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The clinical utilization of radiation therapy in Korea between 2009 and 2013

Jin-Kyu Kang, MD[1], Mi-Sook Kim, MD, PhD[1,2], Won-Il Jang, MD[1], Young Seok Seo, MD[1], Hee Jin Kim[2], Chul Koo Cho, MD, PhD[1], Hyung Jun Yoo, MD[1], Eun Kyung Paik, MD[1], Yu Jin Cha, MD[1], Hyun Jin Song, MPharm, PhD[3]

[1]Department of Radiation Oncology and, [2]Radiation Medicine Policy Development Center, Korea Institute of Radiological & Medical Sciences, Seoul; [3]College of Pharmacy and Research Institute of Pharmaceutical Sciences, Kyungpook National University, Daegu, Korea

Purpose: The purpose of this study was to estimate the clinical utilization of radiation therapy (RT) in Korea between 2009 and 2013.

Materials and Methods: We analyzed open claims data from the Health Insurance Review and Assessment Service. The subjects were patients who had diagnostic codes C00-C97 or D00-D48 according to the 10th revision of the International Classification of Diseases, with procedure codes indicating RT treatment.

Results: The total number of patients who received RT in 2009, 2010, 2011, 2012, and 2013 were 45,571, 49,593, 54,671, 59,172, and 61,485, respectively. Among them, the total numbers of male and female patients were 20,780/24,791 in 2009, 22,711/26,882 in 2010, 24,872/29,799 in 2011, 27,101/32,071 in 2012, and 27,941/33,544 in 2013. The five cancers that were most frequently treated with RT between 2009 and 2012 were breast, lung, colorectal, liver, and uterine cervical cancers. However, the fifth most common cancer treated with RT that replaced uterine cervical cancer in 2013 was prostate cancer. The three leading types of cancer among the male patients were lung, colorectal, and liver cancers, whereas in female patients, they were breast, uterine cervical, and lung cancers. The type of cancer most commonly treated by RT was cancer of the central nervous system in patients aged 20 years or less, breast cancer in patients aged 30–50 years, and lung cancer in patients aged 60 years or more.

Conclusion: Data from this study provided the clinical utilization of RT in Korea between 2009 and 2013.

Keywords: Neoplasms, Radiotherapy, Statistics, Korea

Introduction

Cancer is a major public health problem in Korea. According to the annual report of the Korea Central Cancer Registry, more than 200,000 people have been diagnosed with cancer every year since 2010, with a steadily increasing cancer incidence [1-4]. This trend is expected to persist in the future because of population aging, westernized lifestyle, development of diagnostic tools that can detect cancer, and a medical system that encourages cancer screening [5-6].

As radiation therapy (RT) is an indispensable part of cancer treatment, it is reasonable and necessary to estimate the

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Correspondence: Mi-Sook Kim, MD, PhD, Department of Radiation Oncology, Korea Institute of Radiological & Medical Sciences, 75 Nowon-ro, Nowon-gu, Seoul 01812, Korea. Tel: +82-2-970-2484, Fax: +82-2-970-2412, E-mail: mskim@kirams.re.kr

clinical utilization of RT for understanding the status and development of cancer treatment in Korea. The most up to date official records on the clinical utilization of RT in Korea were reported for the period 1999–2006 [7-10]. These records were compiled using questionnaire-based methods over a long period and possibly had recall bias. Recently, we reported the findings of a pilot study for the clinical utilization of RT in 2009 and 2013 [11] in order to estimate the feasibility of statistics using claims data from the Health Insurance Review and Assessment Service (HIRA). In previous studies [7-11], we categorized patients according to the cancer site treated by RT, instead of their primary cancer diagnostic codes. In the present study, the patients were categorized according to their primary cancer codes rather than their metastasis status or the site of treatment. Moreover, a previous study [11] analyzed patients who only had 'C' code diseases. Patients who had ductal carcinoma in situ of the breast or benign brain tumor treated with RT could not be included in the total count of patients who received RT because they are 'D' code diseases and are therefore classified as benign. Consequently, the actual total number of patients who received RT was underestimated. Therefore, in the present study, we analyzed the data from patients having both 'D' code and 'C' code diseases. The aim of the present study was to estimate the clinical utilization of RT in the 2009–2013 period using claims data from the HIRA.

