JIRA

Radiology Japan

Japan Industries Association of Radiological Systems **February 2007 No. 54**

Review of the Japanese Market for Diagnostic Imaging and Therapeutic Systems, the First Half Year 2006

Diagnostic Imaging and Therapeutic Systems (production, exports, imports, domestic market)

From January through June 2006 Unit: Millions of yen

Category / Item	Production		Exports		Imports		Domestic Market			
	Amount	% Δ from Previous Year	Amount	% Δ from Previous Year	Amount	% Δ from Previous Year	Number of Units	% Δ from Previous Year	Amount	% Δ from Previous Year
1 X-ray	**71,812**	**+14**	**23,599**	**+16**	**15,703**	**+12**			**63,917**	**+13**
・General-purpose R/F	17,659	+10	2,521	-6	–	–	832	+9	15,138	+13
・Cardio & angio	7,477	+21	3,683	+45	8,280	+3	157	+11	12,074	+3
・General-purpose radiography	10,302	+22	4,585	-2	893	-15	2,703	+2	6,610	+38
・Mammography	1,596	-4	6	-77	3,684	+23	409	+2	5,274	+14
・Mobile	1,747	-8	766	-23	74	0	406	+2	1,055	+8
・Dental	3,438	+9	987	-5	–	–	2,195	+12	2,451	+17
・Others	29,593	+17	11,051	+32	2,772	+48			21,315	+13
2 CT	**61,902**	**+25**	**40,409**	**+42**	**13,700**	**+61**			**35,193**	**+18**
3 Nuclear medicine	**5,148**	**+101**	**100**	**–**	**7,159**	**-20**			**12,207**	**+6**
4 MRI	**17,148**	**-10**	**6,564**	**-31**	**21,835**	**+4**			**32,419**	**+7**
5 Image processing systems	**12,189**	**+57**	**1,987**	**+28**	**4,506**	**+80**			**14,708**	**+68**
6 Related items & accessories	**15,577**	**+7**	**7,725**	**+29**	**1,123**	**0**			**8,975**	**-8**
7 Diagnostic ultrasound	**44,875**	**0**	**28,120**	**-7**	**4,284**	**+2**			**21,039**	**+12**
8 Therapeutic systems	**2,788**	**-41**	**832**	**-25**	**5,516**	**+102**			**7,471**	**+17**
Total	**231,440**	**+12**	**109,336**	**+12**	**73,825**	**+17**			**195,929**	**+14**

(Note) Domestic Market: Calculated by the formula (Production – Exports + Imports).

Review of the first half (January to June) 2006

( ) refers to increase or fall of percentage over the previous year.

1. The total count of medical imaging systems was as follows.
   - Production 231.4 billion yen (+ 12%)
   - Export 109.3 billion yen (+ 12%)
   - Import 73.8 billion yen (+ 17%)

   Total domestic market 195.9 billion yen (+ 14%)

   Among the domestic market, the amount reported by new member companies reached 2.9 billion yen.

2. The domestic market of major equipment was as follows.
   - X-ray 63.9 billion yen (+ 13%)
   - CT 35.2 billion yen (+ 18%)
   - Nuclear medicine 12.2 billion yen (+ 6%)
   - MRI 32.4 billion yen (+ 7%)
   - Other image processing systems 14.7 billion yen (+ 68%)
   - Diagnostic ultrasound 21.0 billion yen (+ 12%)

   Total diagnostic equipment 188.5 billion yen (+ 14%)

   Breakdown of X-ray was as follows:
   - General-purpose R/F 15.1 billion yen (+ 13%)
   - Cardio & angio 12.1 billion yen (+ 3%)
   - General-purpose radiography 6.6 billion yen (+ 38%)
   - Mammography 5.3 billion yen (+ 14%)
   - Mobile 1.1 billion yen (+ 8%)
   - Dental 2.5 billion yen (+ 17%)

   Total X-ray 63.9 billion yen (+ 13%)

Recent trends in the first half year 2006 are as follows.

In CT, the units of multi-slice systems are three times as many as the units of single-slice systems.

In Nuclear Medicine, PET/CT accounts for around 25% of the total units and more than 50% of the total amount.

More than 90% of ultrasound are general purpose systems.
In X-ray Cardio & angio systems, 80% on units are FPD machines. On the other hand almost General-purpose radiographies are still analog detector machines.
Image processing systems are almost PACS and image viewers.

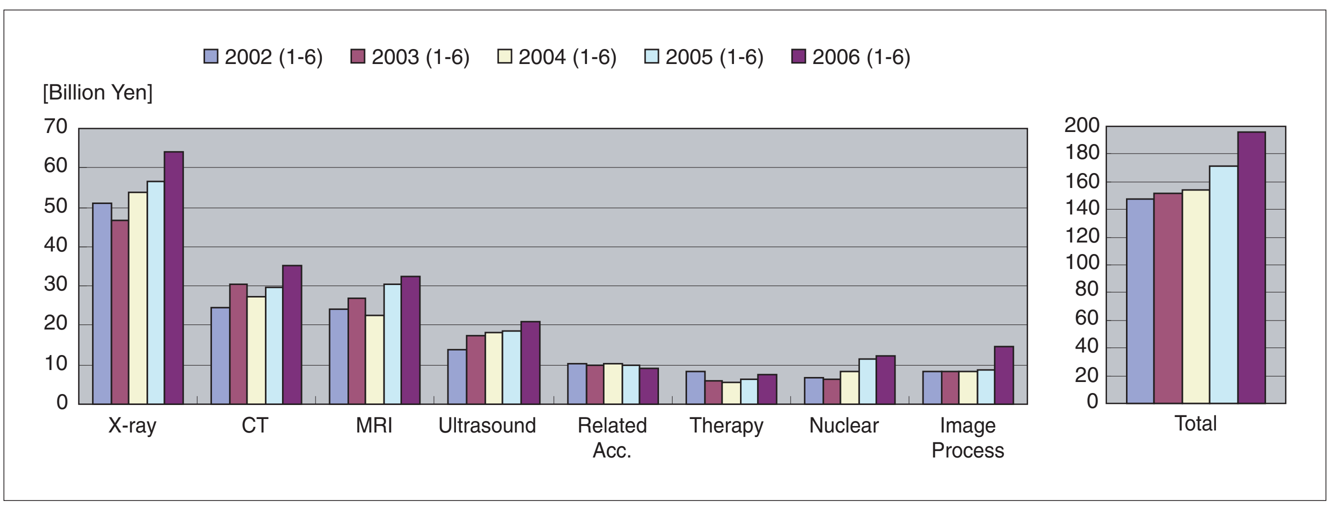
3. The production output increased to 231.4 billion yen (+ 12%).
   Especially, the following increased:
   – Nuclear medicine 5.1 billion yen (+ 101%)
   – Other image processing systems 12.2 billion yen (+ 57%)
   – CT 61.9 billion yen (+ 25%)

