 (5) and 2007. For the implementation of the anticancer law, comparative data of the structure of radiation oncology in Japan and in the United States, as well as relevant PCS data, proved to be very helpful.

Compared with 1990, the number of linac systems increased significantly by a factor of 2.45 and grew by 5.5% over 2005 (5) whereas the percentage of systems using telecobalt decreased to only .15. Furthermore, the various functions of linac, such as dual energy, 3D CRT (multileaf collimator width <1 cm), and IMRT, improved significantly. The number of HDR RALSs in use has increased by 1.4 times, and $^{60}$Co RALSs have been largely replaced by $^{192}$Ir RALSs. In 2007 CT simulators were installed in 65.6% of institutions throughout the country for a 10.3% increase over 2005 (5) and exceeded the percentage of X-ray simulators (60.9%). Radiotherapy planning systems were used in 95.3% of institutions, for an increase in the number of

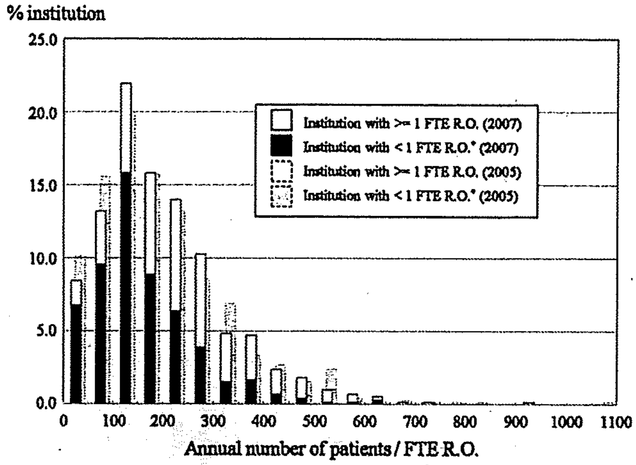


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Fig. 1. Percentage of institutions by patient load per full-time equivalent (FTE) staff of radiation oncologists (RO) in Japan. White bars or gray bars represent institutions with 1 or more FTE staff, and blue bars or aqua bars represent institutions with fewer than 1 FTE RO. Spacing of the bars represents intervals of 50 patients per FTE RO. Asterisk, The number of FTEs for institutions with FTE fewer than 1 was calculated as FTE equal to 1 to avoid overestimating patient Q17 load per FTE RO.

radiotherapy planning systems of 5.54 times compared with 1990 (3). Maturity of the functions of linac and possession rates of CT simulators and systems using $^{192}$Ir RALS also improved further compared with 2005 (5) but still closely correlated with the PCS institutional stratification, which could therefore aid in the accurate discrimination of structural maturity and immaturity and the identification of structural targets for improvement.

The staffing patterns in Japan also improved in terms of numbers. However, institutions with fewer than 1 FTE RO on their staff still account for 56% nationwide, representing a 4% decrease compared with 2005 data (5). Therefore more than half the institutions in Japan still rely on part-time ROs. There are two reasons for this. First, the number of cancer patients who require radiation is increasing more rapidly, by 7.3% in the last 2 years, than the number of FTE ROs, which grew by 6.7% during the same period. Second, specialist fees for ROs in academic institutions are not recognized by the Japanese medical care insurance system, which is strictly controlled by the government. Therefore most ROs or other oncologists at academic institutions must work part time at affiliated hospitals in the B1 and B2 groups to earn a living. To reduce the number of institutions that rely on part-time ROs and thus may encounter problems with their quality of care, a reform of Japan's current medical care system, especially as it applies to staff at academic institutions, is required based on treatment outcome. However, great care is needed to ensure that the long-term success of radiation oncology in Japan and patient benefits are well balanced with costs. Therefore personal identification of ROs in Q11 all four types of institutions (A1, A2, B1, and B2) was recorded in this survey for further detailed analysis of patient load and real cost. Even under current conditions, however, the number of FTE ROs increased by 2.26 times compared with 1990 (3), with a 6.7% increase over 2005 (5). On the other hand, patient load per FTE RO also increased by 1.44 times to 248.2 during the same period, that is, a 0.6% increase over 2005 (5). This may reflect the growing popularity of RT because of an increase in the elderly population and recent advances in technology and improvement in clinical results. The caseload ratio in Japan has already exceeded the limit of the Blue Book guidelines of 200 patients per RO and has been getting worse (19, 20). The percentage distribution of institutions by patient load per RO showed a smaller distribution than that in the United States in 1989 (3) but also showed a major shift to a larger size in 2007 compared with 1990 (3). Therefore Japanese radiation oncology seems to be catching up quickly with the Western system despite limited resources. Furthermore, additional recruiting and education of ROs are still top priorities for JASTRO.

