

この情報だけでは回答は難しいです。セカンドオピニオンに来てください。

質問 12

前立腺癌, 男性, 73 骨に転移, 尾骶骨周辺に痛み

12 年前前立腺がん摘出、6 年前膀胱に転移、摘出。

・一昨年膀胱への放射線治療を受けましたが、今回、尾てい骨周辺(骨への転移部分)への照射が難しい様な話を伺いました。なぜなのでしょう？

回答 (三木先生)

この情報だけでは回答は難しいです。セカンドオピニオンに来てください。

回答 (中村先生)

6 年前に膀胱へ放射線をあてた時に、尾てい骨(尾骨)の周りにも放射線が当たっていたと考えられます。尾てい骨(尾骨)の周りには、直腸などの比較的放射線に弱い臓器があります。放射線を追加することで、直腸などの臓器が耐えることができる線量を超える可能性があり、将来的に副作用が強くなることを危惧したと考えられます。ただし、同じ場所でも、場合によって放射線治療を追加できることがありますので、放射線腫瘍医におたずね下さい。

質問 13

前立腺癌, 男性, 73, 骨に転移

・前立腺に放射線治療は大変効果的とのお話がありましたが、骨に転移した場合、その部分への照射応用は可能でしょうか？また、定位(ピンポイント)放射線治療の可能性はどうでしょうか？これらが可能且つ有効であるとすれば、その際の留意点は何でしょうか？

回答 (中村先生)

骨に転移があり、痛みを伴う場合には、放射線治療は有効です。ただ、痛みなどの症状がなく、脊髄などの神経を圧迫する可能性や、骨折の恐れが少ない場合には、ホルモン療法や抗がん剤のみの治療を行い、放射線治療は行わないことが一般的です。定位放射線治療は、通常骨の転移には行いません。

がん登録回答

質問 1

院内がん登録の整備状況。いつごろ欧米並みのシステムが完成するか。

回答（手島先生）

国立がんセンターのがん対策情報センターが中心になって進めており、拠点病院データを集めて分析しているところです。データを入れる人達の研修を進めています。先程、講演でも説明したように全国を網羅するレベルまで考えると5年以上はかかりそうです。これらをさらに加速するためには皆様の法制化に対するご理解とご支援が必須です。

質問 2

現在治療を受けている病院で、自分の治療経過について「がん登録」がされているかどうか不明な場合、どのようにして確認できるか？

回答（手島先生）

担当医に尋ねてみるのがよいでしょう。拠点病院であれば最近は登録されているはずです。

質問 3

・もし、がん登録がされていない場合、個人で登録する方法はあるのか？（この辛く苦しい貴重な経験を後に罹患した人の為に役立てて欲しいと願う場合、どうすれば良いのか？）

回答（手島先生）

とてもありがたいお申し出ですが、現状では個人で登録できる方法はありません。将来的には自分のデータは各自いつでも確認できるようなシステムにしていきたいです。少し時間がかかるかもしれませんが、努力いたします。

粒子線治療回答

質問 1

まだ施設が限られているようだが、お勧め施設を知りたい(東京 or 関東)。

回答 (鎌田先生)

既存施設は 7 施設(放医研、筑波大学、国立がんセンター東病院、静岡がんセンター、若狭湾エネルギー研究センター、兵庫県粒子線医療センター、南東北がん陽子線治療センター)解らなければ、放医研にお尋ね下さい。

質問 2

人体に重イオンを照射するような大型装置が多くの病院に入るようになるのですか。

回答 (鎌田先生)

すべての病院に入るのは難しいですが、各地方の拠点病院等に設置されると望ましいと考えられています。

質問 3

過去の大まかな実施件数やその成果

回答 (鎌田先生)

放医研では、1994 年治療開始からの累計が 5000 名を超えました。昨年度の国内粒子線治療施設の治療患者数総計は約 1700 名です

質問 4

粒子線治療の失敗例など

回答 (鎌田先生)

臨床試験の初期に皮膚障害などがありました。が、試験の実績により現在は起こるとしても軽微なものになっています。

質問 5

佐賀県の粒子線治療施設の進行状況は

回答（鎌田先生）

建設準備が進み事業計画が承認されて、近日中に関係法人が設立される予定です。

がん遺伝子回答

質問 1～5

- ・がんは遺伝するのか、しないのか。
- ・兄弟もがんで死亡したが、その他の兄弟も高い確率で発病するのか
- ・今後のがん治療の切り札になるか。今、研究で最も困っていることは。
- ・治療への応用についての現状について
- ・個人情報等に関する法整備の実態

