Japanese structure survey of radiation oncology in 2013

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ABSTRACT

This paper describes the ongoing structure of radiation oncology in Japan in terms of equipment, personnel, patient load and geographic distribution to identify and overcome any existing limitations. From December 2014 to July 2017, the Japanese Society for Radiation Oncology conducted a questionnaire based on the Japanese national structure survey of radiation oncology in 2013. Data were analyzed based on 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 216,000 and 257,000, respectively. Additionally, the estimated cancer incidence was 862,452 cases with ~25.0% of all newly diagnosed patients being treated with radiation. The types and numbers of treatment devices actually used included linear accelerator (LINAC; n = 880), Gamma Knife (n = 45), 60Co remote afterloading system (RALS; n = 23) and 192Ir RALS (n = 128). The LINAC system used dual-energy functions in 675 units, 3D conformal radiotherapy functions in 785 and intensity-modulated radiotherapy (IMRT) functions in 494. There were 831 Japan Radiological Society/Japanese Society for Radiation Oncology-certified radiation oncologists, 1130.6 full-time equivalent (FTE) radiation oncologists, 2214.6 FTE radiotherapy technologists, 196.6 FTE medical physicists, 183.8 FTE radiotherapy quality managers and 856.7 FTE nurses. The frequency of IMRT use significantly increased during this time. In conclusion, the Japanese structure of radiation oncology has clearly improved in terms of equipment and utility although there was a shortage of personnel in 2013.

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

INTRODUCTION

In 1991, the Japanese Society for Radiation Oncology (JASTRO) conducted the first national survey of the structure of radiotherapy institutions in Japan based on their status in 1990, and the results were reported by Tsunemoto et al. [1]. The Japanese structure has gradually changed since a greater number of cancer patients are treated with radiation and public awareness of the importance of radiotherapy has grown. JASTRO has conducted national structure surveys every 2 years since 1991 [2–23]. The consecutive structural data gathered and published by JASTRO have been useful in gaining an understanding of our current position and future direction in Japan. Despite some delays, the updated Japanese national structure survey data of radiation oncology in 2013 is now available.

MATERIALS AND METHODS

From December 2014 to July 2017, a questionnaire regarding the 2013 national structure survey of radiation oncology was conducted that 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 2013 were also considered. In total, 717 of 798 active institutions attempted the survey; the response rate was 89.8%.

The current report analyzes these institutional structure data (equipment, personnel, patient load and geographic distribution) based on institutional stratification by the annual number of new patients treated with radiotherapy at each institution. Clinical working hours of each staff member performing radiotherapy were derived...
Table 1. Category of radiotherapy institution

| Institution category | U | G | N | P | O | H |
|----------------------|---|---|---|---|---|---|
| University hospital  |  |   |   |   |   |   |
| Cancer center (including national centers) |  |   |   |   |   |   |
| National hospital organization (excluding cancer centers) |  |   |   |   |   |   |
| Public hospital (excluding cancer centers) |  |   |   |   |   |   |
| Red cross hospital, saiseikai hospital, company hospital, public corporation hospital, national health insurance hospital, social insurance hospital, mutual insurance hospital, industrial accident hospital, association hospital and Japan agricultural co-operatives hospital |  |   |   |   |   |   |
| Medical corporation hospital, medical association hospital, private hospital and other hospital |  |   |   |   |   |   |

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

| Scale category (annual no. of new patients) | U | G | N | P | O | H | Total | Institution ratio (%) |
|--------------------------------------------|---|---|---|---|---|---|-------|-----------------------|
| A (≤ 99)                                   | 5 | 1 | 16| 51| 38| 26| 137   | 19.1                  |
| B (100–199)                                | 11| 1 | 24| 69| 62| 39| 206   | 28.7                  |
| C (200–299)                                | 12| 2 | 9 | 50| 50| 29| 152   | 21.2                  |
| D (300–399)                                | 22| 3 | 8 | 15| 21| 14| 83    | 11.6                  |
| E (400–499)                                | 16| 0 | 2 | 10| 6 | 12| 46    | 6.4                   |
| F (≥ 500)                                  | 48| 18| 1 | 11| 4 | 11| 93    | 13.0                  |
| Total                                      | 114| 25| 60| 206|181|131|717   |100.0                 |

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

| Scale category (no. of institutions) | Institution category (no. of institutions) | Total (717) | Average |
|--------------------------------------|--------------------------------------------|-------------|---------|
|                                      | U (114) | G (25) | N (60) | P (206) | O (181) | H (131) |       |
| A (137)                              | 229 | 59 | 1024 | 3153 | 2665 | 1743 | 8873 | 64.8  |
| B (206)                              | 1586 | 112 | 3605 | 9925 | 9136 | 5418 | 29782 | 144.6 |
| C (152)                              | 3049 | 501 | 2129 | 11992 | 12199 | 7199 | 37069 | 243.9 |
| D (83)                               | 7837 | 1047 | 2809 | 5293 | 7141 | 4896 | 29023 | 349.7 |
| E (46)                               | 7273 | 0 | 828 | 4243 | 2591 | 5362 | 20297 | 441.2 |
| F (93)                               | 34786 | 16618 | 700 | 6346 | 2754 | 7616 | 68820 | 740.0 |
| Total (717)                          | 54760 | 18337 | 11095 | 40952 | 36486 | 32234 | 193864 | 270.4 |
| Average                              | 480.4 | 733.5 | 184.9 | 198.8 | 201.6 | 246.1 | 270.4 |
| Median                               | 460 | 724 | 154 | 154 | 185 | 201 | 209 |

from full-time equivalent (FTE; 40 h per week for radiation oncology work only) data. The Japanese Blue Book Guidelines (JBBG) [24, 25] were used for comparison with the results of this study. These guidelines pertain to the structure of radiation oncology in Japan based on Patterns of Care Study (PCS) [26, 27] 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 radiation oncologist (RO) and at 120 (warning level, 200) for annual patient load per FTE radiotherapy technologist (RTT).

Furthermore, we analyzed data from the designated cancer care hospitals accredited by the Ministry of Health, Labor and Welfare. As of 1 April 2018, Japan had 437 designated cancer care hospitals [28]. A total of 46 institutions did not return the survey; therefore, the structure data for 391 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 ≥1.0 FTE RO.

RESULTS
In this report, all 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 2013. The values obtained by dividing the real numbers of new patients (193 864)
and total (new plus repeat) patients (230 747) by the response rate were 215 765.0 and 256 814.7, respectively. In addition, there may be radiotherapy institutions not perceived by JASTRO. Therefore, the estimated number of new patients was $\sim 216 000$, i.e. 215 765.0 rounded up to the nearest 1000. In the same way, the estimated number of total patients was $\sim 257 000$ (Fig. 1).

**DISCUSSION**

In this report, the estimated number of new patients and total patients were $\sim 216 000$ and 257 000 by a simple calculation using the response rate. However, it is necessary to carefully consider that the estimated numbers of new patients and total patients reported also vary widely according to the difference in the calculation method used as follows.

