

# Japanese structure survey of radiation oncology in 2010

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(Received 16 April 2018; editorial decision 24 April 2018)

## ABSTRACT

We evaluated the evolving structure of radiation oncology in Japan in terms of equipment, personnel, patient load, and geographic distribution to identify and overcome any existing limitations. From March 2011 to June 2013, the Japanese Society for Radiation Oncology conducted a questionnaire based on the Japanese national structure survey of radiation oncology in 2010. Data were analyzed based on the institutional stratification by the annual number of new patients treated with radiotherapy per institution. The estimated annual numbers of new and total (new plus repeat) patients treated with radiation were 211 000 and 251 000, respectively. Additionally, the estimated cancer incidence was 805 236 cases, with ~26.2% of all newly diagnosed patients being treated with radiation. The types and numbers of treatment devices actually used included linear accelerator (LINAC;  $n = 829$ ), telecobalt ( $n = 9$ ), Gamma Knife ( $n = 46$ ), <sup>60</sup>Co remote afterloading system (RALS;  $n = 28$ ), and <sup>192</sup>Ir RALS ( $n = 131$ ). The LINAC system used dual-energy functions in 586 units, three-dimensional conformal radiotherapy functions in 663, and intensity-modulated radiotherapy (IMRT) functions in 337. There were 564 JASTRO-certified radiation oncologists, 959.2 full-time equivalent (FTE) radiation oncologists, 1841.3 FTE radiotherapy technologists, 131.3 FTE medical physicists, 121.5 FTE radiotherapy quality managers, and 649.6 FTE nurses. The frequency of IMRT use significantly increased during this year. To conclude, although there was a shortage of personnel in 2010, the Japanese structure of radiation oncology has clearly improved in terms of equipment and utility.

**Keywords:** structure survey; radiotherapy institution; radiotherapy personnel; radiotherapy equipment

## PREFACE

We greatly appreciate the substantial contributions of the many radiation oncologists (ROs), radiation technologists, and other staff to the national structure survey of radiation oncology. Despite some delays, the updated Japanese national structure survey data for radiation oncology in 2010 is now available.

Since 1991, the Japanese Society for Radiation Oncology (JASTRO) has conducted national structure surveys every 2 years [1–24]. From March 2011 to June 2013, the Japanese Society for Radiation Oncology conducted a questionnaire based on the Japanese national structure survey of radiation oncology in 2010, which included the number of treatment systems by type, number of personnel by category, and number of patients by type, site, and treatment modality. To measure variables over a longer time period, data for the year 2010 were also considered. In total, 705 of 780 active institutions attempted the survey; the response rate was 90.4%.

The current report analyzes these institutional structure data (equipment, personnel, patient load, and geographic distribution) based on institutional stratification according to the annual number of new patients treated with radiotherapy at each institution. The clinical working hours of each staff member performing radiotherapy were derived from full-time equivalent (FTE; 40 h per week for radiation oncology work only) data. The Japanese Blue Book Guidelines (JBBG) [25, 26] were used for comparison with the results of this study. These guidelines pertain to the structure of radiation oncology in Japan based on the Patterns of Care Study (PCS) [27, 28] data. The standard guidelines were set at 250–300 (warning level, 400) for annual patient load per external beam machine, at 200 (warning level, 300) for annual patient load per FTE RO, and at 120 (warning level, 200) for annual patient load per FTE radiotherapy technologist. Furthermore, we analyzed data from the designated cancer care hospitals accredited by the Ministry of Health, Labor, and Welfare. As at 1 August 2013, Japan had 397 designated cancer care hospitals [29]. Twenty-three institutions did not return the survey; therefore, the structure data for 374 designated cancer care hospitals were analyzed and

compared with the data for all radiotherapy hospitals. The analysis was conducted in two groups: institutions with <1.0 FTE RO and those with  $\geq 1.0$  FTE RO.

Here, preliminary results have been presented as tables and figures (Tables 1–18 and Figs 1–6). We have briefly summarized the Japanese national structure survey of radiation oncology for 2010. In total, 780 radiotherapy institutions were surveyed, and the estimated number of new patients was ~211 000; the estimated total number of patients (new plus repeat) was 251 000. In 2010, based on Japanese cancer registries, the cancer incidence was estimated at 805 236 cases [30], with ~26.2% (211 000 of 805 236) of all newly diagnosed patients being treated with radiation. Overall, 829 linear accelerators (LINACs), 9 telecobalt units, 46 Gamma Knife, 28  $^{60}\text{Co}$  remote afterloading systems (RALS) and 131  $^{192}\text{Ir}$  RALS were actually used. The LINAC system used dual-energy functions in 586 units, three-dimensional conformal radiotherapy functions in 663, and intensity-modulated radiotherapy (IMRT) functions in 337. There were 564 JASTRO-certified ROs, 959.2 FTE ROs, 1841.3 FTE radiotherapy technologists, 131.3 FTE medical physicists, 121.5 FTE radiotherapy quality managers, and 649.6 FTE nurses. Approximately 50.0% of all radiotherapy institutions had >200 new radiotherapy patients per year, whereas 31.6% of the institutions had >300. Additionally, 47.5% of all radiotherapy institutions had <1.0 FTE ROs. We expect that this updated national structure survey of radiation oncology for 2010 will aid the continuous improvement of all aspects of radiation oncology in Japan.

## CONFLICT OF INTEREST

The authors state that there are no conflicts of interest.

## FUNDING

This study was supported by the JASTRO and Grants-in-Aid for Scientific Research from the Japan Society for the Promotion of Science [JSPS KAKENHI Grant No. JP16K45678].