回答（吉田先生）

上記は講演内で回答(最後の質問は若干触れる予定)

質問 6

- ・癌幹細胞は治療法があるのか？今の治療で幹細胞迄根治できるのか？再発に関して幹細胞の影響

回答（吉田先生）

- 1) がん幹細胞はまだまだ仮説・概念の段階。正体はまだ確実に捕まえている訳ではないし、全てのがんにがん幹細胞があるのかも不明。
- 2) がん幹細胞を見つけ、その特徴を明らかにし、明らかにしたその特徴を狙った治療の基礎研究は行われている。
- 3) しかしがん幹細胞だけやっつければそれで済むのかというとそれもまだわからない。残された細胞からまたがん幹細胞に変身する細胞が出てくるかも知れない。
- 4) がん幹細胞は再発や転移に関係している、というのが一つの仮説。

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、最近で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）

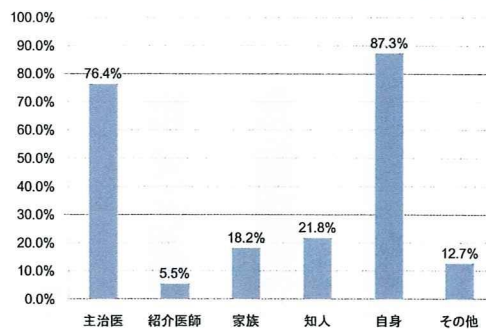
そのように評価していただきとても光栄です。今後ともよろしく願いいたします。

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

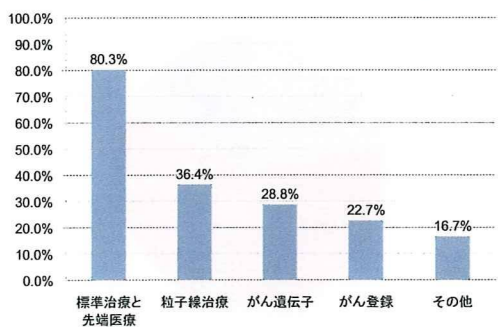
がんに関する情報の入手方法

n=55(複数回答可能)



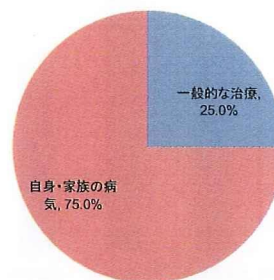
特に聴きたい講演

n=58(複数回答可能)