Materials and Methods

The detailed methods using claims data from the HIRA are described in a previous study [11]. The customized source population criteria for this study are shown in Table 1. In this study, we included not only patients with International Classification of Disease 10 (ICD-10) diagnostic codes C00-C97, but also those with diagnostic codes D00-D48 (including carcinoma in situ or benign neoplasms), who were also associated with at least one of the procedure codes related to RT treatment. In our previous study, we categorized the patients who had diagnostic codes for metastasis (C77-79) based on whether they received RT to the metastatic site, irrespective of the patient's primary cancer diagnostic code. However, in this study, the patients were categorized according to their primary cancer codes rather than their metastasis status, even if they had diagnostic codes indicating metastasis. For example, if the patient had code C34 for primary lung cancer and code C79.30 for brain metastasis, the patient was categorized as having primary lung cancer instead of brain metastasis. This method of categorization was to identify the number of patients who underwent RT for their primary cancers. However, if the patient only had a diagnostic code for metastasis, we could not determine the primary cancer diagnosis; therefore, the patient was categorized as 'unknown primary.' If the patient had both C and D diagnostic codes, it was assumed the patient had received RT for the disease with the C diagnostic code.

Table 1. The customized source population

List	Criterion
Treatment period	01/01/2009–12/31/2013
Type of healthcare facility	Tertiary, secondary
Diagnostic code	C00–C97, D00–D48
Type of insurance	Health insurance, medical aid
Hospital region	National
Sex	Male, female
Age	All ages

Table 2. Procedure codes related to radiation therapy

Procedure code	Name of procedure code
HD51-HD56	Teletherapy—single or opposed ports
HD58-HD59	Rotational irradiation
HD61	3-Dimensional conformal therapy
HD80-HD89	Brachytherapy
HD91	Total body irradiation
HD92	Total body lymph node irradiation
HD93	Total skin electron beam therapy
HD110-HD115, HD211-HD212	Stereotactic radiation therapy
HD121	Proton therapy
HZ271	Intensity-modulated radiation therapy

We analyzed the claims data from the HIRA in order to identify the total number of patients who underwent RT, and the number of patients who received RT by primary cancer diagnosis, gender, and age group between 2009 and 2013 in Korea. In addition, through the classification of the procedure codes (Table 2), we estimated the total number of patients who received specific RT modalities, including brachytherapy, intensity-modulated radiation therapy (IMRT), stereotactic radiation therapy (SRT), and proton therapy.

Results

The total number of patients who received RT in 2009, 2010, 2011, 2012, and 2013 were 45,571, 49,593, 54,671, 59,172, and 61,485, respectively (Fig. 1). Among them, the total number of cancer patients (C00-C97) who received RT in 2009, 2010,

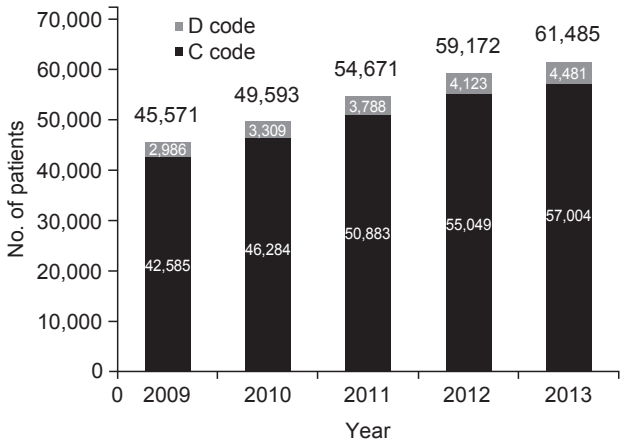

Fig. 1. The total number of patients who underwent radiation therapy between 2009 and 2013 in Korea.