**Table 1. Categories of radiotherapy institution**

Institution category
U: university hospital
G: cancer center (including national cancer center)
N: national hospital organization (excluding national cancer center)
P: public hospital (excluding national cancer center), red cross hospital, saiseikai hospital, company hospital, public corporation hospital, national health insurance hospital
O: social insurance hospital, mutual insurance hospital, industrial accident hospital, association hospital, Japan agricultural cooperatives hospital
H: medical corporation hospital, medical association hospital, private hospital, other hospitals

**Table 2. Number of radiotherapy institutions by scale classification and institution category**

Scale category (annual number of new patients)	Institution category						Total	Institution ratio [%]
	U	G	N	P	O	H		
A (1–99)	5	2	14	44	35	23	123	17.6
B (100–199)	11	1	27	80	70	38	227	32.4
C (200–299)	14	3	12	41	36	23	129	18.4
D (300–399)	14	5	7	20	25	15	86	12.3
E (400–499)	16	1	1	10	8	9	45	6.4
F (500–)	51	17	2	7	5	13	95	13.6
Total	111	29	63	202	179	121	705	100.0
Institution ratio [%]	15.7	4.1	8.9	28.7	25.4	17.2	100.0	

**Table 3. Annual number of new patients by scale classification and institution category**

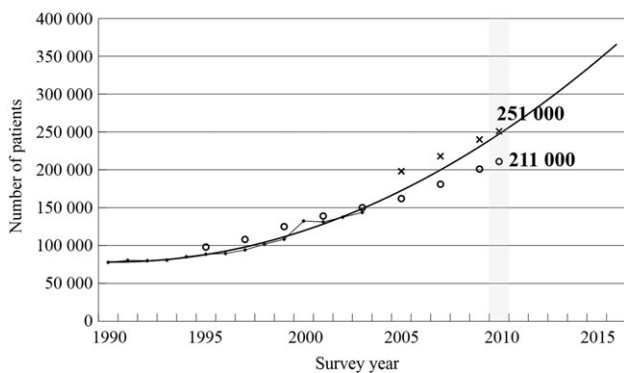
Scale category (number of institutions)	Institution category (number of institutions)						Total (705)	Average
	U (111)	G (29)	N (63)	P (202)	O (179)	H (121)		
A (123)	162	101	750	2677	2498	1475	7663	62.3
B (227)	1573	106	4138	12 067	10 050	5693	33 627	148.1
C (129)	3601	831	2734	10 009	8679	5527	31 381	243.3
D (86)	4774	1656	2318	6700	8521	5012	28 981	337.0
E (45)	7134	476	433	4266	3377	4114	19 800	440.0
F (95)	36 908	14 665	1290	4054	3245	8708	68 870	724.9
Total (705)	54 152	17 835	11 663	39 773	36 370	30 529	190 322	270.0
Average	492.3	615.0	185.1	196.9	203.2	252.3	270.0	

**Table 4. Annual number of total (new plus repeat) patients by scale classification and institution category**

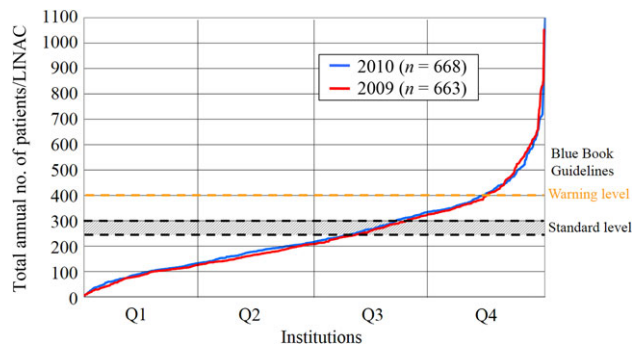
Scale category (number of institutions)	Institution category (number of institutions)						Total (705)	Average
	U (111)	G (29)	N (63)	P (202)	O (179)	H (121)		
A (123)	178	110	949	3042	2871	1747	8897	72.3
B (227)	1713	147	4809	13 784	11 366	7188	39 007	171.8
C (129)	4288	1096	3111	12 118	9991	6408	37 012	286.9
D (86)	5496	2050	2588	7853	10 327	6443	34 757	404.2
E (45)	8498	583	490	5188	4214	5293	24 266	539.2
F (95)	44 624	17 686	1678	4653	3609	10 662	82 912	872.8
Total (705)	64 797	21 672	13 625	46 638	42 378	37 741	226 851	321.8
Average	583.8	747.3	216.3	230.9	236.7	311.9	321.8	

**Table 5. Number of treatment devices and their functions by scale classification**

Treatment devices and their functions	Scale category (number of institutions)						Total (705)
	A (123)	B (227)	C (129)	D (86)	E (45)	F (95)	
LINAC	117	213	132	101	69	197	829
with dual-energy function	63	149	105	83	54	152	606
with 3DCRT function (MLC width ≤1.0 cm)	83	167	109	93	65	184	701
with IMRT function	17	51	54	66	40	147	375
with cone-beam CT or CT on rail	15	42	37	41	33	71	239
with treatment position verification system (X-ray perspective image)	14	42	44	39	33	74	246
with treatment position verification system (other than those above)	19	49	30	31	17	68	214
Annual no. patients/LINAC	76.0	183.1	280.4	344.1	351.7	420.9	273.6
CyberKnife®	3	5	1	2	2	4	17
Novalis®	1	2	4	5	4	9	25
Tomotherapy®	3	2	1	4	2	3	15
Particle	0	0	0	0	0	7	7
Microtron	0	5	1	0	2	5	13
Telecobalt (actual use)	3 (3)	4 (3)	1 (0)	2 (1)	0 (0)	2 (2)	12 (9)
Gamma knife®	3	11	10	7	6	9	46
Other accelerator	0	0	3	1	0	3	7
Other external irradiation device	0	1	2	0	0	4	7
New type <sup>60</sup> Co RALS (in actual use)	0 (0)	3 (3)	4 (3)	3 (3)	2 (2)	6 (6)	18 (17)
Old type <sup>60</sup> Co RALS (in actual use)	2 (0)	7 (2)	4 (3)	4 (3)	3 (2)	1 (1)	19 (11)
<sup>192</sup> Ir RALS (in actual use)	0 (1)	8 (6)	21 (18)	20 (20)	17 (17)	70 (70)	136 (131)
<sup>137</sup> Cs RALS (in actual use)	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	1 (1)



