The Evolution of Filmless PACS in Korea

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ABSTRACT

The growth of PACS (Picture Archiving and Communications System) market in Korea over the past 10 years is a brilliant development. In order to reach these brilliant achievements, the efforts of the Korean Society of PACS, the supports of the government on the information technology industry and the efforts of PACS companies in market expansion were all served as vital manures of the sowing time. By the end of 2001, 21% of the total Korean hospitals were under the clinical operation using filmless full PACS and it is believed to be the first incident in the world. The purpose of this paper is to look back upon the growing process of filmless PACS in Korea and analyze the cause of this tremendous growth. I believe that the Korean PACS experience would be helpful to many PACS experts who pray for a proliferation of PACS distribution.

Keywords: PACS, Filmless PACS, PACS history, HL7

1. THE BACKGROUND & THE ROLE OF THE KOREAN SOCIETY OF PACS

According to the Korean statistic of the year 2000, the official area of South Korea is 99,481 km^2. Its population is 46,136,101 and among them, 9,895,271 are living in the capital city, Seoul. The GDP (Gross Domestic Product) of South Korea is 457 billion US dollars and the GNI (Gross National Income) is 455 billion US dollars. The number of distributed computers among the whole population is 3,457,200 with 77.6% of PC owned families. The number of internet users has increased from 19,040,000 in the year 2000 to 24,380,000 in the year 2001. The Korean government is actively supporting the information technology with a huge investment in the information superhighway infrastructure and education of many engineers [1-4].

In South Korea, there are 42,082 medical hospitals and clinics (10,749 institutions located in Seoul) and 287,401 patients' beds. Among them, 132 are large hospitals having more than 400 inpatient beds (approximately 200,000 examinations per year or more) and 267 are small hospitals having 100 to 400 beds. There are 72,503 medical doctors, and 2,200 are radiologists. There is one medical insurance company in Korea called National Health Insurance Corporation. The Korean medical insurance is a fee for service system with a unified medical bill policy that is determined and controlled by the government. Recently DRG (Diagnosis Related Group) is adapted by small portion of it. Every hospital has outpatient clinics within the facility and more radiology examinations are being taken compared to the ones in the North America. The number of outpatient visits per day is approximately three times as large as the number of inpatient beds.

The Korean Society of PACS is established in 1994 with medical doctors (mainly radiologists) and medical engineering professionals gathered around Dr. Manchung Han. Starting 1995, it has published medical journals and held medical conferences regularly. In 1997 it has conveyed the importance of PACS to the Korean hospitals by opening the IMAC international conference in Seoul. In addition, it has set guidelines on medical reimbursement and convinced the national healthcare administrators and government to bring medical reimbursement on filmless full PACS in Korea with the exception of letting the film generation for mammographic and dental images. Partial PACS cannot be reimbursed by medical insurance company.

2. RATIONALE OF PACS INSTALLATION

Some examples of effective cost savings are savings on film and chemical cost, personnel cost, film storage and handling cost as well as opportunity cost due to re-examination, purchasing cost of laser imagers and local storage cost for modalities.

The necessary films and chemicals in generating film in Korea are totally imported from other countries and the increasing environmental pollution due to the film and chemical waste is becoming an inevitable problem to solve. In Korea, where real-estate price is very high, PACS is viewed as more suitable and economical approach than the film by reducing the cost of film management and storage facility.

Reducing the frequencies of reexamination is also cost saving, as hospitals have to face redundant cost of film, chemical and labor in the event of under-exposure or over-exposure. When PACS is used in the hospital, the image quality can be optimized through the post-processing, leading to a substantial cost saving from re-examination due to unqualified film image.

When PACS is used, the amount of film production in the hospital would be remarkably reduced and the excessive purchase of laser printers, film processor and consumables associated with the film system would be unnecessary.

Some examples of the productivity improvement can be customer satisfaction, improving image quality control, significant decrease in film loss and etc. In the radiology department, a great deal of time has been saved on examination process (from the exposure to the report) and the rate of diagnosis has significantly improved as well by PACS implementation. In university hospitals, interns and residents are wasting a great deal of time in tracking films for conferences, education and patient care. The film loss can be prevented and the saved time for clinicians on searching film can be utilized on better patient treatment, education and medical research. In addition, PACS is very useful in the events of emergency room and intensive care unit, as physicians can acquire examinations on the workstation in a short time upon the exposure instead of moving to a place where film is located and as simultaneous medical consulting with other physicians can be done over the workstations. In PACS, physicians can easily carry out conferences and create educational teaching files for the purpose of research and education, as variety types of cases are managed using the image database.

On November 1999, the Korean government has decided to implement the medical insurance reimbursement program for PACS in order to promote the IT (Information Technology) technology and support active PACS distribution in Korea after investigation of advantages of PACS.