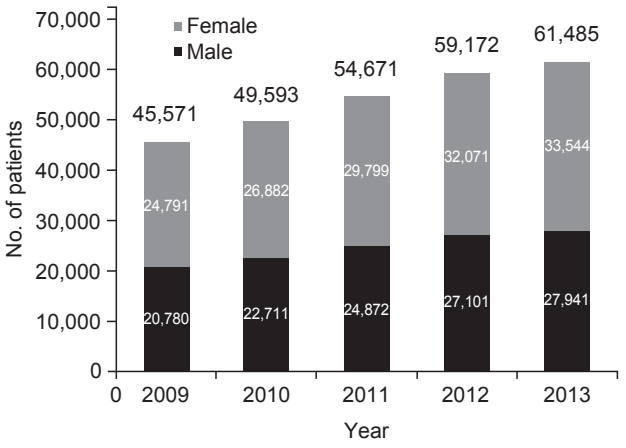

Fig. 2. The total numbers of male and female patients who received radiation therapy between 2009 and 2013 in Korea.

2011, 2012, and 2013 were 42,585, 46,248, 50,883, 55,049, and 57,004, respectively. The total numbers of male and female patients who received RT were 20,780/24,791 in 2009, 22,711/26,882 in 2010, 24,872/29,799 in 2011, 27,101/32,071 in 2012, and 27,941/33,544 in 2013 (Fig. 2). The distribution of patients who received RT by cancer diagnosis between 2009 and 2013 is shown in Table 3. The five most common cancers treated with RT between 2009 and 2012 were breast, lung, colorectal, liver, and uterine cervical cancers. However, the fifth most common cancer treated with RT in 2013 was prostate cancer instead of uterine cervical cancer. The three leading types of cancer among male patients were lung, colorectal, and liver cancers, and those among female patients were breast, uterine cervical, and lung cancers. Breast cancer patients constituted a quarter of the total number of cancer patients who underwent RT, and approximately half of the female cancer patients. Carcinoma in situ of the breast treated with RT was the most common among the diseases with code 'D.' The benign neoplasms of the meninges and the central nervous system were second and third most common among

Table 3. The distribution of cancer patients who underwent radiation therapy based on primary diagnosis between 2009 and 2013

Category	Primary diagnosis (diagnostic code)	No. of patients who received radiation therapy				
		2009	2010	2011	2012	2013
Breast	(C50)	11,111	12,226	13,724	14,956	15,655
Gastrointestinal	Colorectum (C18-C20)	4,323	4,561	5,033	5,004	4,860
	Liver (C22)	2,719	2,757	3,015	3,424	3,595
	Esophagus (C15)	1,106	1,179	1,236	1,327	1,374
	Stomach (C16)	912	1,016	1,077	1,034	1,012
	Pancreas (C25)	566	678	780	940	901
	Gallbladder & biliary (C23-C24)	691	714	772	842	874
	Anus (C21)	146	165	188	220	211
	Small bowel (C17)	28	35	39	40	42
	Other (C26)	5	2	3	4	3
	Subtotal	10,496	11,107	12,143	12,835	12,872
Thoracic	Lung (C34)	7,379	8,238	8,861	9,285	9,980
	Thymus (C37)	190	221	266	235	245
	Mediastinum (C38)	43	42	39	46	47
	Trachea (C33)	14	21	16	18	17
	Other (C39)	3	1	5	2	1
	Subtotal	7,629	8,523	9,187	9,586	10,290