**Fig. 1. Estimate of increase in demand for radiotherapy in Japan, based on statistical correction of annual change in the number of new patients per year at Patterns of Care Study survey facilities [25]. Crosses and circles denote the estimated numbers of total (new plus repeat) and new patients, respectively, from the results in the structure surveys by the JASTRO.**



**Fig. 2. Distribution of annual total (new plus repeat) patient load per LINAC in radiotherapy institutions. Horizontal axis represents institutions arranged in order of increasing total annual number of patients per LINAC within the institution. Q1: 0–25%, Q2: 26–50%, Q3: 51–75%, Q4: 76–100%.**

**Table 6. Numbers of treatment-planning equipment and accessories by scale classification**

Treatment-planning equipment and accessories	Scale category (number of institutions)						Total (705)
	A (123)	B (227)	C (129)	D (86)	E (45)	F (95)	
X-ray simulator	58	105	54	40	21	70	348
CT simulator	91	189	117	86	46	104	633
RTP computer (2 or more)	128 (13)	262 (34)	192 (38)	192 (46)	144 (29)	463 (86)	1 381 (246)
X-ray CT (2 or more) for RT only	219 (79)	491 (172)	357 (113)	275 (80)	172 (44)	456 (89)	1 970 (577)
MRI (2 or more) for RT only	40	105	84	66	35	95	425
MRI (2 or more) for RT only	153 (34)	321 (89)	227 (87)	173 (69)	107 (41)	271 (80)	1 252 (400)
Computer use for RT recording	1	2	6	3	1	3	16
Computer use for RT recording	96	186	109	76	40	86	593
Water phantom (2 or more)	119 (17)	236 (41)	165 (41)	111 (29)	65 (17)	174 (44)	870 (189)
Film densitometer (2 or more)	38 (1)	89 (1)	63 (2)	63 (4)	34 (2)	98 (14)	385 (24)
Dosimeter (3 or more)	311 (56)	690 (130)	482 (80)	358 (59)	203 (33)	564 (78)	2 608 (436)

The numbers in parentheses indicate the number of institutions. CT = computed tomography, RTP = radiotherapy planning, MRI = magnetic resonance imaging, RT = radiotherapy.

**Table 7. Numbers of personnel and annual patients by scale classification**

	Scale category (number of institutions)						Total (705)
	A (123)	B (227)	C (129)	D (86)	E (45)	F (95)	
Scale (annual no. of new patients)	≤99	100–199	200–299	300–399	400–499	500≤	
Institution ratio [%]	17.4%	32.2%	18.3%	12.2%	6.4%	13.5%	100%
New patients	7663	33 627	31 381	28 981	19 800	68 870	190 322
New patients/institution	62.3	148.1	243.3	337.0	440.0	724.9	270.0
Total patients	8897	39 007	37 012	34 757	24 266	82 912	226 851
Total patients/institution	72.3	171.8	286.9	404.2	539.2	872.8	321.8
Beds	39 816	94 885	61 173	48 128	29 179	71 577	344 758
Institutions with RT beds (%)	18 (14.6)	45 (19.8)	38 (29.5)	40 (46.5)	21 (46.7)	68 (71.6)	230 (32.6)
RT beds	85.0	183.0	204.0	259.5	191.0	982.4	1 904.9
RT beds/total beds [%]	0.2%	0.2%	0.3%	0.5%	0.7%	1.4%	0.6%
RT beds/institution	0.7	0.8	1.6	3.0	4.2	10.3	2.7
RT beds/institution with RT beds	4.7	4.1	5.4	6.5	9.1	14.4	8.3
JRS-certified institutions (%)	13 (10.6)	40 (17.6)	57 (44.2)	55 (64)	36 (80)	79 (83.2)	280 (39.7)
JRS-cooperation institutions (%)	28 (22.8)	94 (41.4)	33 (25.6)	21 (24.4)	8 (17.8)	10 (10.5)	194 (27.5)
JASTRO-certified institutions (%)	2 (1.6)	37 (16.3)	60 (46.5)	57 (66.3)	35 (77.8)	84 (88.4)	275 (39)