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

| Scale category (no. of institutions) | Institution category (no. of institutions) | Total (717) | Average |
|--------------------------------------|-------------------------------------------|------------|---------|
|                                      | U (114)                                   | G (25)     | N (60) | P (206) | O (181) | H (131) |         |
|                                      | 240                                       | 97         | 1206   | 3595    | 2994    | 2249    | 10 381  |
| A (137)                              | 1786                                      | 133        | 4306   | 11 364  | 10 504  | 6635    | 168.6   |
| B (206)                              | 3487                                      | 565        | 2311   | 14 286  | 14 635  | 8758    | 289.8   |
| C (152)                              | 8 01                                      | 0          | 917    | 5082    | 3164    | 6358    | 427.2   |
| D (83)                               | 9 337                                     | 1326       | 3168   | 6494    | 8758    | 6372    | 537.8   |
| E (46)                               | 9 218                                     | 0          | 917    | 5082    | 3164    | 6358    | 24 739  |
| F (93)                               | 40 404                                    | 20 198     | 775    | 7372    | 3084    | 9569    | 875.3   |
| Total (717)                          | 64 472                                    | 22 319     | 12 683 | 48 193  | 43 139  | 39 941  | 321.8   |
| Average                              | 565.5                                     | 892.8      | 211.4  | 233.9   | 238.3   | 304.9   | 321.8   |
| Median                               | 532.5                                     | 785        | 194.5  | 189.5   | 203     | 235     | 236     |

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

| Treatment devices and their functions | Scale category (no. of institutions) | Total (717) |
|--------------------------------------|--------------------------------------|-------------|
|                                      | A (137)                              | B (206)     |
| LINAC                                | 131                                   | 200         |
| With dual energy function            | 78                                    | 147         |
| With 3D CRT function (MLC width $\leq 1.0$ cm) | 99                                    | 168         |
| With IMRT function                   | 27                                    | 74          |
| With cone beam CT or CT on rail      | 27                                    | 68          |
| With treatment position verification system (X-ray perspective image) | 32                                    | 62          |
| With treatment position verification system (other than those above) | 24                                    | 66          |
| Annual no. patients/LINAC            | 79.2                                  | 173.6       |
| CyberKnife                           | 2                                     | 5           |
| Novalis                              | 1                                     | 1           |
| Tomotherapy                          | 1                                     | 5           |
| Particle                             | 1                                     | 0           |
| Microtorton                          | 1                                     | 3           |
| Telecobalt (actual use)              | 0 (0)                                 | 1 (0)       |
| Gamma Knife                          | 5                                     | 10          |
| Other accelerator                    | 0                                     | 2           |
| Other external irradiation device    | 0                                     | 1           |
| New type $^{60}$Co RALS (actual use) | 1 (0)                                 | 3 (4)       |
| Old type $^{60}$Co RALS (actual use) | 0 (0)                                 | 2 (1)       |
| $^{10}$Ir RALS (actual use)          | 2 (2)                                 | 6 (5)       |
| $^{137}$Cs RALS (actual use)         | 0 (0)                                 | 0 (0)       |

LINAC = linear accelerator, 3D CRT = 3D conformal radiotherapy, MLC = multileaf collimator, IMRT = intensity-modulated radiotherapy, CT = computed tomography, Co = cobalt, RALS = remote-controlled after-loading system, Ir = iridium, Cs = Cesium.
Table 6. Number of treatment planning equipment and accessories by scale classification

| Treatment planning equipment and accessories | Scale category (no. of institutions) | Total (717) |
|---------------------------------------------|---------------------------------------|-------------|
|                                            | A (137)                               | B (206)     |
| X-ray simulator (≥1)                        | 58 (58)                               | 73 (73)     |
| CT simulator (≥1)                           | 113 (110)                             | 179 (172)   |
| RTP computer (≥2)                           | 169 (22)                              | 279 (53)    |
| X-ray CT (≥2)                               | 251 (87)                              | 466 (167)   |
| MRI (≥2)                                    | 172 (39)                              | 290 (90)    |
| Computer use for RT recording               | 81                                    | 115         |
| Water phantom (≥2)                          | 147 (25)                              | 239 (53)    |
| Film densitometer (≥2)                      | 43 (5)                                | 93 (1)      |
| Dosimeter (≥3)                              | 340 (61)                              | 690 (131)   |

|                                            | C (152)                               | D (83)      |
| X-ray simulator (≥1)                        | 38 (36)                               | 36 (36)     |
| CT simulator (≥1)                           | 147 (140)                             | 83 (74)     |
| RTP computer (≥2)                           | 272 (64)                              | 251 (56)    |
| X-ray CT (≥2)                               | 450 (139)                             | 272 (72)    |
| MRI (≥2)                                    | 279 (113)                             | 174 (67)    |
| Computer use for RT recording               | 112                                   | 64          |
| Water phantom (≥2)                          | 89                                    | 61          |
| Film densitometer (≥2)                      | 83 (2)                                | 69 (5)      |
| Dosimeter (≥3)                              | 614 (107)                             | 466 (52)    |

|                                            | E (46)                                | F (93)      |
| X-ray simulator (≥1)                        | 36 (24)                               | 26 (24)     |
| CT simulator (≥1)                           | 83 (45)                               | 51 (45)     |
| RTP computer (≥2)                           | 182 (39)                              | 582 (88)    |
| X-ray CT (≥2)                               | 191 (44)                              | 470 (88)    |
| MRI (≥2)                                    | 122 (41)                              | 277 (79)    |
| Computer use for RT recording               | 43                                    | 43          |
| Water phantom (≥2)                          | 80 (44)                               | 693 (79)    |
| Film densitometer (≥2)                      | 94 (11)                               | 428 (30)    |
| Dosimeter (≥3)                              | 318 (52)                              | 693 (79)    |

*No. of institutions.

CT = computed tomography, RTP = radiotherapy planning, MRI = magnetic resonance imaging, RT = radiotherapy.

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 [24]. x and o denote the estimated number of total (new plus repeat) and new patients from the results of structure surveys by JASTRO.

If all non-responding institutions were in category A (≤99), the estimated numbers of new patients and total patients were 199 110 and 236 885 by calculation using the average number of new patients in category A. On the other hand, the estimated numbers of new patients and total patients were 253 804 and 301 646 if all non-responding institutions were in category F (≥500).

In 2013, based on Japanese cancer registries, the cancer incidence was estimated at 862 452 cases [39] with ~25.0% (216 000 of 862 452) of all newly diagnosed patients being treated with radiation.

Regarding the case scale of institution, ~52.2% of all radiotherapy institutions had ≥200 new radiotherapy patients per year, whereas 31.0% of the institutions had ≥300. Additionally, 38.9% of all radiotherapy institutions had <1.0 FTE ROs. Compared with the findings of similar data surveys conducted in 2007 [14–17] and 2012 [23], the percentage of institutions that had ≥1.0 FTE RO had improved a little (2007: 43.8%, 2012: 58.5%, 2013: 61.1%), but was not yet sufficient.