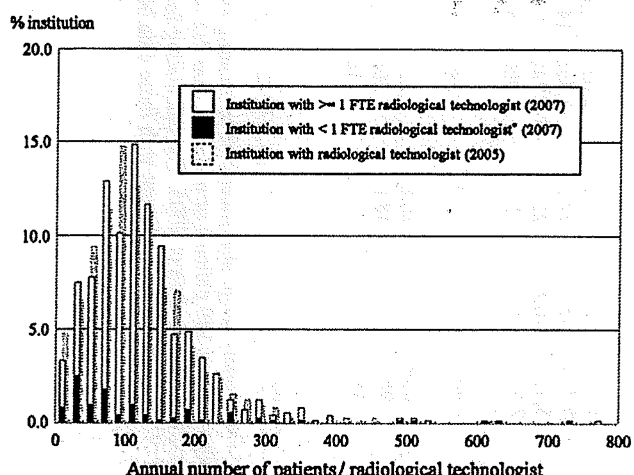


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Fig. 2. Percentage of institutions by patient load per full-time equivalent (FTE) radiotherapy technologist in Japan. Spacing of the bars represents intervals of 20 patients per FTE staff. Asterisk, The number of FTEs for institutions with FTE fewer than 1 was calculated as FTE equal to 1 to avoid overestimating patient load per FTE radiotherapy technologist.

The distribution of patient load per RT technologist shows that only 14.7% of institutions met the narrow guideline range (100–120 per RT technologist) and the rest were densely distributed around the peak level. Compared with the distribution in the United States in 1989, nearly 18% of institutions in Japan had a relatively low caseload of 10 to 60, because there are still a large number of smaller B2-type institutions, which account for nearly 40% of institutions that do not attain the range specified by the guidelines. As for medical physicists, a similar analysis for patient load per FTE staff remains difficult, because their number was very small and they were working mainly in metropolitan areas. In Japan, however, RT technologists have been acting partly as medical physicists. Their education has been changed from 3 to 4 years during the last decade, and graduate and postgraduate courses have been introduced. Currently, those who have obtained a master's degree or RT technologists with enough clinical experience can take the examination for qualification as a medical physicist, as can those with a master's degree in science or engineering, like

Table 5. Primary sites of cancer treatment with radiotherapy in 2005 by Patterns of Care Study institutional stratification for new patients