*Continued*

Table 7. Continued

	Scale category (number of institutions)						Total (705)
	A (123)	B (227)	C (129)	D (86)	E (45)	F (95)	
JRS membership (full-time)	69	167	139	136	103	441	1 055
JRS-certified ROs (full-time)	57	149	125	122	79	335	867
JASTRO membership (full-time)	37	127	131	120	95	440	950
JASTRO-certified ROs (full-time)	13	67	82	82	56	264	564
Institutions with full-time RO (%)	56 (45.5)	147 (64.8)	109 (84.5)	83 (96.5)	44 (97.8)	93 (97.9)	532 (75.5)
ROs (full-time)	85	180	150	146	110	452	1 123
ROs (full-time)/institution	0.7	0.8	1.2	1.7	2.4	4.8	1.6
FTE RO (full-time)	34.3	121.1	120.6	117.5	85.7	373.0	852.1
FTE RO (full-time)/institution	0.28	0.53	0.93	1.37	1.90	3.93	1.21
ROs (part-time)	107	179	93	45	35	120	579
ROs (part-time)/institution	0.87	0.79	0.72	0.52	0.78	1.26	0.82
FTE RO (part-time)	16.6	30.0	16.5	7.6	7.4	29.1	107.1
FTE RO (part-time)/institution	0.1	0.1	0.1	0.1	0.2	0.3	0.2
FTE RO (full-time plus parttime)	50.9	151.1	137.0	125.1	93.1	402.1	959.2
FTE RO (full-time plus part-time)/institution	0.41	0.67	1.06	1.45	2.07	4.23	1.36
Radiologists (full-time)	174.9	381.5	377.4	298.0	299.0	865.0	2 395.8
Radiologists (parttime)	132.7	380.4	203.7	117.2	76.0	184.0	1 094.0
RTTs (full-time) <sup>a</sup>	346	754	479	387	229	703	2 898
FTE RTT	155.7	416.8	282.5	253.9	175.2	557.2	1 841.3
Medical physicists (full-time) <sup>a</sup>	22	69	64	54	36	113	358
FTE medical physicist	6.5	21.4	21.2	21.5	12.5	48.3	131.3
RT quality manager (full-time) <sup>a</sup>	29	105	87	62	49	117	449
FTE RT quality manager	6.7	23.5	25.8	16.3	13.5	35.8	121.5
Dosimetrists (full-time) <sup>a</sup>	12	17	20	18	14	51	132
FTE dosimetrist	2.2	3.4	4.1	3.6	2.7	9.5	25.4
Craftworkers (full-time) <sup>a</sup>	35	63	32	26	12	52	220
FTE craftworker	6.8	11.6	6.3	5.0	1.4	5.7	36.7
Nurses (full-time)	100	282	220	156	125	269	1 152
FTE nurses	44.76	132.3	114.5	86.1	59.4	212.5	649.6
Nursing assistants	5.2	11.2	6.35	9.6	12.4	20.3	65.1
Clerks	29.85	54.3	53.55	59.4	39.5	121.75	358.4

<sup>a</sup>Overlap is included in the total number of each staff (radiotherapy technologist, medical physicist, and radiotherapy quality manager). RT = radiotherapy, JRS = Japan Radiological Society, RO = radiation oncologist, JASTRO = Japanese Society for Radiation Oncology, FTE = full-time equivalent, RTT = radiotherapy technologist.

**Table 8. Population size and numbers of patients, institutions, and patient load according to prefecture**

Prefecture	Population ( $\times 10^3$ )	Institutions	New patients	New patients/institution	Total patients	Total patients/institution
Hokkaido	5 506	30	9 520	317.3	12 200	406.7
Aomori	1 373	9	2 049	227.7	2 281	253.4
Iwate	1 330	8	1 684	210.5	1 868	233.5
Miyagi	2 348	11	4 123	374.8	5 758	523.5
Akita	1 086	10	1 787	178.7	2 167	216.7
Yamagata	1 169	6	1 308	218.0	1 570	261.7
Fukushima	2 029	10	3 071	307.1	3 524	352.4
Ibaraki	2 970	15	3 638	242.5	4 444	296.3
Tochigi	2 008	8	2 751	343.9	3 534	441.8
Gunma	2 008	13	3 769	289.9	4 271	328.5
Saitama	7 195	20	7 070	353.5	8 990	449.5
Chiba	6 216	23	7 398	321.7	9 034	392.8
Tokyo	13 159	67	23 116	345.0	27 951	417.2
Kanagawa	9 048	39	12 597	323.0	14 331	367.5
Niigata	2 374	15	3 930	262.0	4 410	294.0
Toyama	1 093	8	1 542	192.8	1 761	220.1
Ishikawa	1 170	7	1 994	284.9	2 386	340.9
Fukui	806	6	1 250	208.3	1 487	247.8
Yamanashi	863	4	1 140	285.0	1 338	334.5
Nagano	2 152	15	3 331	222.1	3 940	262.7
Gifu	2 081	12	3 245	270.4	4 244	353.7
Shizuoka	3 765	23	6 019	261.7	7 569	329.1
Aichi	7 411	37	10 113	273.3	12 088	326.7
Mie	1 855	12	1 853	154.4	2 116	176.3
Shiga	1 411	10	1 832	183.2	2 238	223.8
Kyoto	2 636	13	4 032	310.2	4 710	362.3
Osaka	8 865	51	13 528	265.3	15 835	310.5
Hyogo	5 588	32	8 096	253.0	9 294	290.4
Nara	1 401	8	2 200	275.0	2 499	312.4
Wakayama	1 002	10	1 717	171.7	2 063	206.3
Tottori	589	7	968	138.3	1 149	164.1
Shimane	717	5	986	197.2	1 099	219.8
Okayama	1 945	11	2 772	252.0	3 271	297.4

*Continued*

Table 8. Continued

Prefecture	Population ( $\times 10^3$ )	Institutions	New patients	New patients/institution	Total patients	Total patients/institution
Hiroshima	2 861	20	5 128	256.4	6 220	311.0
Yamaguchi	1 451	14	1 991	142.2	2 247	160.5
Tokushima	785	5	1 436	287.2	1 664	332.8
Kagawa	996	6	1 194	199.0	1 266	211.0
Ehime	1 431	11	2 277	207.0	2 631	239.2
Kochi	764	6	1 220	203.3	1 379	229.8
Fukuoka	5 072	26	8 585	330.2	9 903	380.9
Saga	850	4	901	225.3	1 017	254.3
Nagasaki	1 427	8	2 343	292.9	2 726	340.8
Kumamoto	1 817	13	3 209	246.8	3 717	285.9
Oita	1 197	11	1 616	146.9	1 913	173.9
Miyazaki	1 135	7	1 520	217.1	1 832	261.7
Kagoshima	1 706	12	2 671	222.6	2 888	240.7
Okinawa	1 393	7	1 802	257.4	2 028	289.7
Total	128 057	705	190 322	270.0	226 851	321.8

Table 9. Population size and numbers of patients, radiation oncologists, and patient load according to prefecture