   Breakdown of X-ray was as follows. The following increased:
   – Cardio & angio 7.5 billion yen (+ 21%)
   – General-purpose radiography 10.3 billion yen (+ 22%)
   The following decreased:
   – Mammography 1.6 billion yen (– 4%)
   – Mobile 1.7 billion yen (– 8%)
   Total X-ray amounted to 71.8 billion yen (+ 14%)
   Also,
   – MRI decreased to 17.1 billion yen (– 10%)
   – Therapeutic systems decreased to 2.8 billion yen (– 41%)

4. Exports increased to 109.3 billion yen (+ 12%).
   Especially,
   – CT increased to 40.4 billion yen (+ 42%)
   Breakdown of X-ray is as follows:
   – Cardio & angio increased to 3.7 billion yen (+ 45%)
   whereas,
   – Mammography decreased to 0.01 billion yen (– 77%)
   – Mobile decreased to 0.8 billion yen (– 23%)
   Total X-ray amounted to 23.6 billion yen (+ 16%)
   Also,
   – MRI decreased to 6.6 billion yen (– 31%)
   – Therapeutic systems decreased to 0.8 billion yen (– 25%)

5. Imports increased to 73.8 billion yen (+ 17%).
   Especially, the following increased:
   – Therapeutic systems 5.5 billion yen (+ 102%)
   – Other image processing systems 4.5 billion yen (+ 80%)
   – CT 13.7 billion yen (+ 61%)
   whereas,
   – Nuclear medicine decreased to 7.2 billion yen (– 20%)
   Breakdown of X-ray was as follows:
   – Mammography increased to 3.7 billion yen (+ 23%)
   whereas,
   – General-purpose radiography decreased to 0.9 billion yen (– 15%)
   Total X-ray amounted to 15.7 billion yen (+ 12%)

Diagnostic Imaging and Therapeutic Systems Market in Japan
Trends in the Last Five First-Half Years by Modality



JIRA Activity Reports

"Japan IT New Reform Strategy" and JIRA's Commitment

In January 2001, the IT Strategic Center in the Cabinet Secretary office announced its "Japan IT New Reform Strategy". The strategy aims at the realization of a society in the fiscal year 2010 where anyone, at any time or place can access the benefit of IT, listing the following important IT policies.

- The structural reform of medical care through IT
- An eco-friendly society through the maximum use of IT
- A safe and secure society which can have a pride of place in the world
- A society with the safest road traffic in the world
- The most convenient and efficient e-government
- Strengthening of industrial competitiveness through the establishment of IT management
- Life-long affluence

Namely, at the top of the themes for social challenges to overcome in the 21st century, "The structural reform of medical care through IT" is listed.

The "Japan IT New Reform Strategy" defines the direction of the use of IT for medical care for the next five years. It announces planning of a long-term "Grand design of use of IT for medical care".

Furthermore, in June 2006, the "Principal Plan-2006" was prioritized as the first plan under this "Japan IT New Reform Strategy". It reveals a short-term implementation plan for the next one to two years, including an enrichment of assessment systems (see Figure 1).

"The structural reform of medical care through IT" has two core policies. One is "Perfect online processing of receipts". The other is "Your own life-long health care". The following goals are listed. Moreover, the policies towards their implementation are also shown.

1. Optimization of national medical expenditure
2. Assistance for health enhancement
3. Promotion of telemedicine
4. Promotion of the dissemination of medical information systems