| Primary site | A1 (n = 71) | | Comparison with data of 2005* (%) | A2 (n = 70) | | Comparison with data of 2005* (%) | B1 (n = 282) | | Comparison with data of 2005* (%) | B2 (n = 283) | | Comparison with data of 2005* (%) | Total (n = 706) | | Comparison with data of 2005* (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | | n | % | | n | % | | n | % | | n | % | |
| Cerebrospinal | 2,021 | 4.1 | −22.4 | 720 | 4.1 | −6.5 | 5,569 | 7.2 | 25.7 | 1,396 | 5.9 | 75.6 | 9,706 | 5.8 | 12.9 |
| Head and neck (including thyroid) | 6,522 | 13.1 | 3.2 | 2,124 | 12.0 | −10.5 | 6,262 | 8.1 | 3.8 | 1,655 | 6.9 | 0.3 | 16,563 | 9.8 | 1.2 |
| Esophagus | 3,448 | 6.9 | 9.0 | 1,179 | 6.7 | 0.7 | 4,068 | 5.3 | −8.1 | 1,474 | 6.2 | 1.5 | 10,169 | 6.0 | −0.4 |
| Lung, trachea, and mediastinum | 7,460 | 15.0 | 5.5 | 2,852 | 16.1 | 8.1 | 16,811 | 21.7 | 12.5 | 5,844 | 24.5 | 8.5 | 32,967 | 19.5 | 9.7 |
| Lung | 6,794 | 13.6 | 24.2 | 2,452 | 13.9 | 7.9 | 14,546 | 18.8 | 12.6 | 5,393 | 22.6 | 13.9 | 29,185 | 17.3 | 14.9 |
| Breast | 10,336 | 20.8 | 15.6 | 3,663 | 20.7 | 20.1 | 17,334 | 22.4 | 22.5 | 5,011 | 21.0 | 21.7 | 36,344 | 21.5 | 20.1 |
| Liver, biliary tract, and pancreas | 1,929 | 3.9 | −0.4 | 674 | 3.8 | −5.5 | 2,806 | 3.6 | 2.3 | 1,023 | 4.3 | 6.1 | 6,432 | 3.8 | 1.2 |
| Gastric, small intestine, and colorectal | 2,075 | 4.2 | 9.4 | 1,015 | 5.7 | 25.9 | 4,034 | 5.2 | 7.8 | 1,498 | 6.3 | 7.1 | 8,622 | 5.1 | 9.9 |
| Gynecologic | 3,315 | 6.7 | 1.9 | 1,058 | 6.0 | −8.5 | 3,059 | 4.0 | −10.2 | 781 | 3.3 | −8.7 | 8,213 | 4.9 | −5.3 |
| Urogenital | 6,772 | 13.6 | 22.2 | 2,498 | 14.1 | 22.3 | 9,750 | 12.6 | 20.8 | 2,993 | 12.6 | 3.0 | 22,013 | 13.0 | 18.6 |
| Prostate | 5,394 | 10.8 | 25.7 | 1,748 | 9.9 | 26.2 | 7,015 | 9.1 | 24.7 | 2,068 | 8.7 | 7.9 | 16,225 | 9.6 | 22.7 |
| Hematopoietic and lymphatic | 2,591 | 5.2 | 5.3 | 900 | 5.1 | −14.4 | 3,631 | 4.7 | 0.2 | 935 | 3.9 | 3.4 | 8,057 | 4.8 | 0.2 |
| Skin, bone, and soft tissue | 1,456 | 2.9 | −9.4 | 484 | 2.7 | −35.4 | 1,879 | 2.4 | 2.7 | 751 | 3.2 | −26.2 | 4,570 | 2.7 | −12.2 |
| Other (malignant) | 894 | 1.8 | 26.8 | 237 | 1.3 | 0.9 | 897 | 1.2 | 9.1 | 292 | 1.2 | −6.7 | 2,320 | 1.4 | 11.8 |
| Benign tumors | 988 | 2.0 | 48.8 | 266 | 1.5 | −0.7 | 1,288 | 1.7 | −0.1 | 186 | 0.8 | 37.8 | 2,728 | 1.6 | 15.8 |
| Pediatric <15 y (included in totals kiabove) | 440 | 0.9 | 1.1 | 116 | 0.7 | −5.7 | 374 | 0.5 | 100.0 | 126 | 0.5 | −58.3 | 1,056 | 0.6 | 0.9 |
| Total | 49,807 | 100 | 7.9 | 17,670 | 100 | 3.8 | 77,388 | 100 | 11.3 | 23,839 | 100 | 8.9 | 168.704† | 100 | 9.1 |

*Abbreviations:* A1 = university hospitals/cancer centers treating 440 patients or more per year; A2 = university hospitals/cancer centers treating 439 patients or fewer per year; B1 = other national/public hospitals treating 140 patients or more per year; B2 = other national hospital/public hospitals treating 139 patients or fewer per year.