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Table 3. Continued

Category	Primary diagnosis (diagnostic code)	No. of patients who received radiation therapy				
		2009	2010	2011	2012	2013
Head & neck	Larynx (C32)	730	803	761	872	955
	Oropharynx (C01, C09-C10)	340	398	496	611	588
	Oral cavity (C02-C06)	362	412	502	598	583
	Nasopharynx (C11)	307	300	409	493	484
	Salivary gland (C07-C08)	259	276	291	350	344
	Hypopharynx (C12-C13)	287	287	361	392	336
	Paranasal sinus (C31)	106	144	150	167	148
	Nasal cavity (C30)	81	67	96	124	113
	Eye & orbit (C69)	35	36	44	52	49
	Lip (C00)	12	8	12	9	14
	Other (C14)	7	13	19	22	16
	Subtotal	2,526	2,744	3,141	3,690	3,630
Gynecologic	Uterine cervix (C53)	2,439	2,441	2,450	2,470	2,545
	Uterine corpus (C54-C55)	633	588	628	715	737
	Ovary & tubes (C56)	143	183	206	200	240
	Vagina & vulva (C51-C52)	105	119	110	114	94
	Other (C57-C58)	7	13	13	14	10
	Subtotal	3,327	3,344	3,407	3,513	3,626
Genitourinary	Prostate (C61)	1,222	1,446	1,937	2,426	2,552
	Ureter & bladder (C66-C67)	360	429	496	480	523
	Kidney (C64-C65)	294	359	426	405	433
	Penis & testis (C60, C62-C63)	51	65	65	53	66
	Other (C68)	8	9	8	13	12
	Subtotal	1,935	2,308	2,932	3,377	3,586
CNS	Brain (C70-C71)	1,365	1,448	1,386	1,508	1,577
	Spinal cord (C72)	44	44	61	57	55
	Other (C47)	29	35	47	37	50
	Subtotal	1,438	1,527	1,494	1,602	1,682
Lymphoma	Non-Hodgkin's lymphoma (C82-C88)	1,056	1,203	1,177	1,325	1,316
	Hodgkin's disease (C81)	86	98	99	108	91
	Other (C96)	6	4	21	21	22
	Subtotal	1,148	1,305	1,297	1,454	1,429
Soft tissue	(C46, C49)	406	506	540	571	619
Myeloma & plasmacytoma	(C90)	324	338	315	410	438
Thyroid	(C73)	305	340	357	388	358
Leukemia	(C91-C95)	333	367	357	351	352
Skin	(C44)	205	224	240	273	265
Malignant melanoma	(C43)	148	159	203	207	214
Primary bone & cartilage	(C40-C41)	157	179	211	218	169
Endocrine	(C74-C75)	71	66	51	76	91
Unknown primary	(C45,C48, C76-C80, C97)	1,026	1,021	1,284	1,542	1,728
Total no. of cancer patients	-	42,585	46,284	50,883	55,049	57,004
Carcinoma in situ of the breast	(D05)	939	1,128	1,355	1,601	1,870
Benign neoplasm of meninges	(D32)	867	859	1,013	954	1,027
Benign neoplasm of CNS	(D33)	616	639	720	734	731
Benign neoplasm of endocrine	(D34-D35)	197	260	227	276	300
Other D code diseases	(D00-D04, D06-D31, D36-D48)	367	423	473	558	553
Total D code patients	-	2,986	3,309	3,788	4,123	4,481
Total	-	45,571	49,593	54,671	59,172	61,485

CNS, central nervous system.

Table 4. The number of patients who underwent radiation therapy by cancer diagnosis and age group in 2013