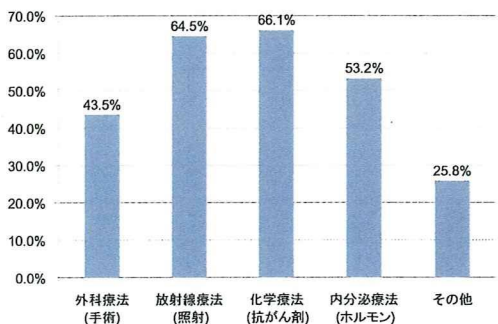
今回、お聞きになりたいこと

n=60



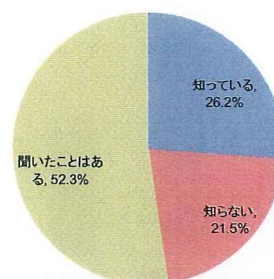
標準的ながん治療 知りたい治療法

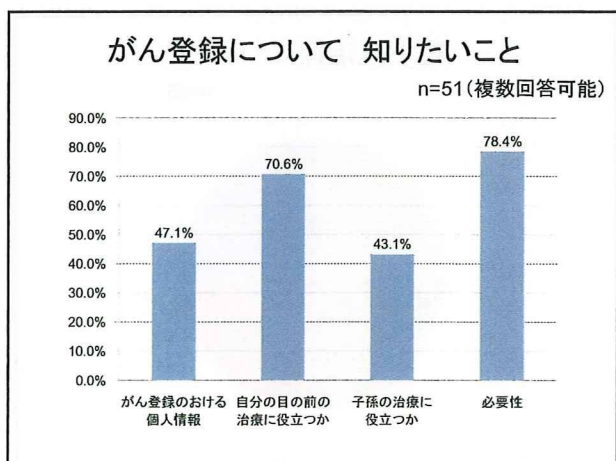
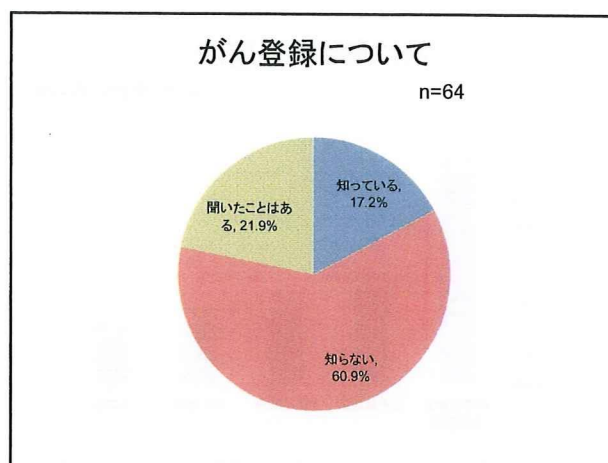
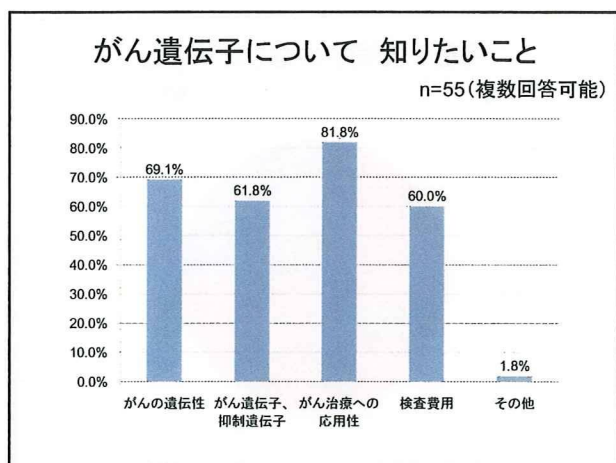
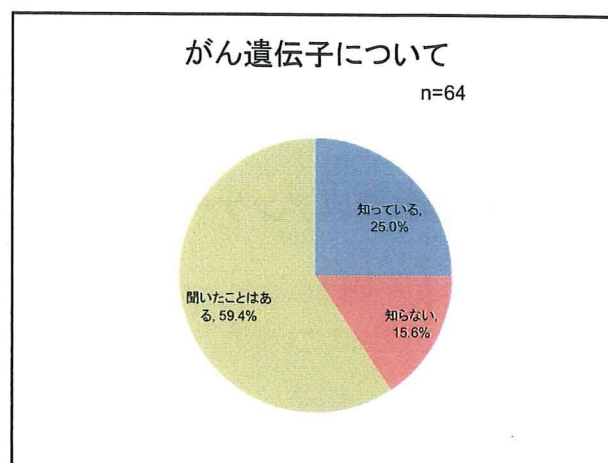
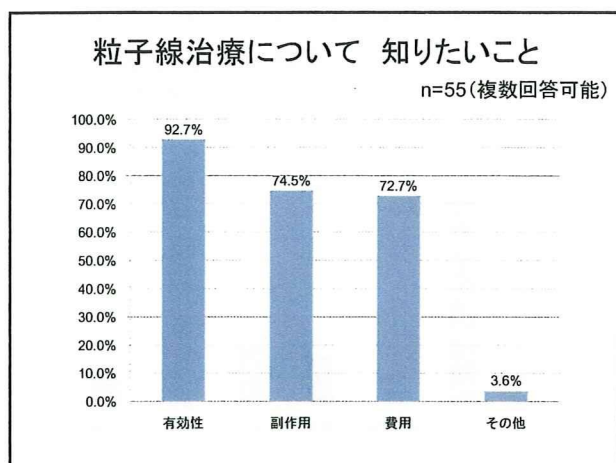
n=62(複数回答可能)



粒子線治療について

n=65

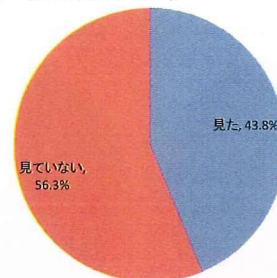




がん登録アンケート結果

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。

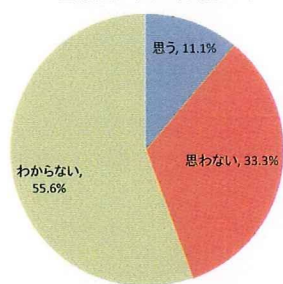
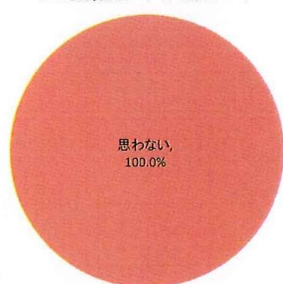