* Rate of increase compared with data of 2005. The calculating formula was as follows: $\frac{\text{data of 2007 (n)} - \text{data of 2005 (n)}}{\text{data of 2005 (n)}} \times 100$ (%)

† The total number of new patients was different with these data because no data on primary sites were reported by some institutions.

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Table 6. Distribution of specific treatments and numbers of patients treated with these modalities by Patterns of Care Study stratification of institutions

| | A1 ($n$ = 71) | | A2 ($n$ = 71) | | B1 ($n$ = 288) | | B2 ($n$ = 291) | | Total ($n$ = 721) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Specific therapy | $n$ | % | $n$ | % | $n$ | % | $n$ | % | $n$ | % | Comparison with data of 2005* (%) |
| Intracavitary RT | | | | | | | | | | | |
| Treatment facilities | 65 | 91.5 | 32 | 45.1 | 70 | 24.3 | 5 | 1.7 | 172 | 23.9 | |
| Cases | 1,795 | | 497 | | 925 | | 18 | | 3,235 | | −0.3 |
| Interstitial RT | | | | | | | | | | | |
| Treatment facilities | 51 | 71.8 | 19 | 26.8 | 22 | 7.6 | 5 | 1.7 | 97 | 13.5 | |
| Cases | 1,968 | | 392 | | 895 | | 46 | | 3,301 | | 19.0 |
| Radioactive iodine therapy for prostate | | | | | | | | | | | |
| Treatment facilities | 43 | 60.6 | 12 | 16.9 | 22 | 7.6 | 1 | 0.3 | 78 | 10.8 | |
| Cases | 1,613 | | 311 | | 759 | | 7 | | 2,690 | | 52.4 |
| Total body RT | | | | | | | | | | | |
| Treatment facilities | 64 | 90.1 | 34 | 47.9 | 68 | 23.6 | 19 | 6.5 | 185 | 25.7 | |
| Cases | 701 | | 185 | | 688 | | 133 | | 1,707 | | −1.8 |
| Intraoperative RT | | | | | | | | | | | |
| Treatment facilities | 15 | 21.1 | 9 | 12.7 | 10 | 3.5 | 7 | 2.4 | 41 | 5.7 | |
| Cases | 92 | | 39 | | 105 | | 15 | | 251 | | −35.1 |
| Stereotactic brain RT | | | | | | | | | | | |
| Treatment facilities | 40 | 56.3 | 24 | 33.8 | 92 | 31.9 | 30 | 10.3 | 186 | 25.8 | |
| Cases | 1,920 | | 433 | | 8,805 | | 1,396 | | 12,554 | | 12.9 |
| Stereotactic body RT | | | | | | | | | | | |
| Treatment facilities | 43 | 60.6 | 14 | 19.7 | 54 | 18.8 | 12 | 4.1 | 123 | 17.1 | |
| Cases | 878 | | 204 | | 1,189 | | 219 | | 2,490 | | 50.2 |
| IMRT | | | | | | | | | | | |
| Treatment facilities | 25 | 35.2 | 4 | 5.6 | 25 | 8.7 | 4 | 1.4 | 58 | 8.0 | |
| Cases | 1,142 | | 38 | | 1,534 | | 85 | | 2,799 | | 270.7 |
| Thermoradiotherapy | | | | | | | | | | | |
| Treatment facilities | 8 | 11.3 | 5 | 7.0 | 8 | 2.8 | 2 | 0.7 | 23 | 3.2 | |
| Cases | 233 | | 34 | | 69 | | 4 | | 340 | | −41.5 |

*Abbreviations:* A1 = university hospitals/cancer centers treating 440 patients or more per year; A2 = university hospitals/cancer centers treating 439 patients or fewer per year; B1 = other national/public hospitals treating 140 patients or more per year; B2 = other national hospital/public hospitals treating 139 patients or fewer per year; RT = radiotherapy; IMRT = intensity-modulated radiotherapy.