3. HISTORICAL EVENTS OF FILMLESS PACS IN KOREA

The growth of filmless PACS in Korea for the past 10 years can be categorized into three phases with some notable events: introductory phase, early growing phase, and maturing phase. The SMC (Samsung Medical Center, Seoul Korea) PACS installation and the establishment of Korean Society of PACS are the most outstanding events during the introductory phase. During the early growing phase, there was a great proliferation of mini-PACS distribution in Korea and many Korean PACS vendors and the university hospitals put their efforts in research and development to create a digital radiology environment. In the maturing phase, the medical insurance reimbursement on PACS has become a turning point for a rapid growth in filmless PACS market.

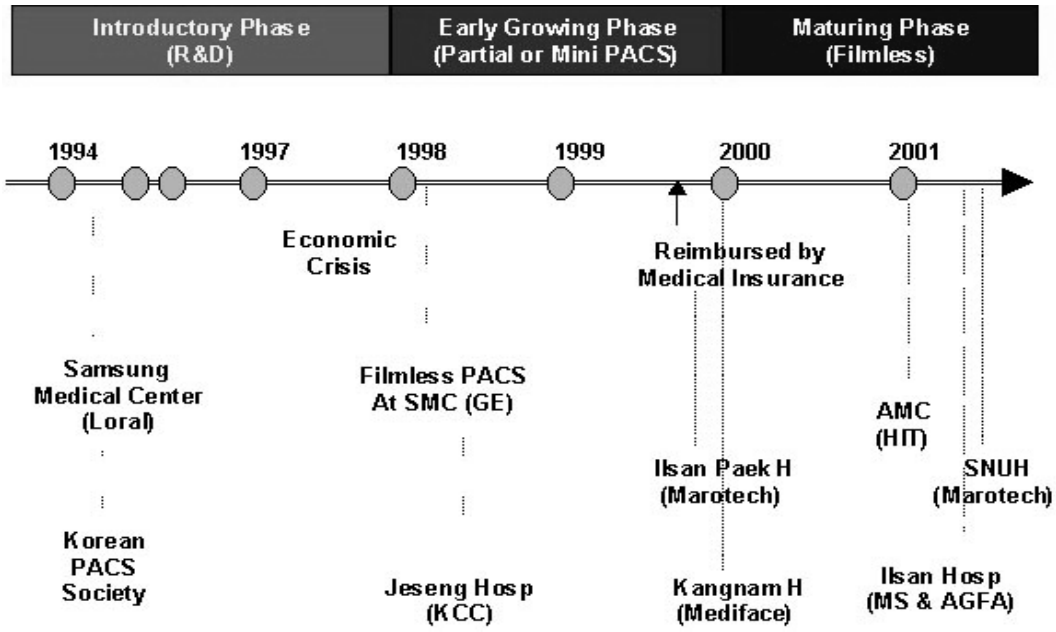


Figure 1. History of filmless PACS in Korea

3.1. INTRODUCTORY PHASE (1990-1997)

The first research on PACS was held at Seoul National University Hospital (SNUH, Seoul Korea) from 1990 to 1992. At that time, film scanner images and ultrasound images were delivered to a few outpatient clinics and inpatient wards. Pediatric radiologists used those images for clinical evaluation [6].

The first filmless PACS in Korea was planned and placed in clinical operation at 1,200-inpatient bed hospital, at Samsung Medical Center (SMC Seoul, Korea), which was opened in 1994. The system was products of Loral Ltd. (currently GE solution). Medical diagnostic imaging support system for military hospitals in the States was configured based on PACS provided by Loral Ltd [7]. The first phase of PACS was installed around neurosurgery, orthopedic surgery, emergency room and intensive care unit. At that point, neuroradiologists and bone radiologists performed diagnosis by using workstations without the film. When that system was successful in clinical operation, SMC was determined to expand the system into the remaining departments and by the year 1996 filmless PACS installation was successfully carried out throughout the whole hospital [8-9]

However, SMC PACS project had begun with enormous disbeliefs of Korean medical doctors because of its unrecognized capability to provide acceptable radiological diagnosis. At that time, most of doctors were unconvinced over the image quality of softcopies produced from computed radiography (CR) and displayed on PACS workstations. Most of them had doubts on performing proper radiological diagnosis using PACS because of uncertainties they had on image qualities, response time and system reliability, which were vital for a proper clinical operation and diagnosis. The available technology on personal computers in that era was not fully developed yet to support acceptable image quality and response time. Most of Korean medical doctors became to accept filmless PACS for the clinical operation when they saw the clinically operating system at SMC with high reliability and consistency.

As the PACS installation at Samsung Medical Center was successfully carried out, some large hospitals such as Seoul National University Hospital (SNUH, Seoul Korea) and Asan Medical Center (AMC, Seoul Korea) also began to develop their own PACS projects in competition with the domestic PACS companies. In later days, the project at SNUH became fully developed with research fund from the government called G7. The AMC, 2,200-inpatient bed

hospital, which was a subsidiary of Hyundai Group, also developed its own filmless PACS with the investment of the company of Hyundai Information Technology (Seoul Korea) [10, 11].