Prefecture	Population ( $\times 10^3$ )	Total patients	JASTRO-certified RO	FTE RO	Total patients/FTE RO
Hokkaido	5 506	12 200	32	51.1	238.7
Aomori	1 373	2 281	7	9.0	253.4
Iwate	1 330	1 868	5	8.0	233.5
Miyagi	2 348	5 758	11	17.9	321.7
Akita	1 086	2 167	2	8.4	258.0
Yamagata	1 169	1 570	5	8.6	182.6
Fukushima	2 029	3 524	5	14.8	238.1
Ibaraki	2 970	4 444	8	15.1	294.3
Tochigi	2 008	3 534	8	14.8	238.8
Gunma	2 008	4 271	21	29.9	142.8
Saitama	7 195	8 990	18	27.0	333.0
Chiba	6 216	9 034	29	48.6	185.8
Tokyo	13 159	27 951	76	119.0	235.0
Kanagawa	9 048	14 331	35	53.0	270.4
Niigata	2 374	4 410	8	16.6	265.7

Continued



Table 9. Continued

Prefecture	Population ( $\times 10^3$ )	Total patients	JASTRO-certified RO	FTE RO	Total patients/FTE RO
Toyama	1 093	1 761	5	7.0	251.6
Ishikawa	1 170	2 386	4	6.7	356.1
Fukui	806	1 487	5	8.2	181.3
Yamanashi	863	1 338	6	7.3	183.3
Nagano	2 152	3 940	6	11.2	353.4
Gifu	2 081	4 244	5	9.1	466.4
Shizuoka	3 765	7 569	18	26.4	286.7
Aichi	7 411	12 088	21	49.8	242.7
Mie	1 855	2 116	4	9.8	215.9
Shiga	1 411	2 238	7	11.0	203.5
Kyoto	2 636	4 710	18	26.3	179.1
Osaka	8 865	15 835	44	77.2	205.2
Hyogo	5 588	9 294	27	43.7	212.9
Nara	1 401	2 499	8	12.4	201.5
Wakayama	1 002	2 063	4	10.0	206.3
Tottori	589	1 149	1	4.3	267.2
Shimane	717	1 099	6	8.3	132.4
Okayama	1 945	3 271	8	17.9	182.7
Hiroshima	2 861	6 220	21	26.2	237.9
Yamaguchi	1 451	2 247	4	10.8	208.1
Tokushima	785	1 664	4	8.2	202.9
Kagawa	996	1 266	3	6.5	194.8
Ehime	1 431	2 631	8	13.3	197.8
Kochi	764	1 379	4	3.9	353.6
Fukuoka	5 072	9 903	24	41.8	236.9
Saga	850	1 017	3	4.8	211.9
Nagasaki	1 427	2 726	4	8.1	336.5
Kumamoto	1 817	3 717	5	15.4	241.4
Oita	1 197	1 913	3	9.6	199.3
Miyazaki	1 135	1 832	4	6.2	295.5
Kagoshima	1 706	2 888	5	10.7	269.9
Okinawa	1 393	2 028	5	5.5	368.7
Total	128 054	226 851	564	959.2	236.5

JASTRO = Japanese Society for Radiation Oncology, RO = radiation oncologist, FTE = full-time equivalent.

**Table 10. Population size and numbers of patients, staffs, and patient load according to prefecture**

Prefecture	Total patients	FTE RTT	Total patients/FTE RTT	FTE MP	FTE RTQM
Hokkaido	12 200	72.3	168.7	6.8	7.1
Aomori	2 281	22.1	103.2	2.6	1.6
Iwate	1 868	18.7	99.9	0.1	0.4
Miyagi	5 758	31.5	182.8	0.1	1.8
Akita	2 167	19.9	108.9	0.5	1.3
Yamagata	1 570	13.2	118.9	0.9	1.4
Fukushima	3 524	30.8	114.4	2.9	1.3
Ibaraki	4 444	42.2	105.3	1.1	1.5
Tochigi	3 534	25.9	136.4	1.6	3.1
Gunma	4 271	38.9	109.8	3.5	3.0
Saitama	8 990	50.3	178.7	2.2	4.2
Chiba	9 034	74.2	121.8	4.4	3.0
Tokyo	27 951	228.4	122.4	14.3	9.0
Kanagawa	14 331	125.3	114.4	6.9	8.3
Niigata	4 410	47.7	92.5	2.1	0.7
Toyama	1 761	21.8	80.8	0.8	1.4
Ishikawa	2 386	19.2	124.3	2.9	1.8
Fukui	1 487	15.7	94.7	1.6	0.9
Yamanashi	1 338	7.0	191.1	0.1	0.6
Nagano	3 940	31.1	126.7	2.2	1.6
Gifu	4 244	27.2	156.0	2.1	1.7
Shizuoka	7 569	71.4	106.0	5.5	4.2
Aichi	12 088	100.3	120.5	6.2	4.6
Mie	2 116	25.0	84.6	1.0	1.4
Shiga	2 238	24.3	92.1	2.1	2.0
Kyoto	4 710	33.3	141.4	5.7	4.7
Osaka	15 835	141.7	111.8	19.7	13.5
Hyogo	9 294	82.2	113.1	6.1	4.7
Nara	2 499	22.9	109.1	0.9	2.2
Wakayama	2 063	17.2	119.9	0.0	0.4
Tottori	1 149	12.3	93.4	0.3	2.1
Shimane	1 099	11.9	92.4	0.3	1.3
Okayama	3 271	30.4	107.6	1.7	2.9

*Continued*

**Table 10.** Continued

Prefecture	Total patients	FTE RTT	Total patients/FTE RTT	FTE MP	FTE RTQM
Hiroshima	6 220	43.9	141.7	2.6	3.0
Yamaguchi	2 247	22.0	102.1	0.8	1.6
Tokushima	1 664	12.3	135.3	0.0	2.0
Kagawa	1 266	10.6	119.4	0.8	0.2
Ehime	2 631	21.2	124.1	2.6	2.3
Kochi	1 379	10.0	137.9	1.6	0.7
Fukuoka	9 903	67.1	147.6	4.2	5.1
Saga	1 017	7.6	133.8	0.0	0.5
Nagasaki	2 726	15.6	174.7	2.6	1.5
Kumamoto	3 717	28.0	132.8	2.5	2.4
Oita	1 913	21.1	90.7	1.9	1.3
Miyazaki	1 832	14.4	127.2	1.1	0.9
Kagoshima	2 888	20.1	143.7	1.0	0.0
Okinawa	2 028	11.1	182.7	0.6	0.4
Total	226 851	1841.3	123.2	131.3	121.5

FTE = full-time equivalent, RTT = radiotherapy technologist, MP = medical physicist, RTQM = radiotherapy quality manager, NS = nurse.