When viewed from the perspective of geographic distribution, radiotherapy institutions cover each region in Japan, although there are considerable differences in the number of radiotherapy institutions in prefectures. Concerning equipment, much of the equipment had been rapidly replaced with instruments with excellent functions, although there are differences depending on the scale of the institution. The numbers of staff (ROs, RTTs, medical physicists (MPs), radiotherapy
### Table 7. Number of personnel and annual number of patients by scale classification

| Scale category (no. of institutions) | A (137) | B (206) | C (152) | D (83) | E (46) | F (93) | Total (717) |
|--------------------------------------|---------|---------|---------|--------|--------|--------|-------------|
| Scale (annual no. of new patients)   | ≤99     | 100–199 | 200–299 | 300–399| 400–499| ⩾500   |             |
| Institution ratio (%)                | 19.1%   | 28.7%   | 21.2%   | 11.6%  | 6.4%   | 13.0%  | 100%        |
| New patients                         | 8873    | 29 782 | 37 069 | 29 023 | 20 297 | 68 820 | 193 864     |
| New patients/institution             | 64.8%   | 144.6%  | 243.9%  | 349.7% | 441.2% | 740.0% | 270.4%      |
| Total patients                       | 10 381  | 34 728  | 44 042  | 35 455 | 24 739 | 81 402 | 230 747     |
| Total patients/institution           | 75.8%   | 168.6%  | 289.8%  | 427.2% | 537.8% | 875.3% | 321.8%      |
| Beds                                 | 46 495  | 79 882  | 75 560  | 46 963 | 29 306 | 68 530 | 346 736     |
| Institutions with RT beds (%)        | 22 (16.1)| 41 (19.9)| 40 (26.3)| 29 (34.9)| 25 (54.3)| 57 (61.3)| 214 (29.8)  |
| RT beds                              | 102.5%  | 172.0%  | 227.0%  | 135.5% | 214.0% | 835.7% | 1686.7%     |
| RT beds/total beds (%)               | 0.2%    | 0.2%    | 0.3%    | 0.3%   | 0.7%   | 1.2%   | 0.5%        |
| RT beds/institution                  | 0.7%    | 0.8%    | 1.5%    | 1.6%   | 4.7%   | 9.0%   | 2.4%        |
| RT beds/institution with RT beds     | 4.7%    | 4.2%    | 5.7%    | 4.7%   | 8.6%   | 14.7%  | 7.9%        |
| JRS-certified institutions (%)       | 3 (2.2%)| 20 (9.7%)| 46 (30.3)| 38 (54.8)| 32 (69.6)| 79 (48.9)| 218 (30.4)  |
| JRS-cooperation institutions (%)     | 48 (35%)| 105 (51%)| 68 (44.7)| 54 (17.4)| 26 (8.4)| 289 (40.3)|           |
| JASTRO-certified institutions (%)    | 5 (3.6%)| 36 (17.5)| 63 (41.4)| 54 (62.1)| 32 (69.6)| 85 (91.4)| 275 (38.4)  |
| JRS membership (full-time)           | 64      | 147     | 159     | 141    | 120    | 466    | 1097        |
| JASTRO membership (full-time)        | 53      | 138     | 153     | 137    | 121    | 464    | 1066        |
| JRS/JASTRO-certified ROs (full-time) | 29      | 116     | 134     | 117    | 93     | 342    | 831         |
| Institutions with full-time ROs (%)   | 59      | 136 (64.1)%| 129 (84.9)%| 78 (94)  | 45 (97.8)| 93 (100)| 536 (74.8)  |
| ROs (full-time)                      | 83      | 168     | 174     | 147    | 124    | 478    | 1174        |
| ROs (full-time)/institution          | 0.6     | 0.8     | 1.1     | 1.8    | 2.7    | 5.1    | 1.6         |
| FTE ROs (full-time)                  | 24.4    | 140.1   | 125.0   | 121.9  | 103.1  | 359.4  | 878.9       |
| FTE ROs (full-time)/institution      | 0.30    | 0.65    | 1.00    | 1.54   | 2.30   | 4.31   | 1.34        |
| ROs (part-time)                      | 121     | 218     | 148     | 64     | 50     | 137    | 738         |
| ROs (part-time)/institution          | 0.88    | 1.06    | 0.97    | 0.77   | 1.09   | 1.47   | 1.03        |
| FTE ROs (part-time)                  | 23.1    | 40.2    | 27.8    | 12.9   | 13.2   | 52.8   | 169.8       |
| FTE ROs (part-time)/institution      | 0.2     | 0.2     | 0.2     | 0.2    | 0.3    | 0.6    | 0.2         |
| FTE ROs (full-plus part-time)        | 64.2    | 173.3   | 179.4   | 140.9  | 119.2  | 453.6  | 1130.6      |
| FTE ROs (full-plus part-time)/institution | 0.47 | 0.84 | 1.18 | 1.70 | 2.59 | 4.88 | 1.58 |
| Radiologists (full-time)             | 164.0   | 357.0   | 459.8   | 347.0  | 301.0  | 951.0  | 2579.8      |
| Radiologists (part-time)             | 152.0   | 314.7   | 324.5   | 120.3  | 114.0  | 246.0  | 1271.5      |
| Radiologists (full-time)/institution | 1.2     | 1.7     | 3.0     | 4.2    | 6.5    | 10.2   | 3.6         |
| RTTs (full-time)*                    | 421     | 716     | 681     | 447    | 316    | 834    | 3415        |
| FTE RTTs                             | 210.1   | 413.0   | 403.0   | 311.7  | 230.4  | 646.5  | 2214.6      |
| MPs (full-time)*                     | 29      | 64      | 78      | 59     | 55     | 148    | 433         |
| FTE MPs                              | 8.8     | 28.3    | 33.8    | 24.6   | 23.6   | 77.6   | 196.6       |
| RTQMs (full-time)*                   | 5.0     | 111     | 120     | 94     | 52     | 130    | 557         |
| FTE RTQMs                            | 16.4    | 35.1    | 41.9    | 32.0   | 15.9   | 42.7   | 183.8       |
| Dosimetrists (full-time)*            | 16      | 33      | 41      | 14     | 26     | 57     | 187         |
| FTE dosimetrists                     | 4.9     | 7.1     | 9.3     | 5.7    | 6.7    | 13.5   | 47.2        |
| Craftworkers (full-time)*            | 31      | 49      | 63      | 13     | 40     | 67     | 263         |
| FTE craftworker                      | 7.4     | 11.4    | 14.2    | 2.4    | 6.9    | 12.8   | 55.1        |
| Nurses (full-time)                   | 160     | 272     | 271     | 196    | 133    | 302    | 1334        |
| FTE nurses                           | 65.32   | 156.54  | 174.95  | 124.89 | 89.7   | 245.3  | 856.7       |
| Nursing assistants                   | 6.8     | 7.5     | 12.2    | 16     | 14.8   | 23.24  | 80.5        |
| Clerks                               | 25.9    | 58.4    | 84.55   | 66.3   | 59.4   | 142.7  | 437.3       |