アンケート問1

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しますか？

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)

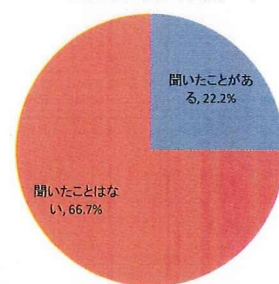
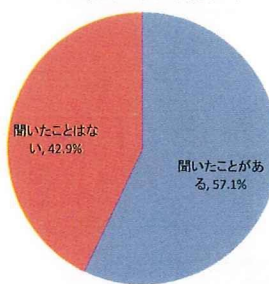


アンケート問2

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)

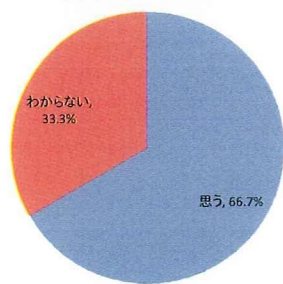


アンケート問3

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)

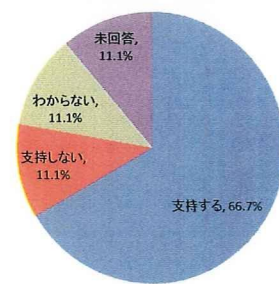
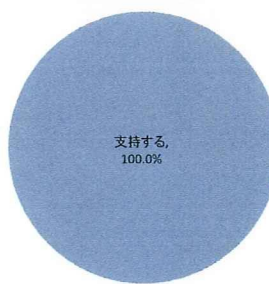


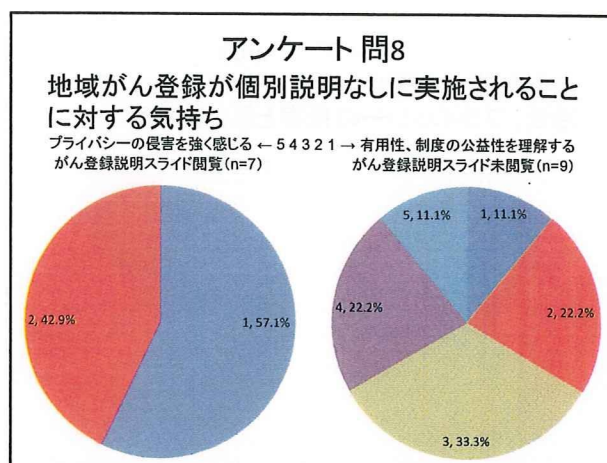
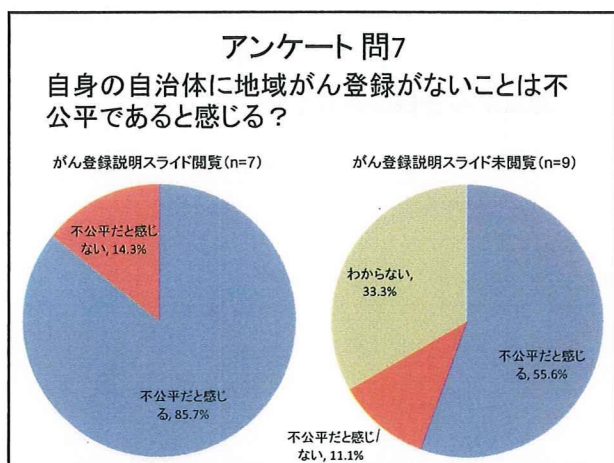
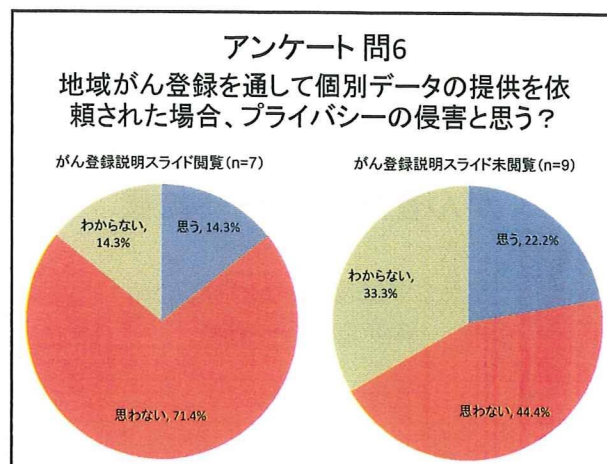
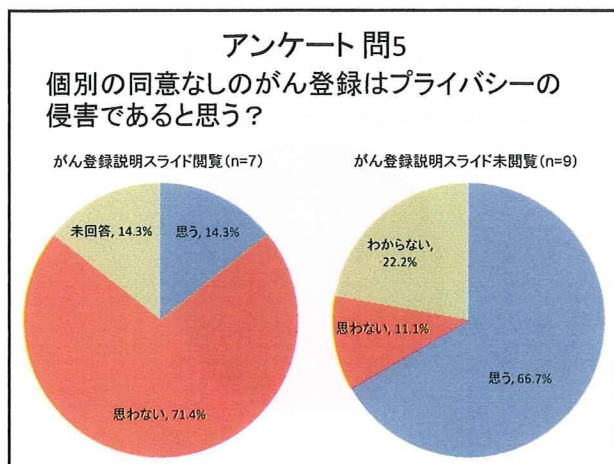
アンケート問4