Primary diagnosis	No. of patients who received radiation therapy by age group						
	20's or under	30's	40's	50's	60's	70's or older	Total
Breast (C50)	151	1,600	5,705	5,157	2,203	839	15,655
Colorectum (C18-C20)	13	146	549	1,366	1,392	1,394	4,860
Liver (C22)	4	78	433	1,211	1,106	763	3,595
Esophagus (C15)	0	2	55	345	416	556	1,374
Stomach (C16)	7	57	134	279	278	257	1,012
Pancreas (C25)	1	12	75	238	318	257	901
Gallbladder & biliary (C23-C24)	0	8	51	213	312	290	874
Anus (C21)	0	7	19	61	58	66	211
Small bowel (C17)	1	2	9	11	10	9	42
Other (C26)	0	1	0	0	1	1	3
Subtotal	26	313	1,325	3,724	3,891	3,593	12,872
Lung (C34)	13	126	624	2,182	3,280	3,755	9,980
Thymus (C37)	5	23	58	56	67	36	245
Mediastinum (C38)	7	6	8	11	11	4	47
Trachea (C33)	2	0	5	3	2	5	17
Other (C39)	0	0	0	0	0	1	1
Subtotal	27	155	695	2,252	3,360	3,801	10,290
Larynx (C32)	1	5	36	230	330	353	955
Oropharynx (C01, C09-C10)	3	14	80	214	170	107	588
Oral cavity (C02-C06)	14	33	88	157	145	146	583
Nasopharynx (C11)	19	55	93	150	110	57	484
Salivary gland (C07-C08)	19	30	58	101	82	54	344
Hypopharynx (C12-C13)	0	1	22	77	124	112	336
Paranasal sinus (C31)	4	8	18	40	42	36	148
Nasal cavity (C30)	6	9	17	31	25	25	113
Eye & orbit (C69)	4	3	10	14	7	11	49
Lip (C00)	0	0	1	3	3	7	14
Other (C14)	0	0	1	1	4	10	16
Subtotal	70	158	424	1,018	1,042	918	3,630
Uterine cervix (C53)	49	273	603	724	381	515	2,545
Uterine corpus (C54-C55)	0	19	106	325	201	86	737
Ovary & tubes (C56)	6	12	50	98	55	19	240
Vagina & vulva (C51-C52)	2	3	8	17	19	45	94
Other (C57-C58)	1	1	0	4	4	0	10
Subtotal	58	308	767	1,168	660	665	3,626
Prostate (C61)	0	0	22	265	868	1,397	2,552
Ureter & bladder (C66-C67)	2	2	25	65	138	291	523
Kidney (C64-C65)	13	14	44	121	114	127	433
Penis & testis (C60, C62-C63)	13	18	14	7	6	8	66
Other (C68)	0	0	0	1	4	7	12
Subtotal	28	34	105	459	1,130	1,830	3,586
Brain (C70-C71)	270	150	281	340	298	238	1,577
Spinal cord (C72)	15	6	12	6	5	11	55
Other (C47)	15	8	6	10	7	4	50
Subtotal	300	164	299	356	310	253	1,682
Non-Hodgkin's lymphoma (C82-C88)	87	115	211	347	262	294	1,316
Hodgkin's disease (C81)	44	15	8	13	4	7	91
Other (C96)	6	1	4	3	2	6	22
Subtotal	137	131	223	363	268	307	1,429

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Table 4. Continued

Primary diagnosis	No. of patients who received radiation therapy by age group						
	20's or under	30's	40's	50's	60's	70's or older	Total
Soft tissue (C46, C49)	82	61	86	133	120	137	619
Myeloma & plasmacytoma (C90)	0	11	38	110	146	133	438
Thyroid (C73)	8	15	45	92	78	120	358
Leukemia (C91-C95)	151	71	51	49	25	5	352
Skin (C44)	4	13	26	41	52	129	265
Malignant melanoma (C43)	2	12	32	68	52	48	214
Primary bone & cartilage (C40-C41)	49	15	26	38	22	19	169
Endocrine (C74-C75)	37	4	12	11	13	14	91
Unknown primary (C45, C48, C76-C80, C97)	30	61	235	463	508	431	1,728
Total	1,160	3,126	10,094	15,502	13,880	13,242	57,004

Table 5. The distribution of patients who received radiation therapy according to specific radiation therapy modalities

Radiation therapy modality	Year				
	2009	2010	2011	2012	2013
Brachytherapy	1,441	1,376	1,384	1,401	1,387
Intensity-modulated radiation therapy	-	-	3,113	6,648	6,747
Stereotactic radiation therapy	4,226	4,894	5,435	5,543	5,945
Proton therapy	-	-	25	50	33

the diseases with code 'D.'

The distribution of patients who received RT in 2013 based on cancer diagnosis and age group is shown in Table 4. The most common cancer was that of the central nervous system for patients aged 20 years or less, while breast cancer was the most common cancer in patients aged 30–50 years, and lung cancer was the most common cancer in patients aged 60 years or more. Similar trends were observed for previous years.

The distribution of patients who received RT with specific modalities is shown in Table 5. Because National health insurance had not covered IMRT and proton therapy before 2011, the number of patients who received IMRT and proton therapy before 2011 was not calculated.