*Overlap is included in the total number of each staff type (RTT, MP, RTQM, dosimetrists and craftworker).
Table 8. Population, number of patients, institutions and patient load according to prefecture

| Prefecture | Population \( \times 10^3 \) [30] | Institutions | New patients | New patients/institution | Total patients | Total patients/institution |
|------------|-----------------------------------|--------------|--------------|--------------------------|---------------|---------------------------|
| Hokkaido   | 5431                              | 30           | 9013         | 300.4                    | 11766         | 392.2                     |
| Aomori     | 1335                              | 10           | 2207         | 220.7                    | 2457          | 245.7                     |
| Iwate      | 1295                              | 8            | 1837         | 229.6                    | 2410          | 301.3                     |
| Miyagi     | 2328                              | 12           | 4089         | 340.8                    | 4844          | 403.7                     |
| Akita      | 1050                              | 10           | 1815         | 181.5                    | 2087          | 208.7                     |
| Yamagata   | 1141                              | 7            | 1687         | 241.0                    | 2147          | 306.7                     |
| Fukushima  | 1946                              | 9            | 2975         | 330.6                    | 3408          | 378.7                     |
| Ibaraki    | 2931                              | 14           | 3706         | 264.7                    | 4206          | 300.4                     |
| Tochigi    | 1986                              | 9            | 2649         | 294.3                    | 3249          | 361.0                     |
| Gunma      | 1984                              | 14           | 4380         | 312.9                    | 4822          | 344.4                     |
| Saitama    | 1722                              | 21           | 7244         | 345.0                    | 8412          | 400.6                     |
| Chiba      | 6192                              | 24           | 8427         | 351.1                    | 9859          | 410.8                     |
| Tokyo      | 13300                             | 67           | 24427        | 364.6                    | 29915         | 446.5                     |
| Kanagawa   | 9079                              | 39           | 12342        | 316.5                    | 14050         | 360.3                     |
| Niigata    | 2330                              | 14           | 3496         | 249.7                    | 4259          | 304.2                     |
| Tottori    | 1076                              | 8            | 1584         | 198.0                    | 1815          | 226.9                     |
| Ishikawa   | 1159                              | 7            | 1975         | 282.1                    | 2281          | 325.9                     |
| Fukushima  | 795                               | 6            | 1325         | 220.8                    | 1525          | 254.2                     |
| Yamanashi  | 847                               | 5            | 1178         | 235.6                    | 1423          | 284.6                     |
| Nagano     | 2122                              | 15           | 3264         | 217.6                    | 3959          | 263.9                     |
| Gifu       | 2051                              | 13           | 2925         | 225.0                    | 3502          | 269.4                     |
| Shizuoka   | 3723                              | 22           | 5772         | 262.4                    | 7260          | 330.0                     |
| Aichi      | 7443                              | 39           | 10784        | 276.5                    | 13144         | 337.0                     |
| Mie        | 1833                              | 12           | 2000         | 166.7                    | 2395          | 199.6                     |
| Shiga      | 1416                              | 10           | 1875         | 187.5                    | 2321          | 232.1                     |
| Kyoto      | 2617                              | 13           | 4096         | 315.1                    | 4925          | 378.8                     |
| Osaka      | 8849                              | 55           | 14681        | 266.9                    | 17138         | 311.6                     |
| Hyogo      | 5558                              | 32           | 8896         | 278.0                    | 10331         | 322.8                     |
| Nara       | 1383                              | 9            | 2253         | 250.3                    | 2582          | 286.9                     |
| Wakayama   | 979                               | 10           | 1496         | 149.6                    | 1780          | 178.0                     |
| Tottori    | 578                               | 7            | 1072         | 153.1                    | 1238          | 176.9                     |
| Shimane    | 702                               | 5            | 988          | 197.6                    | 1111          | 222.2                     |
| Okayama    | 1930                              | 11           | 2807         | 255.2                    | 3269          | 297.2                     |
| Hiroshima  | 2840                              | 19           | 4631         | 243.7                    | 5769          | 303.6                     |
| Yamaguchi  | 1420                              | 14           | 2009         | 143.5                    | 2418          | 172.7                     |
| Tokushima  | 770                               | 5            | 1262         | 252.4                    | 1444          | 288.8                     |
| Kagawa     | 985                               | 6            | 1,196        | 199.3                    | 1394          | 232.3                     |
| Ehime      | 1405                              | 10           | 2,291        | 229.1                    | 2658          | 265.8                     |
| Kochi      | 745                               | 6            | 1,252        | 208.7                    | 1446          | 241.0                     |
| Fukuoka    | 5090                              | 26           | 8456         | 325.2                    | 9915          | 381.3                     |
| Saga       | 840                               | 5            | 985          | 197.0                    | 1116          | 223.2                     |
| Nagasaki   | 1397                              | 9            | 2298         | 255.3                    | 2766          | 307.3                     |
| Kumamoto   | 1801                              | 13           | 3029         | 233.0                    | 3538          | 272.2                     |
| Oita       | 1178                              | 11           | 1,455        | 132.3                    | 1858          | 168.9                     |
| Miyazaki   | 1120                              | 7            | 1,508        | 215.4                    | 1800          | 257.1                     |
| Kagoshima  | 1680                              | 12           | 2,690        | 224.2                    | 2993          | 249.4                     |
| Okinawa    | 1415                              | 7            | 1537         | 219.6                    | 1742          | 248.9                     |
| Total      | 127297                            | 717          | 193864       | 270.4                    | 230747        | 321.8                     |
Table 9. Number of total patients, radiation oncologists and patient load according to prefecture

| Prefecture   | Total patients | JRS/JASTRO-certified ROs | FTE ROs | Total patients/FTE RO |
|--------------|----------------|--------------------------|---------|-----------------------|
| Hokkaido     | 11 766         | 39                       | 55.1    | 213.5                 |
| Aomori       | 2457           | 10                       | 13.2    | 186.1                 |
| Iwate        | 2410           | 7                        | 10.6    | 227.4                 |
| Miyagi       | 4844           | 13                       | 20.0    | 242.8                 |
| Akita        | 2087           | 3                        | 6.5     | 323.6                 |
| Yamagata     | 2147           | 6                        | 9.3     | 230.9                 |
| Fukushima    | 3408           | 11                       | 19.3    | 176.6                 |
| Ibaraki      | 4206           | 13                       | 22.1    | 190.3                 |
| Tochigi      | 3249           | 12                       | 14.1    | 230.4                 |
| Gunma        | 4822           | 30                       | 32.4    | 148.8                 |
| Saitama      | 8412           | 23                       | 29.2    | 288.1                 |
| Chiba        | 9859           | 40                       | 51.3    | 192.4                 |
| Tokyo        | 29 915         | 95                       | 139.9   | 213.8                 |
| Kanagawa     | 14 050         | 47                       | 65.3    | 215.2                 |
| Niigata      | 4259           | 16                       | 20.6    | 206.7                 |
| Tojima       | 1815           | 4                        | 6.7     | 270.9                 |
| Ishikawa     | 2281           | 7                        | 9.4     | 242.7                 |
| Fukui        | 1525           | 12                       | 11.6    | 131.5                 |
| Yamanashi    | 1423           | 7                        | 8.1     | 175.7                 |
| Nagano       | 3959           | 9                        | 15.0    | 263.9                 |
| Gifu         | 3502           | 9                        | 13.4    | 261.3                 |
| Shizuoka     | 7260           | 24                       | 29.8    | 243.6                 |
| Aichi        | 13 144         | 45                       | 61.7    | 213.0                 |
| Mie          | 2395           | 7                        | 11.6    | 206.5                 |
| Shiga        | 2321           | 8                        | 14.0    | 166.4                 |
| Kyoto        | 4925           | 19                       | 29.4    | 167.5                 |
| Osaka        | 17 138         | 70                       | 90.8    | 188.7                 |
| Hyogo        | 10 331         | 41                       | 60.1    | 171.9                 |
| Nara         | 2582           | 11                       | 14.4    | 179.3                 |
| Wakayama     | 1780           | 8                        | 9.2     | 193.5                 |
| Tottori      | 1238           | 6                        | 5.3     | 233.6                 |
| Shimane      | 1111           | 6                        | 8.7     | 127.7                 |
| Okayama      | 3269           | 15                       | 20.0    | 163.5                 |
| Hiroshima    | 5769           | 21                       | 25.0    | 230.8                 |
| Yamaguchi    | 2418           | 10                       | 13.2    | 183.2                 |
| Tokushima    | 1444           | 7                        | 6.3     | 229.2                 |
| Kagawa       | 1394           | 5                        | 6.5     | 214.5                 |
| Ehime        | 2658           | 10                       | 15.6    | 170.4                 |
| Kochi        | 1446           | 5                        | 4.6     | 314.3                 |
| Fukuoka      | 9915           | 38                       | 49.2    | 201.5                 |
| Saga         | 1116           | 9                        | 10.9    | 102.4                 |
| Nagasaki     | 2766           | 10                       | 13.8    | 201.2                 |
| Kumamoto     | 3538           | 13                       | 18.4    | 192.3                 |
| Oita         | 1858           | 4                        | 8.0     | 232.3                 |
| Miyazaki     | 1800           | 8                        | 7.5     | 240.0                 |
| Kagoshima    | 2993           | 11                       | 14.1    | 212.3                 |
| Okinawa      | 1742           | 7                        | 9.6     | 181.5                 |
| **Total**    | **230 747**    | **831**                  | **1130.6** | **204.1**             |
### Table 10. Number of total patients, staff and patient load according to prefecture