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)

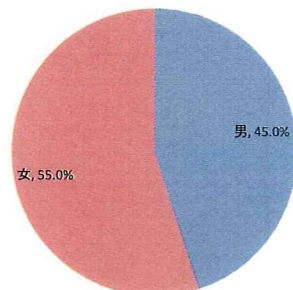




がん登録アンケート結果

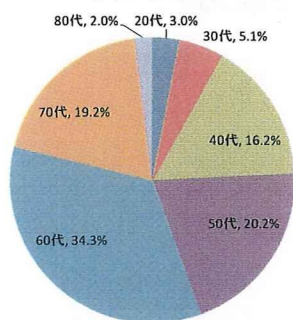
市民公開講座当日に回収した
事後アンケート結果

アンケート回答者 背景 性別 (n=100)



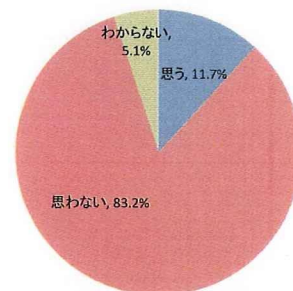
アンケート回答者 背景

年代 (n=99)



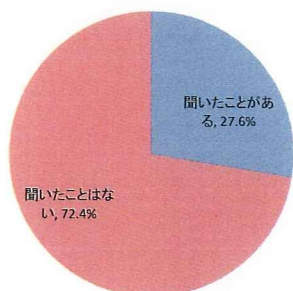
アンケート 問1 (n=196)

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？



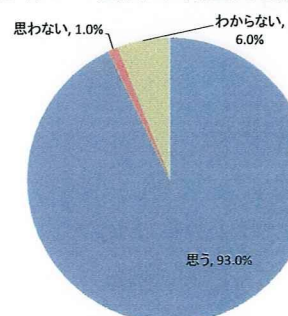
アンケート 問2 (n=199)