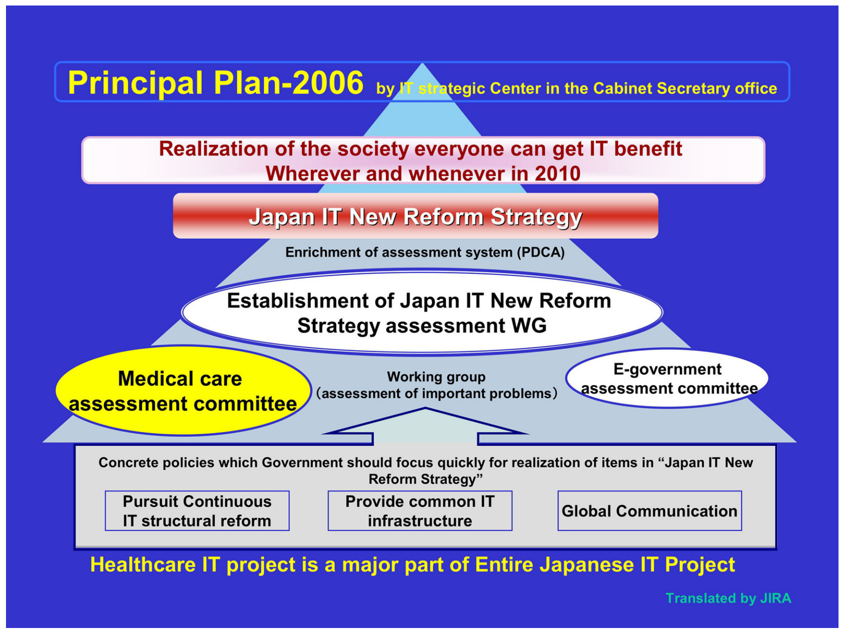


Figure 1. Principal Plan-2006

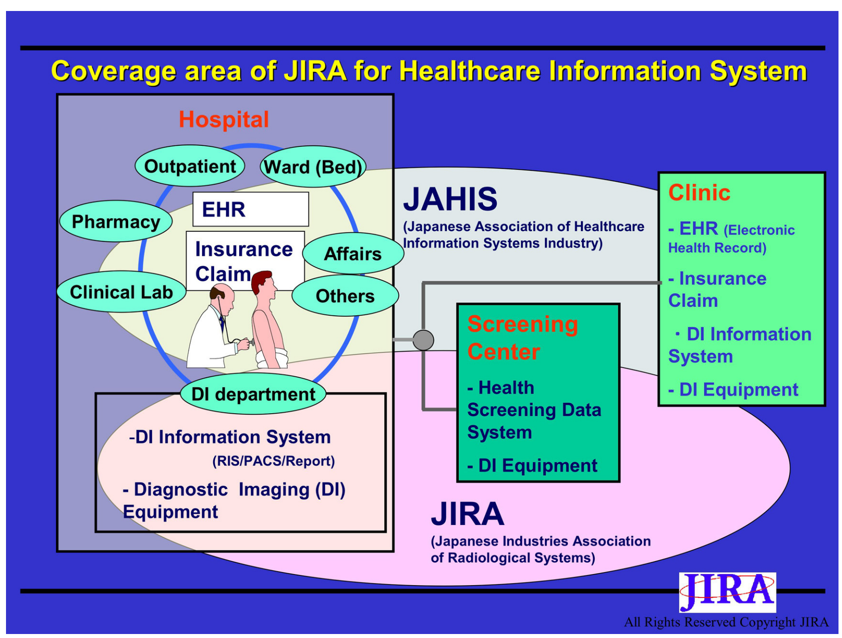


Figure 2. Coverage area of JIRA Healthcare Information System

In order to realize above proposal, "Promotion of the dissemination of medical information systems", JIRA considers the following issues must be solved.

- Establishment of an identification method between healthcare information and patient.
- Standardized secure networking architecture over all related facilities.
- Guidelines that describe the development and standardization of a data control system connecting multiple sites and the responsible party for its administration and the areas of responsibility involved.
- Need for a business model which shows economical effectiveness throughout medical care and for a clear valuation index.
- A proposal for a cost reduction plan for related healthcare institutions which manage the cost of the system.

In response to the above-mentioned issues, JIRA has the coverage area as shown in Figure 2, and draws a scenario of building an image collaboration model by an industry, academia and government consortium. It proposes an "Implementation plan for sharing medical information among institutions", in which there is regional collaboration to use medical image information which is advanced in specifications and their implementation.

Thus, the JIRA's proposal is reflected in part in the contents of the "Japan IT New Reform Strategy".

JIRA conducts training for the management of registered organizations

The revision of the Pharmaceutical Affairs Law was effective in April 2005. The resulting enforced regulations stipulate continuous training courses as follows. Article 168 and Article 175 Paragraph 2 stipulates courses for business supervisors of retailers of medical devices. Article 194 stipulates courses for engineering supervisors of repair firms of medical devices.

JIRA takes the responsibility to provide annual training course to all registered companies. This activity was supported jointly by Japan Electronics and Information Technology Industries Association (Medical Electronics Committee), Japan Medical-Optical Equipment Industrial Association, and Japan Industries Association of Physical Therapy Devices. It is the first trials of the implementation of continuous training courses for business supervisors of medical device retail; rental services and engineering supervisors of repair firms done by JIRA for the fiscal year 2006.

The outline of the implementation of continuous training:

1. Organization for implementation

The Training Committee is in charge of this activity. The Continuous Training WG operates the routine work. This WG consists of related divisions, committee members, supporting organizations and their secretariats. We delegated a part of the concrete work of this activity to the third party. We collaborated with the supporting organizations to create textbooks and to secure lecturers.

2. Contents of training

The contents of the lectures consist of 4 subjects as specified by the rules related with Good Vigilance Practice (GVP). They were divided into subject 1) and subjects 2) to 4).

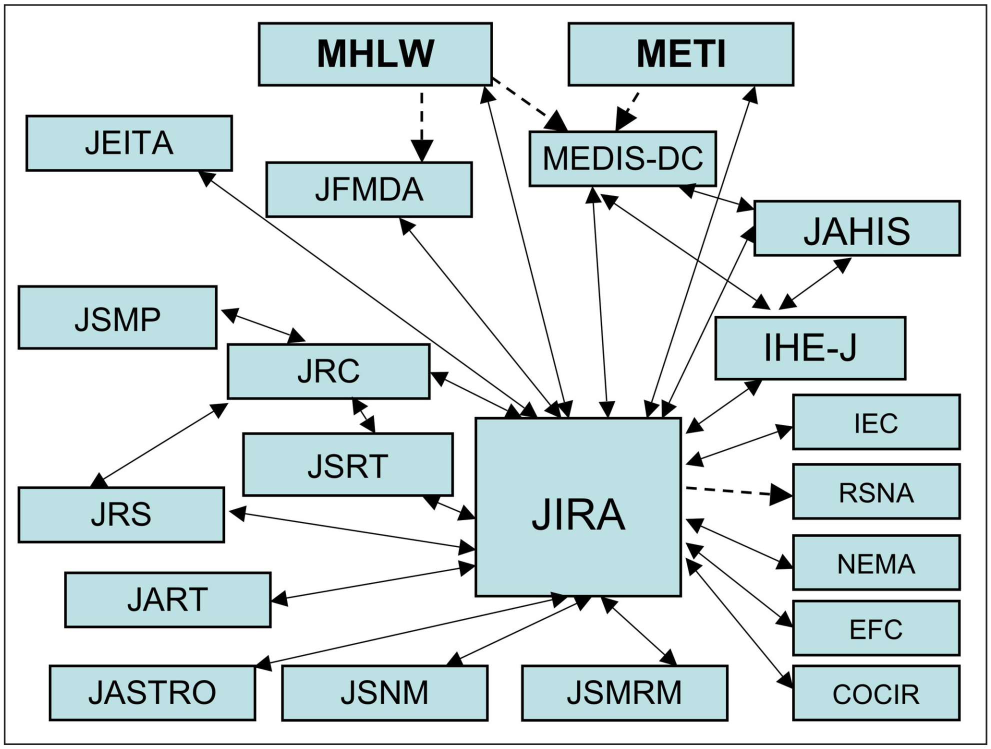
1) The Pharmaceutical Affairs Law and the laws related with pharmaceutical affairs
2) Quality control of medical devices
3) Nonconformity report and recall report of medical devices
4) Provision of information on medical devices

3. Number of participants and number of sessions

We held 10 sessions at 7 sites. The number of participants was approx. 1,600 persons.