| Prefecture  | Total patients | FTE RTTs | Total patients/FTE RTTs | FTE MPs | FTE RTQM |
|------------|----------------|----------|-------------------------|---------|---------|
| Hokkaido   | 11 766         | 84.6     | 139.0                   | 10.7    | 7.3     |
| Aomori     | 2457           | 25.0     | 98.3                    | 3.4     | 3.5     |
| Iwate      | 2410           | 25.6     | 94.3                    | 2.4     | 1.3     |
| Miyagi     | 4844           | 37.0     | 130.9                   | 2.9     | 3.4     |
| Akita      | 2087           | 23.3     | 89.6                    | 1.2     | 2.6     |
| Yamagata   | 2147           | 21.2     | 101.3                   | 1.4     | 0.9     |
| Fukushima  | 3408           | 34.0     | 100.4                   | 1.0     | 1.3     |
| Ibaraki    | 4206           | 51.5     | 81.7                    | 3.1     | 2.7     |
| Tochigi    | 3249           | 32.5     | 100.0                   | 2.4     | 1.5     |
| Gunma      | 4822           | 49.6     | 97.2                    | 3.8     | 2.5     |
| Saitama    | 8412           | 64.2     | 131.1                   | 5.1     | 6.0     |
| Chiba      | 9859           | 93.8     | 105.1                   | 7.2     | 2.7     |
| Tokyo      | 29 915         | 263.0    | 113.7                   | 26.8    | 14.2    |
| Kanagawa   | 14 050         | 139.9    | 100.4                   | 15.2    | 10.8    |
| Niigata    | 4259           | 46.3     | 92.0                    | 2.4     | 2.3     |
| Toyama     | 1815           | 20.0     | 90.8                    | 0.7     | 2.5     |
| Ishikawa   | 2281           | 23.4     | 97.5                    | 1.7     | 2.2     |
| Fukui      | 1525           | 23.2     | 65.9                    | 2.7     | 1.3     |
| Yamanashi  | 1423           | 10.5     | 136.2                   | 0.9     | 1.5     |
| Nagano     | 3959           | 33.5     | 118.4                   | 2.4     | 1.0     |
| Gifu       | 3502           | 35.6     | 98.4                    | 1.8     | 3.2     |
| Shizuoka   | 7260           | 82.3     | 88.3                    | 9.8     | 8.1     |
| Aichi      | 13 144         | 126.7    | 103.7                   | 12.1    | 11.0    |
| Mie        | 2395           | 24.2     | 99.0                    | 4.6     | 3.3     |
| Shiga      | 2321           | 27.8     | 83.5                    | 1.9     | 4.3     |
| Kyoto      | 4925           | 43.7     | 112.7                   | 4.4     | 6.8     |
| Osaka      | 17 138         | 176.1    | 97.3                    | 21.0    | 16.6    |
| Hyogo      | 10 331         | 103.7    | 99.6                    | 6.6     | 6.1     |
| Nara       | 2582           | 25.0     | 103.3                   | 2.8     | 3.9     |
| Wakayama   | 1780           | 22.2     | 80.2                    | 0.3     | 1.4     |
| Tottori    | 1238           | 13.6     | 91.0                    | 1.0     | 2.2     |
| Shimane    | 1111           | 12.2     | 91.1                    | 0.0     | 2.7     |
| Okayama    | 3269           | 34.6     | 94.6                    | 3.1     | 3.2     |
| Hiroshima  | 5769           | 48.6     | 118.7                   | 2.9     | 4.4     |
| Yamaguchi  | 2418           | 26.4     | 91.6                    | 1.2     | 3.1     |
| Tokushima  | 1444           | 15.5     | 93.2                    | 1.2     | 0.6     |
| Kagawa     | 1394           | 13.6     | 102.9                   | 0.6     | 1.3     |
| Ehime      | 2658           | 25.5     | 104.2                   | 3.4     | 5.6     |
| Kochi      | 1446           | 10.8     | 133.9                   | 1.3     | 0.8     |
| Fukuoka    | 9915           | 87.5     | 113.3                   | 7.2     | 9.0     |
| Saga       | 1116           | 14.4     | 77.5                    | 0.4     | 2.9     |
| Nagasaki   | 2766           | 19.9     | 139.3                   | 3.7     | 3.1     |
| Kumamoto   | 3538           | 36.0     | 98.3                    | 3.0     | 3.2     |
| Oita       | 1858           | 18.9     | 98.3                    | 1.8     | 2.0     |
| Miyazaki   | 1800           | 17.1     | 105.3                   | 0.8     | 1.3     |
| Kagoshima  | 2993           | 32.7     | 91.5                    | 2.4     | 2.3     |
| Okinawa    | 1742           | 18.3     | 95.1                    | 0.5     | 0.6     |
| Total      | 230 747        | 2214.6   | 104.2                   | 196.6   | 183.8   |
| Specific therapy                                      | 2013    | 2012    |
|------------------------------------------------------|---------|---------|
|                                                      | A (137) | B (206) |
| Intracavitary radiotherapy                           |         |         |
| Treatment institutions                               | 1       | 8       |
| Patients                                             | 10      | 85      |
|                                                      | 20      | 213     |
|                                                     | 27      | 338     |
|                                                     | 26      | 415     |
|                                                     | 73      | 2067    |
|                                                     | 155     | 3128    |
| Total (717)                                          | 146     |         |
|                                                      |         |         |
| Interstitial radiotherapy                            |         |         |
| Treatment institutions                               | 4       | 8       |
| Patients                                             | 46      | 147     |
|                                                      | 15      | 365     |
|                                                     | 20      | 505     |
|                                                     | 18      | 360     |
|                                                     | 60      | 2535    |
|                                                     | 125     | 3958    |
| Total (717)                                          | 117     |         |
| ¹²³I seed implantation therapy for prostate          |         |         |
| Treatment institutions                               | 3       | 5       |
| Patients                                             | 36      | 140     |
|                                                      | 13      | 359     |
|                                                     | 15      | 389     |
|                                                     | 14      | 186     |
|                                                     | 57      | 2182    |
|                                                     | 107     | 3292    |
| Total (717)                                          | 103     |         |
|                                                      |         |         |
| Radioactive iodine therapy for thyroid cancer         |         |         |
| Treatment institutions                               | 1       | 7       |
| Patients                                             | 2       | 63      |
|                                                      | 7       | 102     |
|                                                     | 10      | 513     |
|                                                     | 16      | 496     |
|                                                     | 29      | 1156    |
|                                                     | 70      | 2332    |
| Total (717)                                          | 65      |         |
|                                                      |         |         |
| Total body radiotherapy                              |         |         |
| Treatment institutions                               | 12      | 9       |
| Patients                                             | 105     | 24      |
|                                                      | 32      | 368     |
|                                                     | 28      | 230     |
|                                                     | 25      | 378     |
|                                                     | 68      | 1222    |
|                                                     | 174     | 2327    |
| Total (717)                                          | 175     |         |
|                                                      |         |         |
| Intraoperative radiotherapy                          |         |         |
| Treatment institutions                               | 0       | 0       |
| Patients                                             | 0       | 0       |
|                                                      | 1       | 0       |
|                                                     | 0       | 0       |
|                                                     | 4       | 6       |
|                                                     | 11      | 76      |
|                                                     | 16      | 83      |
| Total (717)                                          | 23      |         |
|                                                      |         |         |
| Stereotactic brain radiotherapy                      |         |         |
| Treatment institutions                               | 14      | 40      |
| Patients                                             | 632     | 2807    |
|                                                      | 55      | 2930    |
|                                                     | 55      | 3487    |
|                                                     | 30      | 2036    |
|                                                     | 57      | 3936    |
|                                                     | 251     | 15 828  |
| Total (717)                                          | 233     |         |
|                                                      |         |         |
| Stereotactic body radiotherapy                       |         |         |
| Treatment institutions                               | 5       | 44      |
| Patients                                             | 12      | 412     |
|                                                      | 64      | 745     |
|                                                     | 60      | 809     |
|                                                     | 32      | 817     |
|                                                     | 79      | 2228    |
|                                                     | 284     | 5023    |
| Total (717)                                          | 284     |         |
|                                                      |         |         |
| IMRT                                                 |         |         |
| Treatment institutions                               | 3       | 26      |
| Patients                                             | 51      | 1336    |
|                                                      | 36      | 2631    |
|                                                     | 43      | 2178    |
|                                                     | 34      | 2594    |
|                                                     | 77      | 6329    |
|                                                     | 219     | 15 119  |
| Total (717)                                          | 198     |         |
|                                                      |         |         |
| Thermoradiotherapy                                   |         |         |
| Treatment institutions                               | 1       | 7       |
| Patients                                             | 19      | 59      |
|                                                      | 5       | 19      |
|                                                     | 5       | 5      |
|                                                     | 22      | 246     |
| Total (717)                                          | 21      |         |
|                                                      |         |         |
| ¹⁰⁶Sr radiotherapy for pterygia                       |         |         |
| Treatment institutions                               | 1       | 1       |
| Patients                                             | 6       | 1       |
|                                                      | 10      | 9       |
|                                                     | 2       | 0       |
|                                                     | 2       | 21      |
| Total (717)                                          | 7       |         |
|                                                      |         |         |
| Internal¹⁰⁶Sr radiotherapy                           |         |         |
| Treatment institutions                               | 8       | 34      |
| Patients                                             | 23      | 112     |
|                                                      | 41      | 176     |
|                                                     | 25      | 116     |
|                                                     | 25      | 125     |
|                                                     | 46      | 311     |
|                                                     | 179     | 863     |
| Total (717)                                          | 195     |         |
|                                                      |         |         |
| Internal¹⁰³Y radiotherapy                            |         |         |
| Treatment institutions                               | 2       | 3       |
| Patients                                             | 12      | 9       |
|                                                      | 5       | 16      |
|                                                     | 3       | 7       |
|                                                     | 4       | 19      |
|                                                     | 13      | 55      |
| Total (717)                                          | 29      |         |