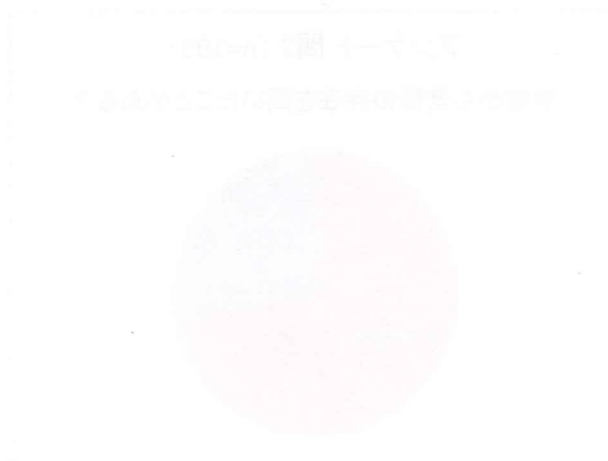
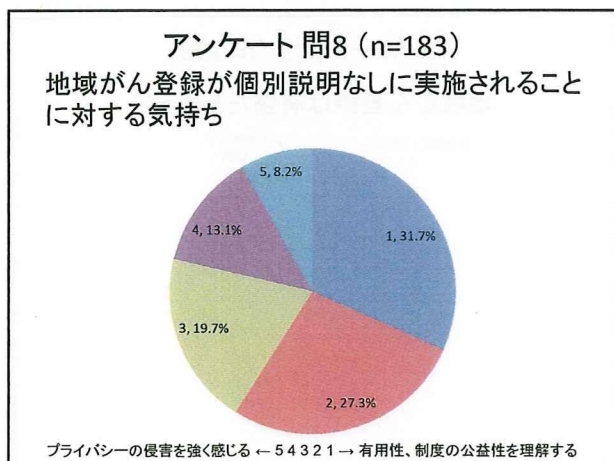
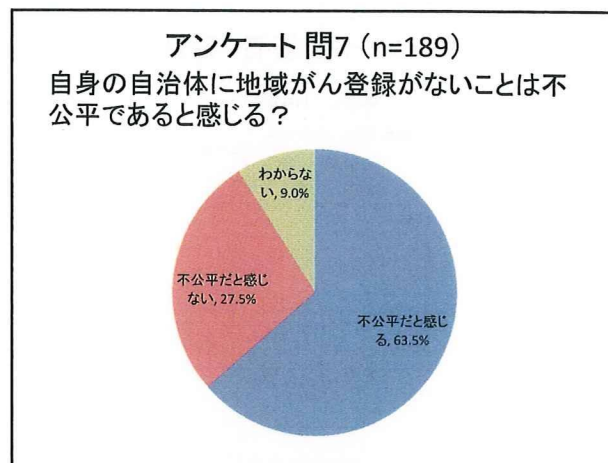
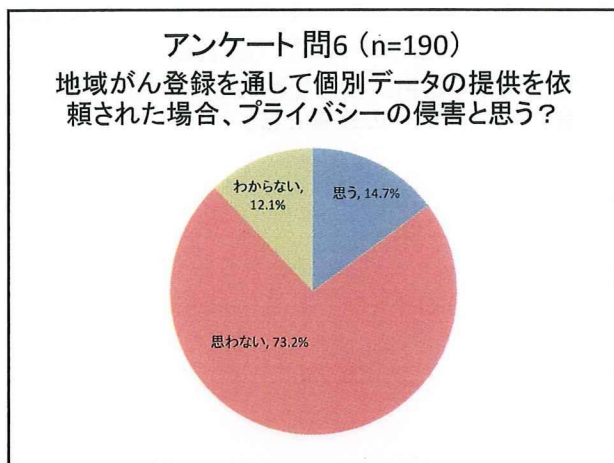
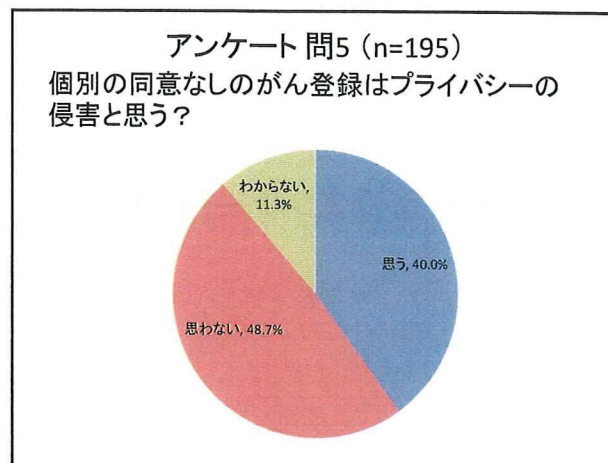
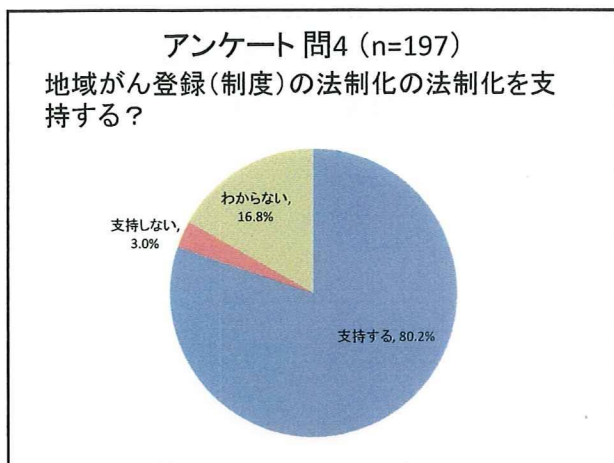
地域がん登録の存在を聞いたことがある？



アンケート 問3 (n=199)

地域がん登録は有益だと思う？





IV. 研究成果の刊行物・別刷



CLINICAL INVESTIGATION

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

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 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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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 2007 were estimated at 181,000 and 218,000, respectively. There were 807 linear accelerator, 15 telecobalt, 46 Gamma Knife, 45 ⁶⁰Co remote-controlled after-loading, and 123 ¹⁹²Ir 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.