JIRA Partnership Update

JIRA-Related Organizations



COCIR	The European Coordination Committee of the Radiological, Electromedical and Healthcare IT Industry	http://www.cocir.org/index.php?mode=0
EFC	Electro-Federation Canada	http://www.electrofed.com/home/index.html
IEC	International Electrotechnical Commission	http://www.iec.ch/index.html
IHE-J	Integrating the Healthcare Enterprise-Japan	http://www.ihe-j.org
JAHIS	Japanese Association of Healthcare Information Systems Industry	http://www.jahis.jp
JART	The Japan Association of Radiological Technologists	http://www.jart.jp
JASTRO	Japanese Society for Therapeutic Radiology and Oncology	http://www.jastro.jp
JEITA	Japan Electronics and Information Technology Industries Association	http://www.jeita.or.jp
JFMDA	The Japan Federation of Medical Devices Associations	http://www.jfmda.gr.jp/index.html
JRC	Japan Radiology Congress	http://www.j-rc.org
JRS	Japan Radiological Society	http://www.radiology.jp
JSMP	Japan Society of Medical Physics	http://www.jsmp.org/jsmp.html
JSMRM	Japanese Society for Magnetic Resonance in Medicine	http://www.jsmrm.jp/indexj.html
JSNM	Japanese Society of Nuclear Medicine	http://www.jsnm.org/index-j.html
JSRT	Japanese Society of Radiological Technology	http://www.jsrt.or.jp
MEDIS-DC	The Medical Information System Development Center	http://www.medis.or.jp
METI	Ministry of Economy, Trade and Industry	http://www.meti.go.jp
MHLW	Ministry of Health, Labour and Welfare	http://www.mhlw.go.jp
NEMA	National Electrical Manufacturers Association	http://www.nema.org
RSNA	Radiological Society of North America	http://www.rsna.org

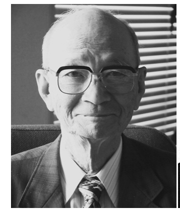
No.	Company Name	No.	Company Name
1	3z Corporation	39	HAMAMATSU PHOTONICS K.K.
2	Accuthera Inc.	40	HITACHI COMPUTER PERIPHERALS CO., LTD.
3	ACRORAD CO., LTD.	41	HITACHI, LTD.
4	ADMIS INC.	42	HITACHI MEDICAL CORPORATION
5	Advanced Media Inc.	43	HOKUTO SEIKI CO., LTD.
6	AGFA-GEVAERT JAPAN, LTD.	44	HOSHINA CO., LTD.
7	ALCO ELECTRIC CO., LTD.	45	IBD Co., Ltd.
8	ALOKA CO., LTD.	46	IKEN ENGINEERING
9	AMIN Ltd.	47	ImageONE Co., Ltd.
10	ANZAI MEDICAL CO., LTD.	48	IMANISHI CO., LTD.
11	ASAHI ROENTGEN INDUSTRIES CO., LTD.	49	IMATION CORPORATION JAPAN
12	ATUMI IND. CO.	50	INFINITT JAPAN Co., Ltd.
13	Auto System.Co., Ltd.	51	INFOCOM CORPORATION
14	AZE, Ltd.	52	J.MORITA MFG CORP.
15	CANON INC.	53	JFE Environmental Solutions Corporation
16	CANON Marketing Japan INC.	54	J-MAC SYSTEM INC.
17	CHIYODA TECHNOL CO.	55	K.K.LAMTEC
18	CLIMB MEDICAL SYSTEMS CO., LTD.	56	KAGA ELECTRONICS CO., LTD.
19	CMI, Inc.	57	KAIGEN CO., LTD.
20	CMS Japan K. K.	58	Kanematsu Electronics Ltd. Sapporo Branch
21	Codonics Limited KK	59	KASEI OPTONIX LTD.
22	DIREX JAPAN CO., LTD.	60	KEIKOH SANGYO CO., LTD.
23	DORNIER MEDTECH JAPAN CO., LTD.	61	KGT Inc.
24	Edaptechnomed Co., Ltd.	62	KINKI ROENTGEN INDUSTRIAL CO., LTD.
25	EIZO NANAO CORPORATION	63	KODAK JAPAN LTD.
26	ELECTA KK	64	Konica Minolta Medical & Graphic, Inc.
27	ELK CORPORATION	65	Konica Minolta Medical Co., Ltd.
28	e-Medical System Co., Ltd.	66	KOWA COMPANY LTD.
29	Engineering System Co., Ltd.	67	KS OLYMPUS.CO., LTD.
30	Enuiiji Kenzai Co., Ltd.	68	KURARAY TRADING CO., LTD.
31	EURO MEDITECH CO., LTD.	69	KYOTO KAGAKU CO., LTD.
32	FUJI FILM Corporation	70	LEXI CORPORATION
33	FUJI FILM MEDICAL CO., LTD.	71	MAEDA & CO., LTD.
34	FUJITSU LIMITED	72	MALLINCKRODT JAPAN CO., LTD.
35	FU-UNDO CO., LTD.	73	MARUBUN TSUSYO CORPORATION
36	GE YOKOGAWA MEDICAL SYSTEMS, LTD.	74	MEDICAL SUPPLY JAPAN CO., LTD.
37	GIKEN KOGYO CO., LTD.	75	MEDICO'S HIRATA INC.
38	Goodman Healthcare IT Solutions, Inc.	76	MEDIOTECH CO., LTD.

