Current Status of Gamma Camera in Korea

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Introduction

Over the three decade since the nuclear medicine in Korea was started in 1960, nuclear medicine has continued its exponential growth and is now recognized medical specialty. The first dot scanner (Trace Lab) in the country was installed at Seoul National University Hospital (SNUH), Seoul in 1960. Since then, the era of scanner had continued until the early 1980's. The first gamma camera (NC, Pho/Gamma) was installed in 1969 at SNUH. At the beginning of the 1970's, the increase in numbers of gamma camera was slow until few years later (1978~1982) but it is being rapidly increased in the beginning of the 1980's. At present, there are 184 gamma cameras at 96 hospitals (Fig. 1). This gives the ratio of one gamma camera per 250,000 heads of population. Of these hospitals, 15 belong to the government and 80 are private hospitals, which account for about 84 % of all hospitals. Fig. 2 shows number of

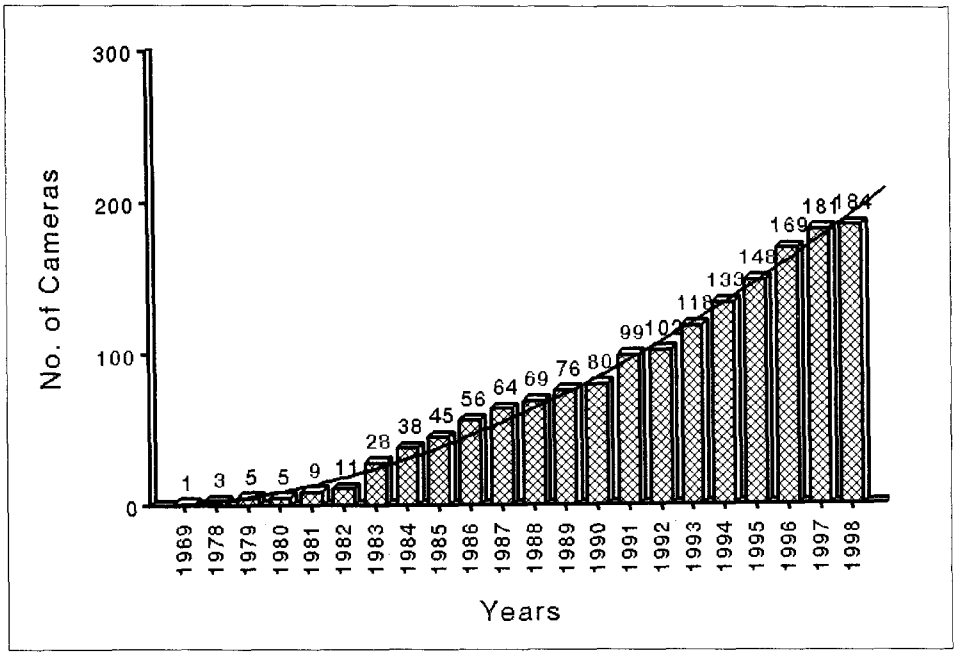

Fig. 1. Distribution of cameras.

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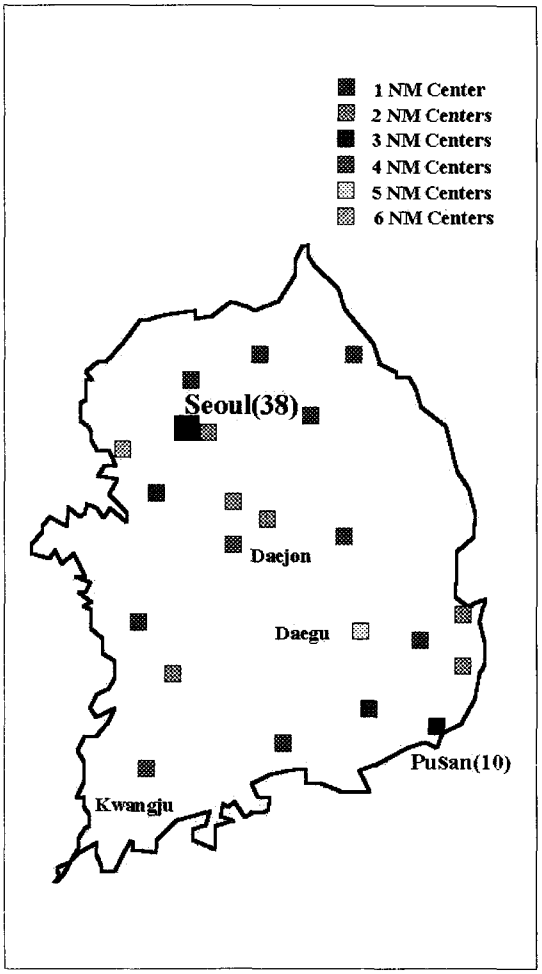