* Rate of increase compared with data of 2005. The calculating formula was as follows: $\frac{data\ of\ 2007\ (n) - data\ of\ 2005\ (n)}{data\ of\ 2005\ (n)} \times 100$ (%)

those in the United States or Europe. In Japan a unique, hybrid-like education system for medical physicists has been developed since the anticancer law actively started to support improvement in QA/quality control specialization for RT. However, the validity of this education and training system remains to be proven, not only for QA/quality control but also for unique research and developmental activities. The discrepancy between FTE medical physicists and the number of registered medical physicists in Japan reflects the fact that their role in the clinic is not recognized as a full-time position only for medical physics service.

The distribution of the primary site for RT showed that more lung cancer patients were treated in B1- or B2-type nonacademic institutions whereas more head-and-neck cancer patients were treated in A1- or A2-type academic institutions. These findings may reflect the fact that more curative patients are referred to academic institutions and more palliative patients with lung cancer are treated at nonacademic institutions

Table 7. Brain metastasis or bone metastasis patients treated with radiotherapy in 2005 by Patterns of Care Study institutional stratification

| | No. of patients | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | A1 ($n$ = 71) | | A2 ($n$ = 71) | | B1 ($n$ = 288) | | B2 ($n$ = 291) | | Total ($n$ = 721) | | |
| Metastasis | $n$ | % | $n$ | % | $n$ | % | $n$ | % | $n$ | % | Comparison with data of 2005* (%) |
| Brain | 3,761 | 6.2 | 1,402 | 6.4 | 13,097 | 13.9 | 2,977 | 10.4 | 21,237 | 10.4 | 38.6 |
| Bone | 6,893 | 11.4 | 2,761 | 12.6 | 13,332 | 14.2 | 4,984 | 17.4 | 27,970 | 13.6 | 1.8 |

*Abbreviations:* A1 = university hospitals/cancer centers treating 440 patients or more per year; A2 = university hospitals/cancer centers treating 439 patients or fewer per year; B1 = other national/public hospitals treating 140 patients or more per year; B2 = other national hospital/public hospitals treating 139 patients or fewer per year.

* Rate of increase compared with data of 2005. The calculating formula was as follows: $\frac{data\ of\ 2007\ (n) - data\ of\ 2005\ (n)}{data\ of\ 2005\ (n)} \times 100$ (%)

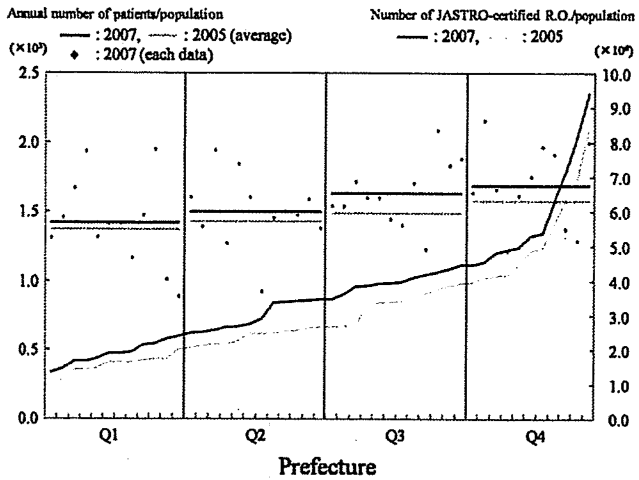


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Fig. 3. Geographic distribution for 47 prefectures of annual numbers of patients (new plus repeat) per 1,000 population arranged in order of increasing number of Japanese Society of Therapeutic Radiology and Oncology (JASTRO)–certified radiation oncologists (ROs)/1,000,000 population by prefecture: Q1, 0–25%; Q2, 26–50%; Q3, 51–75%; and Q4, 76–100%. Horizontal lines show average annual number of patients (new plus repeat) per 1,000 prefectural population per quarter.