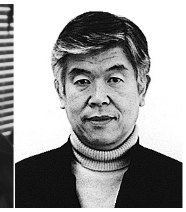
No.	Company Name	No.	Company Name
77	MEDITEC CORPORATION	114	SHIMADZU CORPORATION
78	MITAYA MANUFACTURING CO., LTD.	115	SHIMADZU MEDICAL SYSTEMS CORPORATION
79	MITSUBISHI ELECTRIC CORPORATION	116	SIEMENS-ASAHI MEDICAL TECHNOLOGIES LTD.
80	MITSUBISHI HEAVY INDUSTRIES, LTD.	117	Sony Corporation
81	MIURA CORPORATION	118	SUMIRE MEDICAL CORPORATION
82	MIWA ELECTRIC MEDICAL CO., LTD.	119	Sumisho Computer Systems Corporation
83	MORIYAMA X-RAY EQUIPMENTS CO., LTD.	120	SUMITOMO HEAVY INDUSTRIES, LTD.
84	MURANAKA MEDICAL INSTRUMENTS CO.,LTD.	121	SUNRAYS CO., LTD.
85	NEC CORPORATION	122	TAKARA MEDICAL CO., LTD.
86	NEC Display Solutions, Ltd.	123	TechMatrix Corporation
87	NEMOTO KYORINDO CO., LTD.	124	TERARECON, INC.
88	NIHON BINARY CO., LTD.	125	THE FURUKAWA ENGINEERING SERVICE CO., LTD.
89	NIHON DENSHI OHYO CO., LTD.	126	THE YOSHIDA DENTAL MFG.CO., LTD.
90	NIHON HOUSHASEN BOUGYO CO.	127	TOKIMEC AVIATION INC.
91	NIHON MEDICAL CO., LTD.	128	Too Corporation
92	Nihon Medi-Physics Co., Ltd.	129	TORECK CO., LTD.
93	NIHON MEDRAD K.K.	130	TOSHIBA ELECTRON TUBES & DEVICES CO., LTD.
94	NIKKO FINES INDUSTRIES CO., LTD.	131	TOSHIBA MEDICAL MFG. CO., LTD.
95	Nippon Electric Glass Co., Ltd.	132	TOSHIBA MEDICAL SUPPLY CO., LTD.
96	Nihon Poradigital K.K.	133	TOSHIBA MEDICAL SYSTEMS CORPORATION
97	NISHI NIHON M.C. CO., LTD.	134	TOSHIBA MEDICAL SYSTEMS ENGINEERING CO., LTD.
98	OBAYASHI MFG.CO., LTD.		
99	OKABE MANUFACTURING CO., LTD.	135	TOSHIBA POWER SYSTEMS RADIATION TECHNO-SERVICE CO., LTD.
100	OKAMOTO MANUFACTURING CO., LTD.		
101	ORION ELECTRIC CO., LTD.	136	TOTOKU ELECTRIC CO., LTD.
102	Panasonic AVC Medical Co., Ltd.	137	TOWA HOSHASEN BOGO SETUBI CO., LTD.
103	Philips Electronics Japan, Ltd.	138	TOYO Corporation
104	Pilkington Special Glass KK	139	TOYO MEDIC CO., LTD.
105	PSP CORPORATION	140	Universal Giken
106	Real Vision	141	Varian ME Medical Systems
107	RIKUTOH CORP.	142	ViewSend Co., Ltd.
108	RIMPACK	143	WIN INTERNATIONAL CO., LTD.
109	S.R Corporation	144	YOKOGAWA ELECTRIC CORPORATION
110	SANKYO CO., LTD.	145	YOSHIDA DENZAI KOGYO CO., LTD.
111	SANKYO MEDICAL CO., LTD.	146	YOSHIDA SEIKO MFG.CO., LTD.
112	SEIKORIKA IRYODENKI CO., LTD.	147	YUFU ITONAGA CO., LTD.
113	SHEENMAN CO., LTD.	148	Ziosoft, Inc.

JIRA 2006 New Members List

No.	Company Name	Type of Business
149	AcroBio Corporation	Import and sales of X-ray and measuring instrument
150	BrainLAB KK	Manufacturing and sales of fluoroscope for surgery, particle accelerator for treatment and variable beam limiting device
151	C.S. Net Co., Ltd.	Manufacturing and sales of diagnostic image processing system
152	DoctorNet Inc.	Manufacturing and sales of other diagnostic image processing system, remote image diagnostic support service, and consultation of radiology
153	Image Research Co., Ltd.	Manufacturing and sales of medical image workstation
154	JRC Engineering Co., Ltd.	Manufacturing and sales of control software
155	KAJIMA CORPORATION	Manufacturing and sales of equipment & system and other general building & construction
156	Mihama Medical, Inc.	Import and sales of products for irradiation protection
157	MIKASA X-RAY CO., LTD.	Manufacturing and sales of mobile X-ray system Wholesale of domestic automatic processor, other equipments and instruments, imaging accessories, irradiation protection items, film viewer, and X-ray film
158	Nexis Co., Ltd.	Manufacturing and sales of other diagnostic image processing system (PACS)
159	PHOTRON LIMITED	Manufacturing & sales, and import & sales of other diagnostic image processing system
160	Rimage Japan Co., Ltd.	Manufacturing and sales of recording & printing machine for CD and DVD
161	Sony Marketing (Japan) Inc.	Wholesale of domestic imager and X-ray film

Development of Japanese Radiological Equipment in the Post-World War II Period (19)





Sumio Makino (Advisor, JIRA)   Yasuo Ashino (CMS Japan)

Development of the radiotherapy simulator

1. How to identify lesions of Tumor

The Radiation Oncologists' endless pursuit and its beginnings.

In the ruins of bombing soon after the end of War, the study of how to identify a lesion was advancing at the Radiology Department of Hirosaki University, although it did not attract much attention in those days. It was the research of Shinji Takahashi. When he started the study, he found that the conventional X-ray was not suitable for identifying lesions.

He thought the following. "If dissection or pathological anatomy is compared with an ordinary X-ray examination, the X-ray image on the film or fluorescent screen is two-dimensional. But the body has a three-dimensional structure. The dimension of depth is lost in the X-ray image."

He further questioned. "An x-ray image overlaps and if the contrast of the image is low, the lesion is invisible. For a posthumous dissection, we look for a lesion by making a cross section in every direction. Is it possible to use this method in the case of an X-ray image? Indeed, tomography could produce a cross section, but it was limited to the direction of the body's axis. The tomographic image was greatly distorted and incomplete".

Then, he concluded, "If we rotate an object and take a series of X-ray images during object rotation from every direction, then we will be able to see each part of its contour at least, though not its internal cross section. A combination of such procedures will give us an X-ray image of a cross section".

It is surprising that this idea occurred to him in 1948, only a few years after the end of War. His idea was exactly the prediction of an X-ray CT, and the prediction of the best technique to identify a lesion useful for radiotherapy.

As the result of experiments at the University, the location and size of organs were visible in the cross-sectional image. The picture of the experiment and these acquired images are shown in Figures 1 to 4. They were images which were seen for the first time after the war.