**Table 11. Numbers of institutions and patients receiving special radiotherapy by scale classification**

Specific therapy	2010							2009
	A (123)	B (227)	C (129)	D (86)	E (45)	F (95)	Total (705)	Total (700)
Intracavitary radiotherapy								
Treatment institutions	0	10	23	25	21	73	152	151
Patients	0	107	335	393	329	2 081	3 245	3 139
Interstitial radiotherapy								
Treatment institutions	1	8	17	18	12	59	115	109
Patients	41	66	319	550	305	2 913	4 194	4 070
Radioactive iodine therapy for prostate								
Treatment institutions	1	4	16	17	11	52	101	96
Patients	41	44	312	485	215	2 018	3 115	3 080
Radioactive iodine therapy for hyperthyroidism								
Treatment institutions	0	5	11	7	11	25	59	97
Patients	0	62	427	100	377	1 114	2 080	4 478

Continued

Table 11. Continued

Specific therapy	2010						2009	
	A (123)	B (227)	C (129)	D (86)	E (45)	F (95)	Total (705)	Total (700)
Total body radiotherapy								
Treatment institutions	9	20	25	31	28	73	186	180
Patients	57	148	254	171	294	1 013	1 937	1 790
Intraoperative radiotherapy								
Treatment institutions	1	1	2	5	5	10	24	28
Patients	2	1	5	18	25	110	161	173
Stereotactic brain radiotherapy								
Treatment institutions	12	40	37	42	28	52	211	202
Patients	511	2 364	2 108	2 629	2 214	3 974	13 800	13 855
Stereotactic body radiotherapy								
Treatment institutions	5	29	35	45	22	67	203	165
Patients	120	205	482	603	307	1 819	3 536	2 537
IMRT								
Treatment institutions	4	13	17	25	14	63	136	101
Patients	165	503	780	1 049	646	3 213	6 356	4 296
Thermoradiotherapy								
Treatment institutions	1	2	7	2	3	5	20	20
Patients	9	6	38	11	184	111	359	391
Sr-90 radiotherapy for pterygia								
Treatment institutions	0	0	2	2	0	1	5	11
Patients	0	0	8	14	0	11	33	90
Internal <sup>89</sup> Sr radiotherapy								
Treatment institutions	4	25	22	29	15	47	142	
Patients	12	111	80	172	83	335	793	
Internal Y-90 radiotherapy								
Treatment institutions	1	3	1	4	4	20	33	
Patients	1	8	3	11	8	122	153	

IMRT = intensity-modulated radiotherapy, Sr = strontium, Y = yttrium.

**Table 12. Annual numbers of new patients by disease site<sup>a</sup>**

Primary site	<i>n</i>	%
Cerebrospinal	8 065	4.4
Head and neck (including thyroid)	17 513	9.6
Esophagus	10 207	5.6
Lung, trachea and mediastinum	35 149	19.3
Lung	32 540	17.8
Breast	43 315	23.7
Liver, biliary tract, pancreas	6 835	3.7
Gastric, small intestine, colorectal	8 741	4.8
Gynecologic	8 563	4.7
Urogenital	25 832	14.2
Prostate	20 303	11.1
Hematopoietic and lymphatic	8 587	4.7
Skin, bone and soft tissue	4 601	2.5
Other (malignant)	2 377	1.3
Benign tumors	2 706	1.5
Pediatric ≤15 years (included in totals above)	858	0.5
Total	182 491	100

<sup>a</sup>The total numbers of new patients in Table 3 differ from these data, because no data on primary sites were reported by some institutions.

**Table 13. Annual number of total patients (new plus repeat) treated for brain metastasis and bone metastasis by scale classification**

Metastasis	Scale category (number of institutions)												Total (705)	
	A (123)		B (227)		C (129)		D (86)		E (45)		F (95)		<i>n</i>	%
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%		
Brain	761	8.6	4 504	11.5	3 345	9.0	3 622	10.4	2 317	9.5	7 216	8.7	21 765	9.6
Bone	1 414	15.9	5 847	15.0	5 059	13.7	4 812	13.8	2 629	10.8	9 235	11.1	28 996	12.8

Data presented as number of patients, with percentages in parentheses.

**Table 14. Classification of institutions by number of FTE radiation oncologists in all radiotherapy institutions and designated cancer care hospitals**

Institution category	Description	Institutions
RH-A	All radiotherapy hospitals (FTE RO $\geq$ 1.0)	374
RH-B	All radiotherapy hospitals (FTE RO < 1.0)	331
Total		705
DCCH-A	Designated cancer care hospitals (FTE RO $\geq$ 1.0)	260
DCCH-B	Designated cancer care hospitals (FTE RO < 1.0)	114
Total		374

FTE = full-time equivalent, RO = radiation oncologist.