Fig. 2. Distribution of hospitals in Korea.

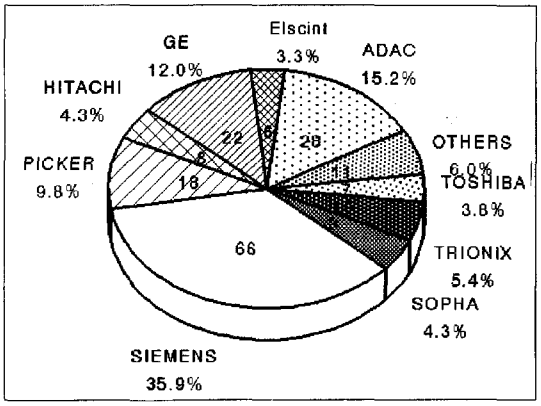

Fig. 3. Camera market share in Korea.

hospitals scattered through within country. Majority of hospitals located in the major metropolitan cities namely Seoul, Pusan and Daegu. Today, computers are essential to the practice of nuclear medicine. In 1979, the first computer (Gamma-11) was installed and there are now 156. The SPECT and multi-detector systems were installed in the middle of the 1980's and in 1989 respectively. Recent gamma camera purchases have been multi-detector systems with dual head systems predominating over triple head systems. In most cases, the

Table 1. Computer Systems Connected to Camera

Computer system	No. of Computer
DEC	
PDP-11	4
Siemens	
Icon	25
MicroDelta	19
Scintiview	14
CDA	
VAX-11	2
Picker	
PCS	5
Odyssey	11
Sopha	
Sophy	10
Trionix	
Sun	10
ADAC	
Pegasys	26
Elscint	
APEX	5
Hitachi	
Harp	2
Toshiba	
Toshibac	4
GE	
Star	8
Starcam	11
CGR	
Imac	2
Other	1
Total	159

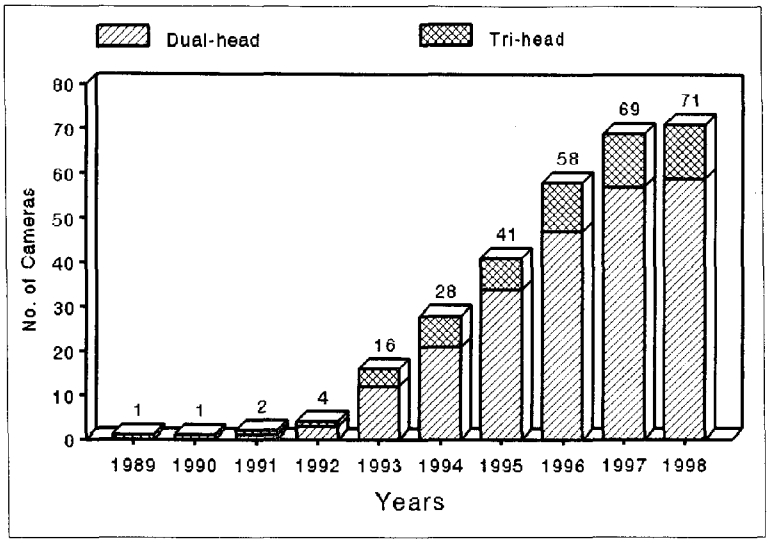

Fig. 4. Multi-head camera in Korea.