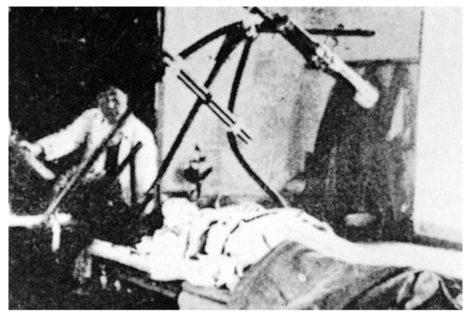


Figure 1. Experiment at the University of Hirosaki

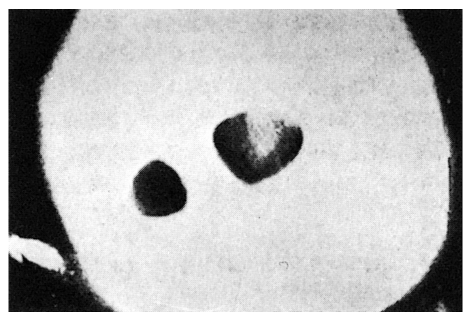


Figure 2. Flowing cross-sectional image of forearm (showing the cross section of radius and ulna in the center of image)

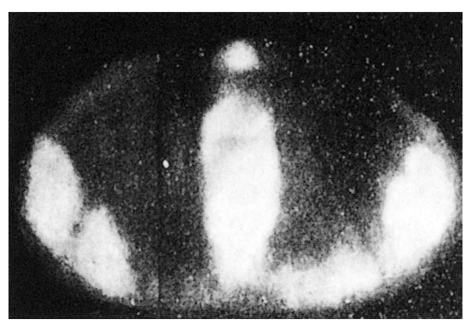


Figure 3. Axial transverse tomogram of chest of adult (Thorax, breast bone, lungs, mediastinum, aorta at tracheal bifurcation, vertebral body, rib and blade bone are seen.)

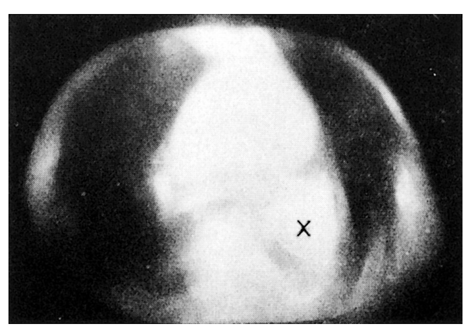


Figure 4. Axial transverse tomogram. Aortic aneurysm (X) is seen at posterior of left lung.

After several experiments and trial productions, an axial transverse tomograph as shown in Figure 5 was completed. The images of axial transverse sections of the head taken by this equipment are shown in Figures 6 and 7.

The desperate effort continued to identify lesions. But, in the end, the axial transverse tomograph was completely replaced by the X-ray CT.

2. Development of the radiotherapy simulator

In 1960s, the United States already used dedicated simulators for radiotherapy. In 1964, Toshiba Corporation made the first simulator in Japan in joint research with The Cancer Institute Hospital. Improvements on the equipment were continually made and X ray TV was also mounted. Figure 8 shows the equipment.

This equipment produces fluoroscopic images of lesions and defines irradiation parameters, such as the size of the X-ray beam, the optimal incidence angle of the X ray beam and the size of irradiation field that changes with the incidence angle, etc. The axial transverse tomography mentioned in the previous item defines the location, size and shape of lesion. In order to finalize radiotherapy planning, the simulator and the axial transverse tomograph are installed facing each other and shares one table. While a patient is lying on the table, all the planning procedures are completed. This combination equipment became popular, especially in the United States.

3. Research of Conformation Therapy

The axial transverse tomograph and simulator reached the stage of practical use. After that, Shinji Takahashi and Youichiro Umegaki (National Cancer Center) studied improvements in the structure of the collimator. The aim was to conform the radiation field so that it matched the shape of the tumor and to minimize the adverse effect of radiation on healthy tissues around the tumor. This was called “Conformation Therapy”. They made a model of the shape of the tumor and used it as a matrix to make a cam structure. This cam structure controls the multi-leaf collimator during rotational radiotherapy to complete the Conformation Therapy. Umegaki has continued the study to realize computer-aided control.

4. Today’s radiotherapy of cancer…the present situation in Japan

Today, radiotherapy plays a major role in the treatment of cancer. Especially for the treatment of elderly people’s cancer, QOL-oriented treatment is the first choice, and radiotherapy plays an important role.

Tables 1 and 2 describe the situation in Japan and the United

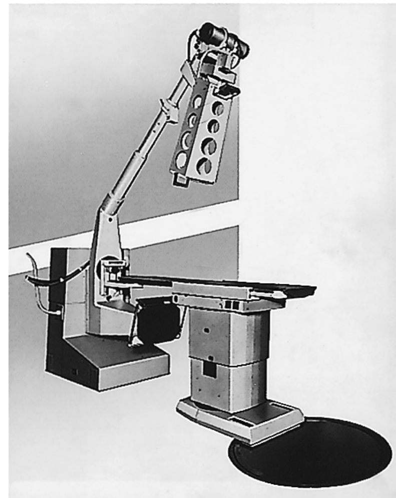


Figure 5.

Figure 6.

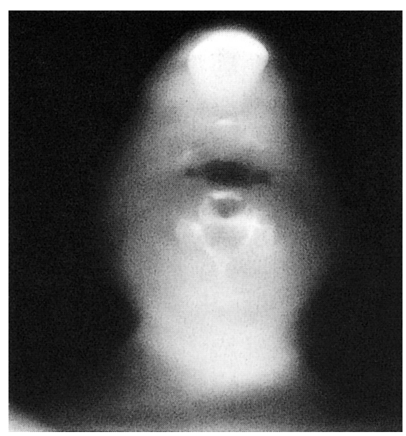


Figure 7.

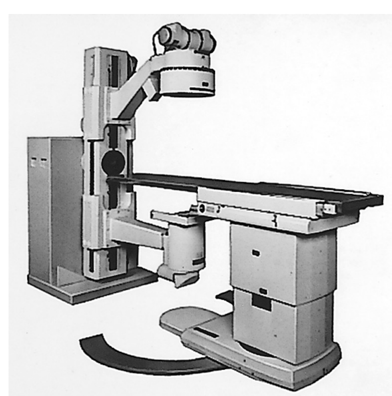


Figure 8.