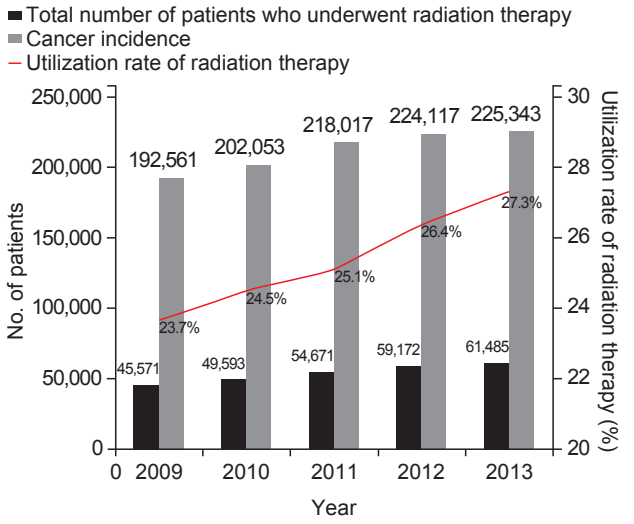

Fig. 3. Cancer incidence and the total number of patients who received radiation therapy between 2009 and 2013 in Korea.

Discussion and Conclusion

This study was conducted to analyze the clinical utilization of RT between 2009 and 2013 in Korea using claims data from the HIRA. The total number of patients who underwent RT increased 4%–10% per year between 2009 and 2013 (Fig. 1). Considering the annual cancer incidence [1-4,12], although the percentage of patients who underwent RT increased from 23% to 27% during these 5 years, it remained below 30% (Fig. 3). Table 6 shows the utilization rate of RT, which is defined as the proportion of all cancers with indications for RT by country [13-17]. This value can be dependent on the distributions of cancer types and stages. According to these reports, about 47%–55% of cancer patients in developed or developing countries would be candidates for RT treatment. Although the optimal utilization rate of RT in Korea was not reported yet,

Table 6. List of relevant studies conducted on the utilization rates of radiation therapy by country

Author	Year	Country	Optimal utilization rate of radiation therapy (%)
Delaney et al. [13]	2005	Australia	52.3
Jaen Olasolo et al. [14]	2007	Spain	55.0
Barton et al. [15]	2014	Australia	48.3
Borras et al. [16]	2015	40 European countries	47.0–53.2
Rosenblatt et al. [17]	2015	Ghana, Philippines, Tunisia, Serbia, Costa Rica, Romania, Malaysia, Uruguay, Slovenia	47.0–56.0

it is estimated to be within the same range. Even though the optimal RT utilization rate has been criticized for potentially overestimating the demand for RT [18], the clinical utilization rate of RT in Korea could be estimated to be much lower than the optimal utilization rate of RT.

Generally, the number of cancer patients who underwent RT for primary cancer increased steadily; however, the number of uterine cervical cancer patients remained approximately at 2,500 during these 5 years. While, the number of prostate cancer patients who received RT notably increased during this period, and consequently, prostate cancer became the fifth most common cancer in 2013 replacing the cervical cancer. This might not only be attributed to the increased prevalence of prostate cancer, but also to the improvement of RT techniques including IMRT or SRT.

In terms of RT modalities, while the numbers of patients who received brachytherapy were similar for each year between 2009 and 2013, the cases receiving IMRT notably increased from 2011 to 2013, and this increase is expected to continue in the future because of national health insurance coverage of IMRT. Similar to IMRT, the number of cases treated with SRT also has steadily increased during these 5 years. Because the claims data from the HIRA only included that of the insured cases and the number of uninsured treatments could not be recorded, the actual number of patients who received proton therapy is expected to be more than the reported number.

In comparison to the results from a previous study [11], differences were observed in the total number of patients who underwent RT in 2009 and 2013. One of the reasons for the difference could be attributed to the different collection time of claims data from the HIRA, considering that some patients' data are registered after 1 or more years. Therefore, the total number of patients who received RT in the same year might not indicate the actual number.

This study could provide useful clinical utilization data for RT in Korea, and we aim to continuously provide the results on the clinical utilization of RT using claims data from the HIRA in the form of an annual report in the future.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Acknowledgments

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