**Table 15. Annual numbers of patients receiving radiotherapy, numbers of LINACs, numbers of staff, patient load per LINAC, and patient load per member of staff according to institution category shown in Table 14; all radiotherapy hospitals**

	RH-A (374)		RH-B (331)		Total (705)	
	Average per hospital	Total number	Average per hospital	Total number	Average per hospital	Total number
Total patients	456.5	170 739	169.5	56 112	321.8	226 851
New patients	379.4	141 879	146.4	48 443	270.0	190 322
LINACs	1.4	514	1.0	315	1.2	829
Annual total no. of patients / LINAC	332.2		178.1		273.6	
Annual no. of new patients / LINAC	276.0		153.8		229.6	
FTE ROs	2.2	819.0	0.4	140.2	1.4	959.2
JASTRO-certified ROs (full time)	1.3	503	0.2	61	0.8	564
Annual total no. of patients / FTE RO	208.5		400.3		236.5	
Annual no. of new patients / FTE RO	173.2		345.6		198.4	
FTE RT technologists	3.5	1297.1	1.6	544.2	2.6	1841.3
Annual total no. of patients / FTE RTT	131.6		103.1		123.2	
Annual no. of new patients / FTE RTT	109.4		89.0		103.4	
FTE RT technologists / LINAC	2.5		1.7		2.2	
FTE medical physicists	0.28	103.9	0.08	27.5	0.19	131.3
Annual total no. of patients / FTE MP	1644.1		2044.2		1727.7	
Annual no. of new patients / FTE MP	1366.2		1764.8		1449.5	
FTE RT quality managers	0.24	90.0	0.10	31.5	0.17	121.5
Annual total no. of patients / FTE RTQM	1897.1		1781.3		1,867.1	
Annual no. of new patients / FTE RTQM	1576.4		1537.9		1566.4	
FTE RT quality managers / LINAC	0.18		0.10		0.15	

**Table 16. Annual numbers of patients receiving radiotherapy, numbers of LINACs, numbers of staff, patient load per LINAC, and patient load per member of staff according to institution category shown in Table 14; designated cancer care hospitals**

	DCCH-A (260)		DCCH-B (114)		Total (374)	
	Average per hospital	Total number	Average per hospital	Total number	Average per hospital	Total number
Total patients	529.8	137 744	203.8	23 234	430.4	160 978
New patients	440.8	114 609	178.0	20 295	360.7	134 904
LINACs	1.5	401	1.0	117	1.4	518
Annual total no. of patients / Linac	343.5		198.6		310.8	
Annual no. of new patients / Linac	285.8		173.5		260.4	
FTE ROs	2.5	637.5	0.5	62.4	1.9	699.9
JASTRO-certified ROs (full time)	1.6	426	0.2	28	1.2	454
Annual total no. of patients / FTE RO	216.1		372.6		230.0	
Annual no. of new patients / FTE RO	179.8		325.5		192.8	
FTE RT technologists	3.9	1013.1	1.9	219.9	3.3	1233.0
Annual total no. of patients / FTE RTT	136.0		105.7		130.6	
Annual no. of new patients / FTE RTT	113.1		92.3		109.4	
FTE RT technologists / LINAC	2.5		1.9		2.4	
FTE medical physicists	0.31	80.9	0.05	5.6	0.23	86.5
Annual total no. of patients / FTE MP	1702.6		4186.3		1862.1	
Annual no. of new patients / FTE MP	1416.7		3656.8		1560.5	
FTE RT quality managers	0.27	70.9	0.11	12.6	0.22	83.5
Annual total no. of patients / FTE RTQM	1944.2		1844.0		1929.0	
Annual no. of new patients / FTE RTQM	1617.6		1610.7		1616.6	
FTE RT quality managers / LINAC	0.18		0.11		0.16	

LINAC = linear accelerator, FTE = full-time equivalent, RO = radiation oncologist, RTT = radiotherapy technologist, MP = medical physicist, RTQM = radiotherapy quality manager.

**Table 17. Number of items of equipment and their functions according to institution category showing Table 14**

	RH-A ( <i>n</i> = 374)		RH-B ( <i>n</i> = 331)		Total ( <i>n</i> = 705)	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
LINAC	514	95.7	315	93.7	829	94.8
with dual-energy function	397	82.6	209	62.5	606	73.2
with 3DCRT function (MLC width ≤ 1.0 cm)	475	89.3	226	68	701	79.3
with IMRT function	310	57.8	65	19.6	375	39.9
with cone-beam CT or CT on rail	190	41.4	49	14.8	239	28.9
with treatment position verification system (X-ray perspective image)	192	39	54	15.7	246	28.1
with treatment-position verification system (other than those above)	148	32.6	66	19.9	214	26.7
CT simulator	365	90.4	268	76.1	633	83.7

	DCCH-A ( <i>n</i> = 260)		DCCH-B ( <i>n</i> = 114)		Total ( <i>n</i> = 374)	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
LINAC	401	98.8	117	99.1	518	98.9
with dual-energy function	318	90.4	94	80.7	412	87.4
with 3DCRT function (MLC width ≤ 1.0 cm)	379	94.6	91	78.9	470	89.8
with IMRT function	261	66.9	34	29.8	295	55.6
with cone-beam CT or CT on rail	158	48.1	24	21.1	182	39.8
with treatment-position verification system (X-ray perspective image)	154	43.5	23	19.3	177	36.1
with treatment-position verification system (other than those above)	117	36.2	29	25.4	146	32.9
CT simulator	264	94.2	104	83.3	368	90.9

LINAC = linear accelerator, 3DCRT = three dimensional conformal radiotherapy, MLC = multileaf collimator, IMRT = intensity-modulated radiotherapy, CT = computed tomography.