States. Radiotherapy is more popular in the United States than in Japan. This popularization in the United States indicates the direction that should be followed by Japan in future. Table 3 shows the transition of the number of cancer patients being given radiotherapy in Japan. Breast cancer is responsible for the increase in the number of radiotherapy patients. The conservative treatment of breast cancer made the role of radiotherapy recognized among patients widely. From here on, the number of prostate cancer patients will rapidly increase. If we look at the situation in the United States concerning prostate cancer, it is presumed that radiotherapy will play a major role also in Japan.

5. Modernized radiotherapy planning system and therapy system

Shinji Takahashi started "to identify lesions directly" immediately after the War. This pursuit was later replaced by X-ray CT system as explained above. Table 4 shows a comparison of technical feasibility between the Takahashi era and the CT era.

Today's radiotherapy is well represented by "Image Guided Radiotherapy". We can visualize organs precisely, the extension and even metastasis of cancer, which are usually invisible from the outside of the body. We plan radiotherapy to minimize radiation doses that exposes healthy tissues. In this procedure of radiotherapy planning, computers play a significant role, because

Table 1. Comparison of radiotherapy between Japan and U.S.A.

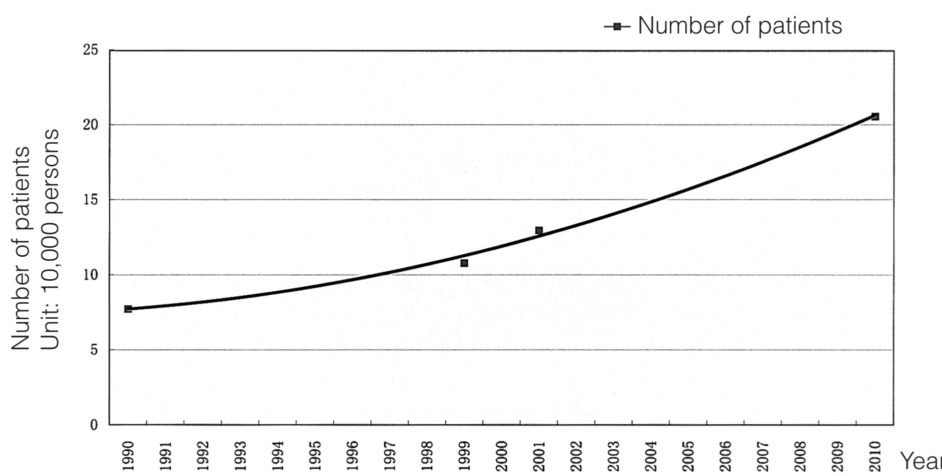
	Japan	U.S.A.
Ratio of patients treated by radiotherapy to total cancer patients	22%	50%
Number of radiotherapy equipment installed per 100,000 inhabitants	0.6 set	1.2 set
Organ-specific difference of cancer prevalence	The difference is likely to decrease, because Japanese are consuming westernized meals more than ever.	

Table 2. Difference in environment surrounding radiotherapy between Japan and U.S.A.

(as of 2000)

	Japan	U.S.A.
Number of Radiation Therapy Facility	720	1,800
Number of Radiation Therapy Equipment	767	3,000
Number of Radiation Therapy Equipment (Brachy)	216	500
Number of Certified Radiation Oncologist	356	4,500
Number of Certified Medical Physicist	27 (105)	3,000
(105 persons were certified. 27 persons are engaged at clinical sites.)		
Number of Patients treated by Radiation Therapy in 1998	120,000	525,000

Table 3. Changes in demand for radiotherapy and future prediction



they calculate and produce the dose distribution in a patient body desired by Radiation Oncologists.

The irradiation technical parameters produced by computers are quite different from conventional ones. They identify very accurately the region that should not be irradiated and it is certain that irradiation does not occur. To achieve that objective, a complicated sequence is used to repeat irradiation of the same region. The target dose is obtained by accumulating the repeated irradiation.

Figure 9 shows therapy of "prostate cancer", which is a good example of IMRT (Intensity Modulated Radiation Therapy). In this case, the radiation beam should not expose the rectum but it should converge to the prostate lesion. This is an improvement over the conventional technique, which merely distributed the radiation dose in a ring shape or uniformly with the tumor at the center. IMRT can plan more precise distribution of the dose.

Table 4. Comparison of era-dependent changes in radiotherapy equipment

	Invented by Shinji Takahashi	Equipment available at present
Acquisition and extraction of body contour	Possible by axial transverse tomography.	CT
Acquisition and extraction of organs	Difficult using axial transverse tomography.	CT, MRI
Extension and metastasis of cancer	Difficult using axial transverse tomography.	CT, MRI, PET (PET is especially effective)
Positioning, therapy planning	X-ray positioning equipment (X-ray simulator): positioning by two-dimensional projection image	X-ray positioning equipment (X-ray simulator), CT-Sim (positioning equipment using CT): three-dimensional positioning in three-dimensional space
Conformation radiotherapy: multi-leaf collimator (MLC)	Used to precisely define the region of treatment (irradiation).	Used to precisely define the region of treatment (irradiation) and to cover the region (domain) that is not to be irradiated.
Optimal therapy technique is presented by computer-aided calculation and solution (Inverse Planning).	It did not exist in that era.	This has become straight-forward thanks to computer progress and mathematical development.