I = iodine, IMRT = intensity-modulated radiotherapy, Sr = strontium, Y = yttrium.
Table 12. Annual number of new patients by disease site

| Primary site                                      | n   | %  |
|--------------------------------------------------|-----|----|
| Cerebrospinal                                    | 7854| 4.2|
| Head and neck (including thyroid)                | 16857| 9.0|
| Esophagus                                        | 9623| 5.2|
| Lung, trachea and mediastinum                    | 36014| 19.3|
| Lung                                             | 32597| 17.5|
| Breast                                           | 43365| 23.3|
| Liver, biliary tract, pancreas                   | 7770| 4.2|
| Gastric, small intestine, colorectal             | 9297| 5.0|
| Gynecological                                    | 8845| 4.7|
| Urogenital                                       | 29904| 16.0|
| Prostate                                         | 24196| 13.0|
| Hematopoietic and lymphatic                      | 8117| 4.4|
| Skin, bone and soft tissue                       | 3914| 2.1|
| Other (malignant)                                | 2252| 1.2|
| Benign disease                                   | 2632| 1.4|
| Pediatric ≤ 15 years (included in totals above)  | 892 | 0.5|
| Pediatric 16–19 years (included in totals above) | 275 | 0.1|
| Total                                            | 186444| 100.0|

*Total number 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 any brain metastasis and bone metastasis by scale classification

| Metastasis     | Scale category (no. of institutions) | A (137) | B (206) | C (152) | D (83) | E (46) | F (93) | Total (717) |
|----------------|--------------------------------------|--------|--------|--------|--------|--------|--------|-------------|
|                | n         | %    | N      | %   | n       | %    | n       | %    | n       | %    | n       | %    | n       | %    | n       | %    |
| Brain          | 1222      | 11.8 | 3928   | 11.3| 4294    | 9.7  | 4086    | 11.5| 3252    | 13.1| 7108    | 8.7  | 23890   | 10.4|
| Bone           | 1546      | 14.9 | 5192   | 15.0| 6405    | 14.5| 4763    | 13.4| 2866    | 11.6| 9744    | 12.0| 305516  | 13.2|