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.

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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 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: $\frac{\text{data of 2007 (n)} - \text{data of 2005 (n)}}{\text{data of 2005 (n)}} \times 100$ (%).

‡ 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.

217 The cancer incidence in Japan in 2007 was estimated at
 218 692,502 (17), with approximately 26.1% of all newly diag-
 219 nosed patients treated with radiation. This number has in-
 220 creased steadily during the last 17 years and is expected to
 221 increase further (12). In 1990 the rate was estimated to be ap-
 222 proximately 15% (3). The corresponding rates were 16%,
 223 17%, 20%, 22%, 23.3% (4), 24.5% (5), and 26.1% in 1995,
 224 1997, 1999, 2001, 2003, 2005, and 2007, respectively.

225 226 *Facility and equipment patterns*

227 Table 2 shows an overview of RT equipment and related
 Q6 228 functions. There were 807 linear accelerator (linac) systems,
 229 15 telecobalt systems, 46 Gamma Knife systems, 45 ⁶⁰Co re-
 230 mote-controlled after-loading systems (RALSs), and 123
 231 ¹⁹²Ir RALSs in actual use. The linac system used dual-energy
 232 function in 539 units (66.8%), three-dimensional (3D) con-
 233 formal radiation therapy (CRT) in 555 (68.8%), and inten-
 234 sity-modulated radiation therapy (IMRT) in 235 (29.1%).
 235 The IMRT function was used more frequently in the equip-
 236 ment of academic institutions (A1, 61.6%; A2, 31.9%) than
 237 that of nonacademic institutions (B1, 26.4%; B2, 13.0%).
 238 However, 3D CRT functions were disseminated widely in
 239 both academic and nonacademic institutions, with more
 240 than 50% even in B2 institutions. Image-guided radiation
 241 therapy functions have been gradually spreading from A1 in-
 242 stitutions (28.5%) to the other types of institutions (8.2% to
 243 11.1%), although the rate of expansion has remained low.
 244 The annual numbers of patients per linac were 400 for A1 in-
 245 stitutions, 238.6 for A2, 296.2 for B1, and 98.4 for B2. The
 246 number of institutions with telecobalt in actual use showed
 247 a major decrease to 15, and Gamma Knife was installed
 248 more frequently in B1 and B2 institutions. A significant re-
 249 placement of ⁶⁰Co RALSs with ¹⁹²Ir RALSs was observed
 250 especially in academic institutions, whereas the number of
 251 new-type ⁶⁰Co RALSs in use did not increase. Six particle
 252 machines were registered in this survey, two with carbon
 253 beam and five with proton beam irradiation. One machine
 254 at Hyogo is delivering either carbon or proton. Although HI-
 255 MAC at Chiba has two synchrotrons, it was registered as one
 256 machine in the 2007 survey. The total number of new cancer
 257 patients treated at these six institutions was estimated at 1,643
 258 (0.9% of all new patients in Japan). Twenty-one advanced in-
 259 stitutions were included in the A1 Category and treated more
 260 than 800 patients per year. They were equipped with linac
 261 with dual-energy function (77.6% of the institutions), 3D
 262 CRT function (91.4%), and IMRT function (65.5%), as
 263 well as with ¹⁹²Ir RALS (85.7%) and a computed tomogra-
 264 phy (CT) simulator (95.2%).