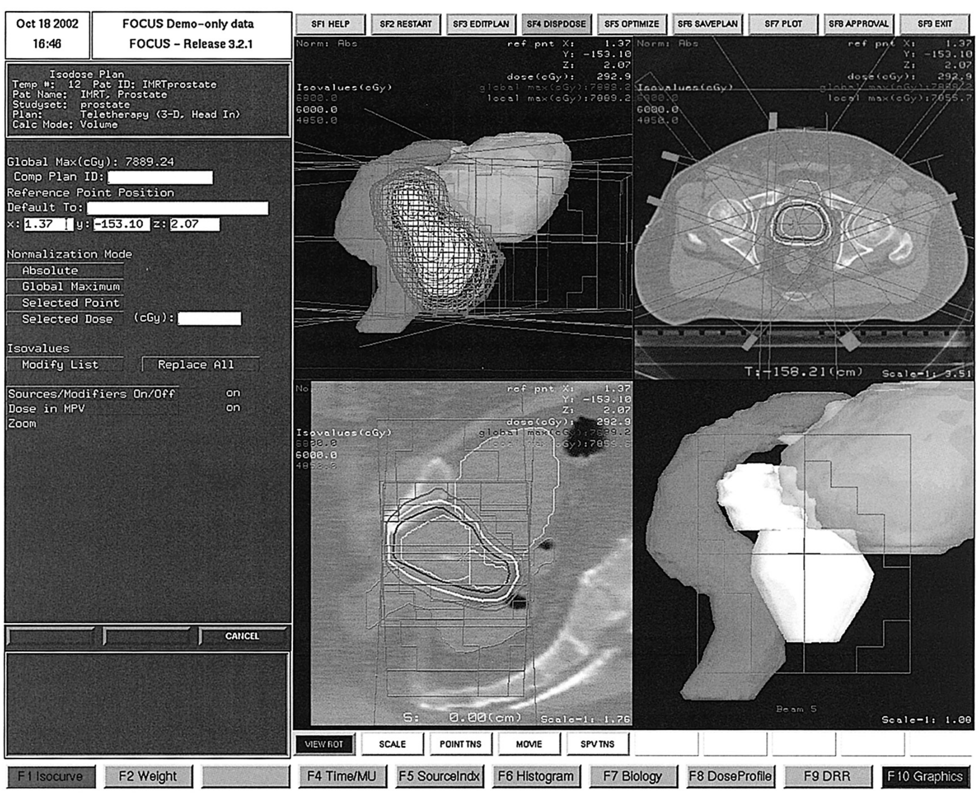


Figure 9. Typical example of IMRT of prostate cancer

6. An example of a modern radiotherapy plan and radiotherapy system

Figure 10 shows the layout of equipment for planning and therapy. Figure 11 shows an example of a dataflow for planning.

7. Summary

Radiotherapy in Japan did not necessarily advance remarkably in the post-war period. Although cancer treatment was advocated, administrative authorities tended to emphasize the development of drugs. They did not pay much attention to radiotherapy.

There are several reasons for this. For example, the radiotherapy planning system did not produce satisfactory accuracy until the advent of computers, as shown in Table 4, although many medical researchers made their best efforts for development.

Recently, with the increasing possibility of using "pinpoint" therapy, radiotherapy is attracting much attention. From now, as predicted in Table 3, radiotherapy is expected to be more precise and become main stream in cancer therapy.

Historically speaking, radiotherapy-related industries in Japan failed to prosper, reflecting the status of radiotherapy in the Japanese medical world. However, this industry will be supported by the progress of electronics and contribute to cancer care of the nation in future.

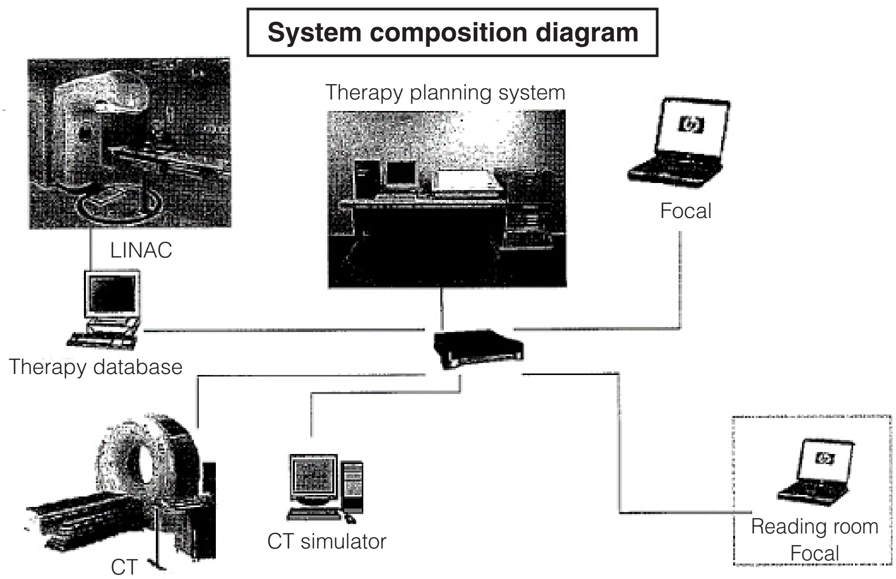


Figure 10. Typical example of radiotherapy system

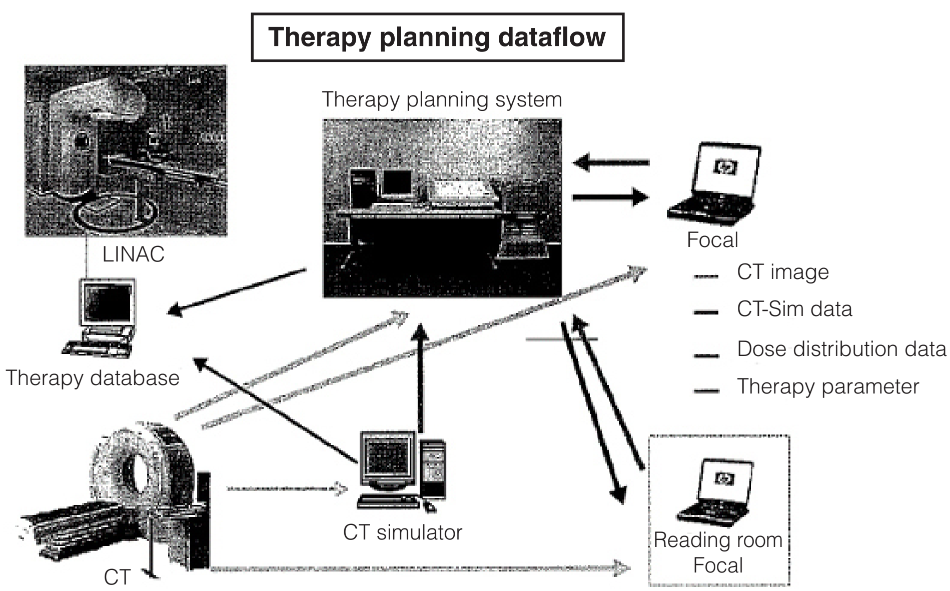


Figure 11. Dataflow in the typical example