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

| Institution category | Description                                      | No. of Institutions |
|----------------------|--------------------------------------------------|---------------------|
| RH-A                 | All radiotherapy hospitals (FTE RO ≥ 1.0)       | 438                 |
| RH-B                 | All radiotherapy hospitals (FTE RO < 1.0)       | 279                 |
| Total                |                                                  | 717                 |
| DCCH-A               | Designated cancer care hospitals (FTE RO ≥ 1.0)  | 299                 |
| DCCH-B               | Designated cancer care hospitals (FTE RO < 1.0)  | 92                  |
| Total                |                                                  | 391                 |
### Table 15. Annual numbers of patients receiving radiotherapy, numbers of LINACs, numbers of staff, patient load per LINAC and patient load per personnel according to institution categories shown Table 14; all radiotherapy hospitals

|                        | RH-A (438) | RH-B (279) | Total (717) |
|------------------------|------------|------------|-------------|
|                        | Average per hospital | Total number | Average per hospital | Total number | Average per hospital | Total number |
| Total patient          | 427.0      | 187 045    | 156.6       | 43 702      | 321.8       | 230 747       |
| New patient            | 357.7      | 156 677    | 133.3       | 37 187      | 270.4       | 193 864       |
| LINAC                  | 1.4        | 614        | 1.0         | 266         | 1.2         | 880           |
| Annual no. of total patients/LINAC | 304.6      | 1643       | 262.2       | 1130.6      |
| Annual no. of new patients/LINAC   | 255.2      | 139.8      | 220.3       | 1130.6      |
| FTERO                  | 2.3        | 1015.7     | 0.4         | 1149.9      | 1.6         | 831           |
| JRS/JASTRO-certified ROs (full-time) | 1.7        | 763        | 0.2         | 68          | 1.2         | 831           |
| Annual No. of total patients/FTERO | 184.2      | 380.3      | 204.1       |             |
| Annual no. of new patients/FTERO | 154.3      | 323.6      | 171.5       |             |
| FTERT                  | 3.9        | 1709.5     | 1.8         | 505.1       | 3.1         | 2214.6        |
| Annual no. of total patients/FTER T | 109.4      | 86.5       | 1.4         |             |
| Annual no. of new patients/FTERTT | 91.7       | 73.6       | 87.5        |             |
| FTE RTTs/LINAC         | 2.8        | 1.9        | 2.5         |             |
| FTE MPs                | 0.39       | 172.8      | 0.09        | 23.8        | 0.27        | 196.6         |
| Annual no. of total patients/FTE MP | 1082.3     | 1835.4     | 1173.5      |             |
| Annual no. of new patients/FTE MP | 906.6      | 1561.8     | 985.9       |             |
| FTE RTQMs              | 0.34       | 149.9      | 0.12        | 33.9        | 0.26        | 83.8          |
| Annual no. of total patients/FTE RTQM | 1248.2     | 1289.1     | 1255.8      |             |
| Annual no. of new patients/FTE RTQM | 1045.6     | 1097.0     | 1055.1      |             |
| FTE RTQMs/LINAC        | 0.24       | 0.13       | 0.21        |             |
Table 16. Annual numbers of patients receiving radiotherapy, numbers of LINACs, numbers of staff, patient load per LINAC and patient load per personnel according to institution categories shown Table 14; designated cancer care hospitals

|                        | DCCH-A (299) | DCCH-B (92) | Total (391) |
|------------------------|--------------|-------------|-------------|
|                        | Average per hospital | Total number | Average per hospital | Total number | Average per hospital | Total number |
| Total patients         | 491.3        | 146 893     | 189.7       | 17 453       | 420.3          | 164 346      |
| New patients           | 411.2        | 122 963     | 164.3       | 15 113       | 353.1          | 138 076      |
| LINAC                  | 1.6          | 468         | 1.0         | 95           | 1.4            | 563          |
| Annual no. of total patients/LINAC | 313.9    | 183.7       | 291.9       |               |               |
| Annual no. of new patients/LINAC | 262.7     | 159.1       | 245.3       |               |               |
| FTERO                  | 2.5          | 752.6       | 0.5         | 47.6         | 2.0            | 800.1        |
| JRS/JASTRO-certified ROs (full-time) | 1.9       | 576         | 1.4         | 563          | 1.6            | 611          |
| Annual no. of total patients/FTERO | 195.2   | 367.0       | 205.4       |               |               |
| Annual no. of new patients/FTERO | 163.4     | 317.8       | 172.6       |               |               |
| FTERTs                 | 4.3          | 1279.3      | 2.1         | 190.9        | 3.8            | 1470.1       |
| Annual no. of total patients/FTERTT | 114.8 | 91.4        | 111.8       |               |               |
| Annual no. of new patients/FTERTT | 96.1      | 79.2        | 93.9        |               |               |
| FTERTs /LINAC         | 2.7          | 2.0         | 2.6         |              |               |
| FTE MPs                | 0.43         | 129.3       | 0.12        | 10.7         | 0.36           | 140.0        |
| Annual no. of total patients/FTE MP | 1,136.5 | 1,629.6     | 1,174.2     |               |               |
| Annual no. of new patients/FTE MP | 951.4     | 1,411.1     | 986.5       |               |               |
| FTE RTQMs             | 0.38         | 112.9       | 0.18        | 16.5         | 0.33           | 129.4        |
| Annual no. of total patients/FTE RTQM | 1,301.7 | 1,057.8     | 1,270.6     |               |               |
| Annual no. of new patients/FTE RTQM | 1,089.6 | 915.9       | 1,067.5     |               |               |
| FTE RTQMs/LINAC       | 0.24         | 0.17        | 0.23        |              |               |
Table 17. Number of items of equipment and their functions according to institution categories shown Table 14

| Equipment Category                                      | RHA (n = 438) | %     | RH-B (n = 279) | %     | Total (n = 717) | %     |
|---------------------------------------------------------|---------------|-------|----------------|-------|----------------|-------|
| LINAC                                                    |               |       |                |       |                |       |
| with dual energy function                               | 614           | 97.5  | 266            | 93.9  | 880            | 96.1  |
| with 3DCRT function (MLC width ≤ 1.0 cm)                | 573           | 91.6  | 212            | 74.6  | 785            | 84.9  |
| With IMRT function                                      | 418           | 66.7  | 76             | 26.9  | 494            | 51.2  |
| With cone beam CT or CT on rail                         | 333           | 59.4  | 69             | 24.4  | 402            | 45.7  |
| With treatment position verification system              | 306           | 53.0  | 66             | 22.9  | 372            | 41.3  |
| (X-ray perspective image)                               |               |       |                |       |                |       |
| With treatment position verification system              | 213           | 39.0  | 70             | 24.7  | 283            | 33.5  |
| (other than those above)                                |               |       |                |       |                |       |
| CT simulator                                            | 445           | 91.6  | 243            | 83.2  | 688            | 88.3  |

| DCCH-A (n = 299)                                        |               |       | DCCH-B (n = 92) |       | Total (n = 391) |       |
|---------------------------------------------------------|---------------|-------|----------------|-------|----------------|-------|
| LINAC                                                    |               |       |                |       |                |       |
| with dual energy function                               | 449           | 100.0 | 98             | 100.0 | 547            | 100.0 |
| with 3DCRT function (MLC width ≤ 1.0 cm)                | 363           | 92.7  | 75             | 77.1  | 438            | 88.8  |
| With IMRT function                                      | 428           | 96.5  | 83             | 85.4  | 511            | 93.7  |
| With cone beam CT or CT on rail                         | 310           | 73.5  | 38             | 38.5  | 348            | 64.8  |
| With treatment position verification system              | 227           | 62.4  | 28             | 28.1  | 255            | 53.8  |
| (X-ray perspective image)                               | 206           | 55.1  | 29             | 29.2  | 235            | 48.6  |
| With treatment position verification system              | 147           | 40.1  | 26             | 27.1  | 173            | 36.8  |
| (other than those above)                                |               |       |                |       |                |       |
| CT simulator                                            | 303           | 96.5  | 90             | 87.5  | 393            | 94.3  |