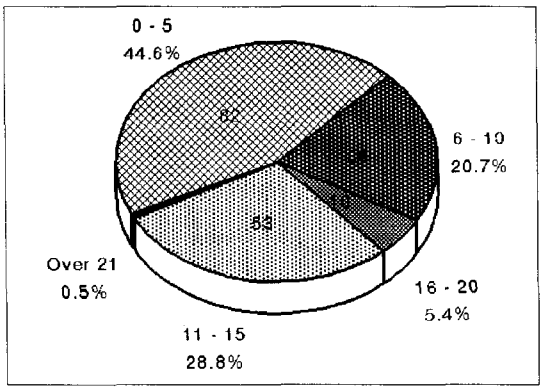

Fig. 5. Age distribution of cameras.

multi-detector systems were added to hospitals, which already had gamma camera. 41 out of 57 hospitals still have one gamma camera with single head and 16 hospitals have dual head systems. Total numbers of dual head systems and triple head systems are 59 and 12 respectively. The number of multi-detector systems has roughly in-creased since 1993. It is expected that the growth of multi-detector systems will continue for few years. Cyclotron and PET scanner have had a renaissance in nuclear medicine. In addition there are 3 PET scanner with an equal number of cyclotrons.

Gamma Camera Market Share

There are 10 local agencies of gamma camera manufacturers. The share of market held by these agencies is shown in Figure 3. Siemens (36%), ADAC (15%), GE (12%), and Picker (10%) were shared 73% of total gamma cameras. Until 1991, Siemens, GE, and Picker were major agencies but ADAC is new entrant since 1992. 113 out of total 184 gamma cameras have SPECT capabilities (61%) and 159 gamma cameras are connected to computers (Table 1). A half of total SPECT systems are mainly being used for a planar imaging. Majority of SPECT systems available is dual head system (56) or triple head systems (12)(Fig. 4). The trend is toward multi-detectors system since early 1990s. The age distribution of gamma cameras is given in figure 5, ranging from null to 29 years old. 82 (45%) are less than 5 years old, 38 (21%) are 6~10 years old, 53 (29%) are 11~15 years old, 10 (5%) are 16~20 years old and one is 29 years old. The mean age of the gamma camera

is 7 years old and the number of gamma cameras at each hospital ranges from 1 to 9. 57 (59%) of hospitals still have one gamma camera.

Quality Control of Gamma Camera

The national quality control (QC) program on nuclear medicine equipments was initiated in 1984. Later on, it was expanded to "QC of advanced nuclear medicine equipment" like SPECT. The awareness of the need for regular QC of the gamma camera is usually well established now. A new program was initiated in 1994 on "Certification of QC and Preventive Maintenance (PM)". The QC of gamma camera is the focus of nuclear medicine equipment. As results shown by survey, uniformity is performed daily in 20%, weekly in 30% and monthly or occasionally in 50% with a point source or flood field uniformity phantom. Most of the hospitals were not able to assess the system uniformity, of which intrinsic uniformity was the commonest test performed. The evaluation are usually evaluated visually or comparison with the reference image. 40% of total gamma cameras can be computed quantitative value by QC software. The QC program is managed by the technologists. Table 2 shows QC phantoms available in each hospitals. There is shortage of phantoms like Co-57 flood source phantoms. Only 12 out of the 96 hospitals have Co-57 sheet source. The reason for this is that the Co-57 sheet source is very expensive and can be used for a short period, namely 1~2 years. Some hospitals have other phantoms such as orthogonal hole, PLES, Jaszczak, Hoffman brain, and dynamic line.