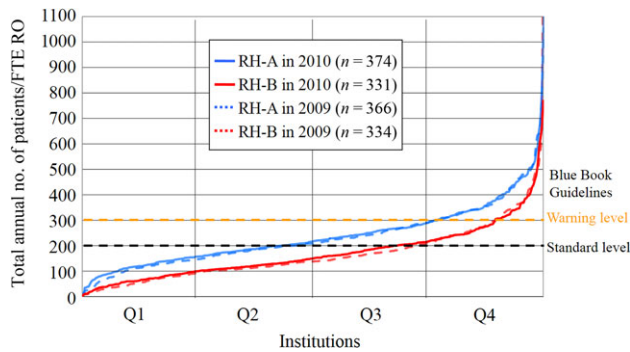


Fig. 3. Distribution of annual total (new plus repeat) patient load per full-time equivalent (FTE) radiation oncologist (RO) in all radiotherapy institutions. Horizontal axis represents institutions arranged in order of increasing total annual number of patients per FTE rRO within the institution. Q1: 0–25%, Q2: 26–50%, Q3: 51–75%, Q4: 76–100%.

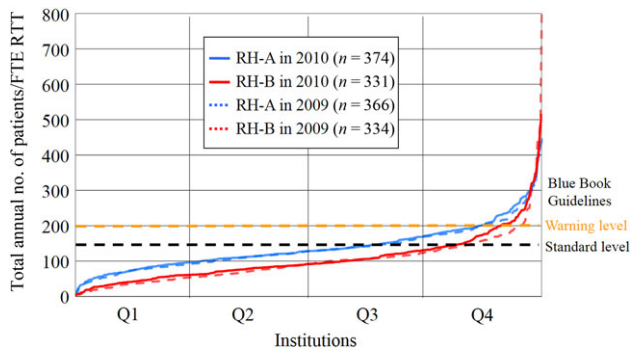


Fig. 4. Distribution of annual total (new plus repeat) patient load per full-time equivalent (FTE) radiotherapy technologist (RTT) in all radiotherapy institutions. Horizontal axis represents institutions arranged in order of increasing total annual number of patients per FTE RTT within the institution. Q1: 0–25%, Q2: 26–50%, Q3: 51–75%, Q4: 76–100%.

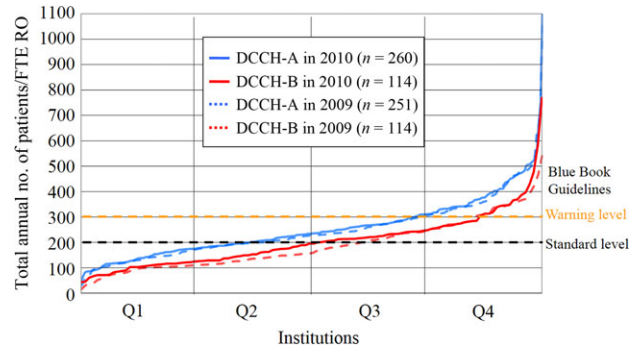


Fig. 5. Distribution of annual total (new plus repeat) patient load per full-time equivalent (FTE) radiation oncologist (RO) in designated cancer care hospitals. Horizontal axis represents institutions arranged in order of increasing value of total annual number of patients per FTE RO within the institution. Q1: 0–25%, Q2: 26–50%, Q3: 51–75%, Q4: 76–100%.

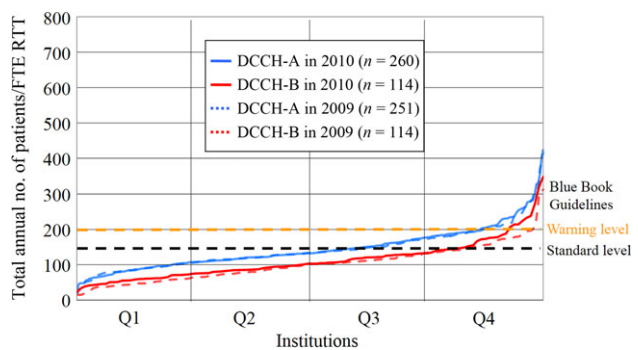


Fig. 6. Distribution of annual total (new plus repeat) patient load per full-time equivalent (FTE) radiotherapy technologist (RTT) in designated cancer care hospitals. Horizontal axis represents institutions arranged in order of increasing total annual number of patients per FTE RTT within the institution. Q1: 0–25%, Q2: 26–50%, Q3: 51–75%, Q4: 76–100%.



**Table 18. Numbers of radiotherapy institutions and treatment devices, and patient load and personnel trend 1990–2010**

	Survey year										
	1990	1993	1995	1997	1999	2001	2003	2005	2007	2009	2010
Institution	378	629	504	568	636	603	726	712	721	700	705
Response rate	48.5%	88.3%	73.9%	78.6%	86.3%	85.3%	100%	96.9%	94.2%	90.9%	90.4%
New patients	62 829		71 696	84 379	107 150	118 016	149 793	156 318	170 229	182 390	190 322
Total patients								191 173	205 087	217 829	226 851
Average no. of new patients	166		142	149	168	196	206	220	236	261	270
Treatment device (in actual use)											
LINAC	311	508	407	475	626	626	744	765	807	816	829
Telecobalt	170	213	127	98	83	45	42	11	15	11	9
<sup>192</sup> Ir RALS			29	50	73	93	117	119	123	130	131
Full-time ROs	547	748	821	889	925	878	921	1 003	1 007	1 085	1 123
FTE ROs								774	826	939	959
Full-time JASTRO-certified ROs						308	369	426	477	529	564
FTE RT technologists	592	877	665	733	771	918	1 555	1 635	1 634	1 836	1 841
Treatment-planning equipment											
X-ray simulators	295	430	394	452	512	464	532	502	445	361	348
CT simulators	30	75	55	96	164	247	329	407	497	575	633
RTP computers	238	468	374	453	682	680	874	940	1 070	1 271	1 381

LINAC = linear accelerator, Ir = iridium, RO = radiation oncologist, FTE = full-time equivalent, JASTRO = Japanese Society for Radiation Oncology, RT = radiotherapy, JRS = Japan Radiological Society, JASTRO = Japanese Society for Radiation Oncology, CT = computed tomography, RTP = radiotherapy planning.

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