LINAC = linear accelerator, 3DCRT = 3D conformal radiotherapy, MLC = multileaf collimator, IMRT = intensity-modulated radiotherapy, CT = computed tomography.
Table 18. Number of radiotherapy institutions, treatment devices, patient load and personnel: trend 1990–2013

| Survey year | 1990 | 1993 | 1995 | 1997 | 1999 | 2001 | 2003 | 2005 | 2007 | 2009 | 2010 | 2011 | 2012 | 2013 |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Institutions| 378  | 629  | 504  | 568  | 636  | 603  | 726  | 712  | 721  | 700  | 705  | 694  | 709  | 717  |
| Response rate (%)| 48.5 | 88.3 | 73.9 | 78.6 | 86.3 | 85.3 | 100  | 96.9 | 94.2 | 90.9 | 90.4 | 88.2 | 90.0 | 89.8 |
| New patients| 62,829| —    | 71,696| 84,379| 107,150| 118,016| 149,793| 156,318| 170,229| 182,390| 190,322| 185,455| 190,910| 193,864|
| Total patients| —    | —    | —    | —    | —    | —    | —    | 191,173| 205,087| 217,829| 226,851| 220,092| 225,818| 230,747|
| Average no. of new patients| 166  | —    | 142  | 149  | 168  | 196  | 206  | 220  | 236  | 261  | 270  | 267  | 269  | 270  |
| Treatment devices (actual use) | | | | | | | | | | | | | | |
| LINAC | 311  | 508  | 407  | 475  | 626  | 626  | 744  | 765  | 807  | 816  | 829  | 836  | 864  | 880  |
| Telecobalt | 170  | 213  | 127  | 98   | 83   | 45   | 42   | 11   | 15   | 11   | 9    | 9     | 3     | 0     |
| 192Ir RALS | —    | —    | 29   | 50   | 73   | 93   | 117  | 119  | 123  | 130  | 131  | 125  | 130  | 128  |
| Full-time ROs | 547  | 748  | 821  | 889  | 925  | 878  | 921  | 1003 | 1007 | 1085 | 1123 | 1102 | 1122 | 1174 |
| FTE ROs | —    | —    | —    | —    | —    | —    | —    | 774  | 826  | 939  | 959  | 1,019 | 1,062 | 1,131 |
| Full-time JRS/JASTRO-certified ROs | —    | —    | —    | —    | —    | —    | —    | 308  | 369  | 426  | 477  | 529  | 564  | 756  |
| JRS/JASTRO-certified RTs | 592  | 877  | 665  | 733  | 771  | 918  | 1555 | 1635 | 1634 | 1836 | 1841 | 2027 | 2124 | 2215 |
| Treatment planning equipment | | | | | | | | | | | | | | |
| X-ray simulators | 295  | 430  | 394  | 452  | 512  | 464  | 532  | 502  | 445  | 361  | 348  | 320  | 305  | 291  |
| CT simulators | 30   | 75   | 55   | 96   | 164  | 247  | 329  | 407  | 497  | 575  | 633  | 654  | 677  | 688  |
| RTP computers | 238  | 468  | 374  | 453  | 682  | 680  | 874  | 940  | 1070 | 1271 | 1381 | 1484 | 1611 | 1,735 |

LINAC = linear accelerator, Ir = iridium, RO = radiation oncologist, FTE = full-time equivalent, JRS = Japan Radiological Society, JASTRO = Japanese Society for Radiation Oncology, RT = radiotherapy, CT = computed tomography, RTP = radiotherapy planning, RALS = remote-controlled after-loading system.
Fig. 2. Distribution of annual total (new plus repeat) patient load per linear accelerator (LINAC) in radiotherapy institutions. The horizontal axis represents institutions arranged in order of increasing value of annual number of total patients per LINAC within the institution. Q1: 0–25, Q2: 26–50, Q3: 51–75 and Q4: 76–100%.

Fig. 3. Distribution of annual total (new plus repeat) patient load per FTE RO according to the institution categories shown Table 14; all radiotherapy hospitals. The horizontal axis represents institutions arranged in order of increasing value of annual number of total patients per FTE RO within the institution. Q1: 0–25, Q2: 26–50, Q3: 51–75 and Q4: 76–100%.
Fig. 4. Distribution of annual total (new plus repeat) patient load per FTE RTT according to institution categories shown Table 14; all radiotherapy hospitals. The horizontal axis represents institutions arranged in order of increasing value of annual number of total patients per FTE RTT within the institution. Q1: 0–25, Q2: 26–50, Q3: 51–75 and Q4: 76–100%.

Fig. 5. Distribution of annual total (new plus repeat) patient load per FTE RO according to institution categories shown Table 14; designated cancer care hospitals. The horizontal axis represents institutions arranged in order of increasing value of annual number of total patients per FTE RO within the institution. Q1: 0–25, Q2: 26–50, Q3: 51–75 and Q4: 76–100%.
quality manager (RTQMs) and nurses] steadily increased. Annual total patient load per radiation oncologist was 204.1, which was lower than the 243.8 of the 2007 survey. However, this patient load exceeds 200.0, which is the standard value recommended in the JBBG [24, 25]. With regard to other staff, the numbers of MPs and RTQMs are absolutely insufficient. Compared with the other types of staff mentioned above, a sufficient number of RTTs is ensured in Japan. Therefore, RTTs partially act as MPs and RTQMs in most institutions.

The average of structure data (the average number of new patients, total patients, LINACs, FTE RO, FTE RTT, FTE MP, and FTE RTQM) of designated cancer care hospitals was better than those of all radiotherapy hospitals (the national average). Annual patient load per designated cancer care hospital was ~100 patients more than the national average, however annual patient load per FTE RO and annual patient load per FTE RTT were almost the same as the national average. These data suggest that the number of radiotherapy patients in all radiotherapy hospitals may be near to saturation. On the other hand, 23.5% of designated cancer care hospitals had <1.0 FTE RO. Compared with the findings of similar data surveys conducted in 2007 [17] and 2012 [23], the above percentages had decreased by 13.8% from 2007 data and 1.5% from 2012 data, but was not yet sufficient. It is conceivable that the more the number of radiotherapy staff (especially ROs, MPs and RTQMs) increases, the greater the number of patients who can undergo radiotherapy.

In conclusion, the Japanese structure of radiation oncology has clearly and steadily improved over the past 20 years in terms of installation and use of equipment and its functions, ∼, nevertheless there are still problems with shortages of manpower and the difference in equipments due to difference of institution types. We expect that this updated national structure survey of radiation oncology for 2013 will aid the continuous improvement of all aspects of radiation oncology in Japan.

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CONFLICT OF INTEREST
None declared.

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