Table 2. QC Phantoms Available at 96 Centers

Flood-field phantom	72	75%
Co-57 disc source	12	13%
Quadrant bar phantom	67	70%
NEMA spatial Res. phantom	35	36%
SPECT phantom	13	14%

Service of Gamma Camera

The gamma cameras are typically serviced by the local agencies of the makers. Service contracts are presented in Table 3. All the gamma cameras are under service contract and yearly service contract cost are 4~8% of the price of gamma camera. It costs approximately US$ 12,000~25,000. There are two kinds of category, which are full service contract, and on call bases. On call service charges US$ 300 for each call and is plus the price of spare parts. The full service covers the

Table 3. Service Contract of Cameras

Maker	# of Ca.	Warranty	Full contract	Call	Oneself
ADAC	28	18	7	3	
Elscint	6	3	2	1	
Siemens	66	7	21	33	4
Picker	18	0	10	6	1
Sopha	8	0	2	5	
GE	22	1	16	4	
Trionix	10	0	3	5	
Others	26	0	0	26	
Total	184	29	61	83	5

Table 4. Acceptance Test of Camera

	Finished	Not finished	% Finished
ADAC	15	13	54
Elscint	2	4	33
Siemens	18	7	72
Picker	10	0	100
Sopha	2	2	50
GE	6	0	100
Trionix	9	0	100
Others	1	0	100
Total	63	26	71

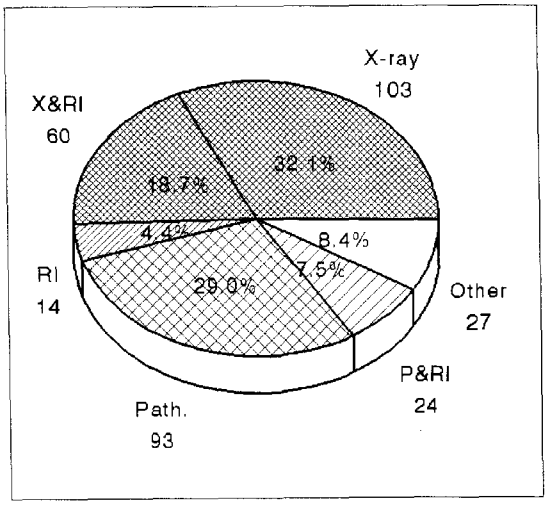

Fig. 6. Distribution of licensee.

monthly routine check, upgrading software and supplies the spare parts except for crystal. Non-service contract is serviced by the center biomedical engineers. The service contracts ensure the regular and adequate preventive maintenance. The lack of trained engineers is major problem.

Acceptance Test

Acceptance test is very important, particularly gamma camera, to evaluate immediately after installation whether the instrument is functioning according to the specifications agreed upon in the purchase contract. In Korea, the regulatory guide of the medical instruments was established in 1992. 99 gamma cameras excepted for acceptance test because they were installed before 1992. Table 4 presents which 63 (71%) gamma cameras were already performed the acceptance test. Nearly 60% of the gamma cameras undergoing the acceptance procedure passed at first attempt. These tests were carried out by local engineers according to NEMA protocols. As you can see in the Table 4, 19 gamma cameras were not performed the acceptance tests yet. The reason for this is that lack of service engineer is causing the test delay for a long time.

Personnel and Training

There is no formal education for nuclear medicine technologists in Korea now. The medical junior college has joint education for diagnostic radiology, radiotherapy, and nuclear medicine for 3 academic years. Only 20% of curriculum relate to nuclear medicine. Some universities opened the master course of a medical physics and biomedical engineering for medical physicists.

As the other training course, nuclear training center associated the KAERI gives 4 weeks course for handling and application of radioisotopes. Fig. 6 shows what the technologists have the license. The specialty board of nuclear medicine started in 1996. About 450 personnel are working in nuclear medicine department including 104 physicians, 13 physicists, and 320 technologists.

Conclusion

There are a total of 184 gamma cameras including 68 multi-detector systems in the 96 hospitals. The positive effect are to recognize need of QC and to set up a national QC program using the

same procedures. The major problems are the lack of qualified service engineers and well-trained technologists. The overcome of these problems descried above were to continue workshop related QC of the gamma cameras.