265 Table 3 shows an overview of RT planning and other
 266 equipment. X-ray simulators were installed in 60.9% of all
 267 institutions and CT simulators in 65.6%, with the latter
 268 exceeding the former for the first time in 2007. There was
 269 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 institu-
 tions. We considered that these numbers were not sufficient Q6
 for accurate evaluation of personnel. Therefore full-time
 equivalent (FTE) (40 hours/week only for radiation oncol-
 ogy 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 institu-
 tions 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 pa-
 tient 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 dis-
 tribution of institutions by patient load per radiation technol-
 ogist 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 as-
 surance (QA) staff. For this survey, personnel numbers
 were checked for duplicate reporting by individual identifica-
 tion 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 institu-
 tional stratification. The most common disease site was
 breast, followed by lung/bronchus/mediastinum and genito-
 urinary 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		
Betatron	0		0		0		0		0		
Microtron	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 = other national hospital/public hospitals treating 140 patients or more per year; B2 = other national hospital/public hospitals treating 139 patients or fewer per year; B1 = other national/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 (%).

0.15
0.18
0.15

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					Comparison with data of 2005* (%)
	A1 (n = 71)	A2 (n = 71)	B1 (n = 288)	B2 (n = 291)	Total (n = 721)	
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.

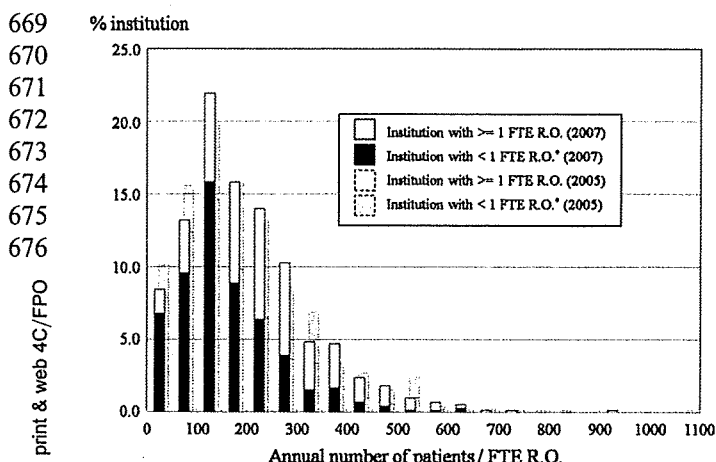
* Rate of increase compared with data of 2005. The calculating formula was as follows: $\frac{\text{data of 2007 (n)} - \text{data of 2005 (n)}}{\text{data of 2005 (n)}} \times 100$ (%)

† 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 tele-

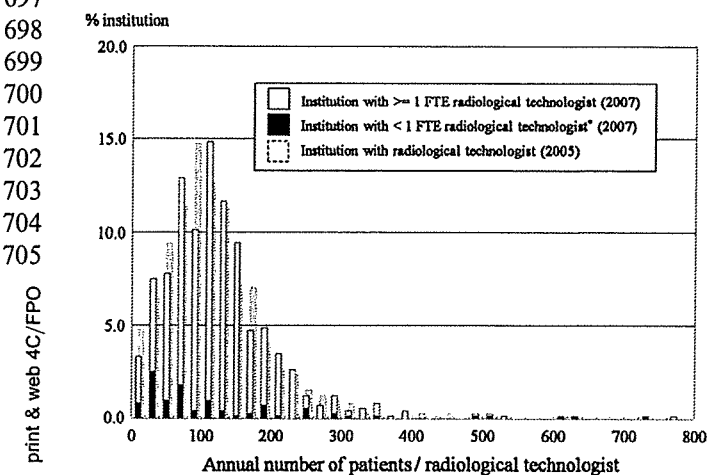
cobalt decreased to only .15. Furthermore, the various functions of linac, such as dual energy, 3D CRT (multileaf collimator width <1 cm), and IMRT, improved significantly. The number of HDR RALSs in use has increased by 1.4₁₀ times, and ⁶⁰Co RALSs have been largely replaced by ¹⁹²Ir RALSs. In 2007 CT 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



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

684 radiotherapy planning systems of 5.54 times compared with
685 1990 (3). Maturity of the functions of linac and possession
686 rates of CT simulators and systems using ¹⁹²Ir RALS also
687 improved further compared with 2005 (5) but still closely
688 correlated with the PCS institutional stratification, which
689 could therefore aid in the accurate discrimination of structural
690 maturity and immaturity and the identification of structural
691 targets for improvement.

692 The staffing patterns in Japan also improved in terms of
693 numbers. However, institutions with fewer than 1 FTE RO
694 on their staff still account for 56% nationwide, representing
695 a 4% decrease compared with 2005 data (5). Therefore
696 more than half the institutions in Japan still rely on part-



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

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 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.

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