in Japan. However, the increase in the number of lung cancer patients in A1 institutions and that in prostate cancer patients in A1-, A2-, and B1-type institutions in 2007 were noteworthy. This suggests that the use of stereotactic body RT for lung cancer in A1 and of 3D CRT for prostate cancer in A1, A2, and B1 increased in 2007. The number of patients with brain metastasis increased significantly by 38.6% over Q13 2005. This may also reflect dissemination of stereotactic body RT for brain metastasis. The use of specific treatments and the number of patients treated with these modalities were significantly affected by institutional stratification, with more specific treatments being performed at academic institutions. These findings indicate that significant differences in patterns of care, as reflected in structure, process, and possibly outcome for cancer patients, continued to be prevalent in Japan in 2007. These differences point to opportunities for improvement. The Japanese PCS group published structural guidelines based on PCS data (20), and we are using the structural data obtained in 2007 to revise the Japanese structural guidelines for radiation oncology. The use of intraoperative RT and thermoradiotherapy decreased significantly, so these two modalities may not be considered as mainstay treatments anymore in Japan.

Geographic patterns showed that there were significant differences among prefectures in the use of RT, and the number of JASTRO-certified physicians per population was associated with the utilization of RT in both 2005 (5) and 2007, so a shortage of ROs or medical physicists on a regional basis will remain a major concern in Japan. However, the overall utilization rate of radiation in 2007 improved further compared with 2005 (5). The Japanese Society of Therapeutic Radiology and Oncology has been making every effort to recruit and educate ROs and medical physicists through public relations, to establish and conduct training courses at academic institutions, to become involved in the national examination for physicians, and to seek an increase in the reimbursement by the government-controlled insurance scheme and other actions.

In conclusion, the Japanese structure of radiation oncology has clearly and steadily improved over the past 17 years in terms of installation and use of equipment and its functions, although a shortage of personnel and differences in maturity by type of institution and by caseload still remain. Structural immaturity is an immediate target for improvement, whereas for improvements in process and outcome, the PCS and National Cancer Database, which are currently operational and the subject of close examination, can be expected to play an important role in the near future in Japan.

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Int J Clin Oncol (2009) 14:237–244
DOI 10.1007/s10147-008-0851-6



ORIGINAL ARTICLE

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# National structure of radiation oncology in Japan with special reference to designated cancer care hospitals

Received: August 22, 2008 / Accepted: October 9, 2008

**Abstract**
***Background.*** The structure of radiation oncology in designated cancer care hospitals in Japan was investigated in terms of equipment, personnel, patient load, and geographic distribution, and compared with the structure in other radiotherapy facilities.
***Methods.*** The Japanese Society of Therapeutic Radiology and Oncology (JASTRO) conducted a questionnaire survey about the national structure of radiation oncology in 2005. In the current study, the structures of 326 designated cancer care hospitals and the other 386 radiotherapy facilities in Japan were compared.
***Results.*** Designated cancer care hospitals accounted for 45.3% of all radiotherapy facilities. The patterns of equipment and personnel in designated cancer care hospitals and the other radiotherapy facilities were as follows: linear accelerators/facility, 1.2 and 1.0; dual-energy function, 73.1% and 56.3%; three-dimensional conformal radiotherapy function, 67.5% and 52.7%; intensity-modulated radiotherapy function, 30.0% and 13.9%; annual number of patients/linear accelerator, 289.7 and 175.1; $^{192}$Ir remote-controlled afterloading systems, 27.6% and 8.6%; and average number of full-time equivalent radiation oncologists/facility, 1.4 and 0.9 ($P < 0.0001$). There were significant differences in equipment and personnel between the two types of facilities. Annual patient loads/full-time equivalent radiation oncologist in the designated cancer care hospitals and the other radiotherapy facilities were 252 and 240. Geographically, the number of designated cancer care hospitals was associated with the population, and the number of JASTRO-certified physicians was associated with the number of patients undergoing radiotherapy.
***Conclusion.*** The Japanese structure of radiation oncology in designated cancer care hospitals was more mature than that in the other radiotherapy facilities in terms of equipment, although a shortage of personnel still exists. The serious understaffing problem in radiation oncology should be corrected in the future.

**Key words** Radiotherapy · Medical Engineering · Epidemiology

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