3.2. EARLY GROWING PHASE (1998-1999)

Even though Korean medical doctors understand that filmless PACS is reliable and clinically acceptable, the Loral PACS introduced to SMC was very expensive and did not fully support Korean Language. In addition, the bi-directional communication to the existing hospital information system (HIS) was not supported as well.

Only departmental and modality oriented partial and mini PACSs were installed in hospitals until 1999, because there was lack of legal government support and acceptance of digital image storage without film. There was no medical insurance reimbursement program on PACS and many of the health administrative issues were not clear on PACS, as it was a new technology, not well known to the hospitals and government.

In addition, there was a great deal of hesitation among the hospitals on implementing filmless PACS to their facility, because there was no legal support or acceptance from the government on complete filmless operation. Hospitals with interest on PACS began to implement mini or partial PACS by clustering modalities such as CT, MR, ultrasound and endoscopy or by installing a network between the emergency room and the intensive care unit and storing the endoscopy images from the gastroenterology. These mini or partial PACS were developed and sold by domestic companies such as Marotech and Mediface.

At the end of year 1997, there was a big economic crisis in Korea. Temporarily, the amount of dollar to be retained in Korea was totally exhausted and the exchange rate of dollar was suddenly increased more than two times. At last, the Korean government had to borrow dollars from the IMF (International Monetary Fund). Because of this economic crisis, many radiologist and hospital administrators began to have a big interest on PACS, as the cost for film and chemical became unaffordable for hospitals and as the operation of hospital became awfully difficult due to a significant cost difference between the medical insurance reimbursement on film and the purchasing cost. Because all the medical films and chemical used in Korea are imported from other countries, the medical insurance reimbursement could not reach the increased purchasing price that hospitals had to bear. This economic crisis was one of the reasons why SMC transformed itself to a completely filmless hospital from the one, where film was partially used. After all, this economic crisis was served as a huge opportunity on PACS part.

3.3. MATURING PHASE (2000-AT PRESENT)

The highest meritorious public officer in the Korean PACS distribution is the approval on medical insurance reimbursement in November 1999. The Korean Society of PACS took the most vital role in the approval process. The important thing is that the government will actively support the proliferation of PACS distribution by reimbursing hospitals 130% of the laser film reimbursement when filmless PACS is implemented. Furthermore, the official approval of the government to allow hospitals to do digital storage and management without film was one of the greatest achievements in the PACS history. From then on, many hospitals with financial difficulties became interested in benefits and profits associated with filmless PACS.

In Korea, there are 132 large hospitals having more than 400 inpatient beds and 267 small hospitals having 100 to 400 inpatients beds. Nine large hospitals and 22 small hospitals implemented filmless PACS in the year 2000. 21 large hospitals and 28 small hospitals did in the year 2001. By the end of year 2001, 33 (25%) out of 132 large hospitals and 50 (19%) out of 267 small hospitals installed filmless PACS

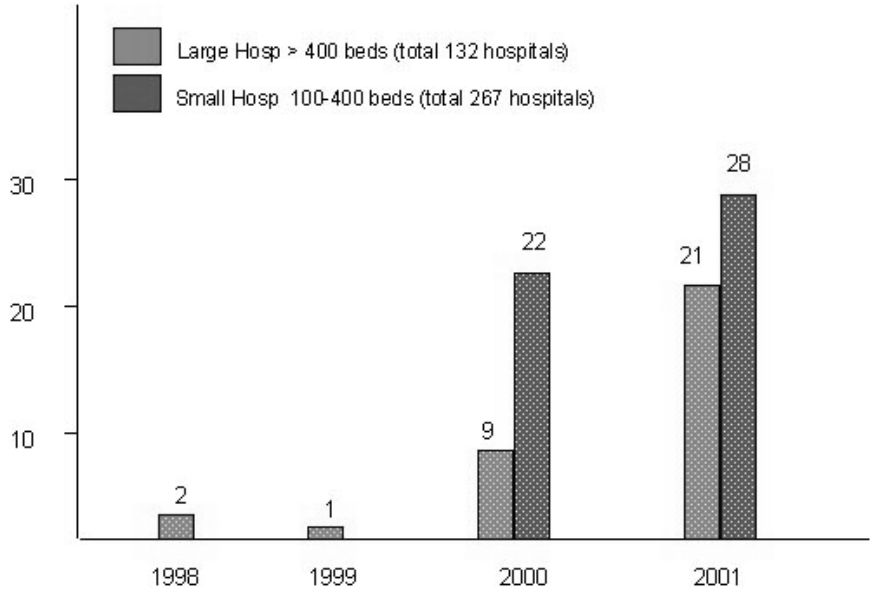


Figure 2. Numbers of Korean hospitals with filmless PACS

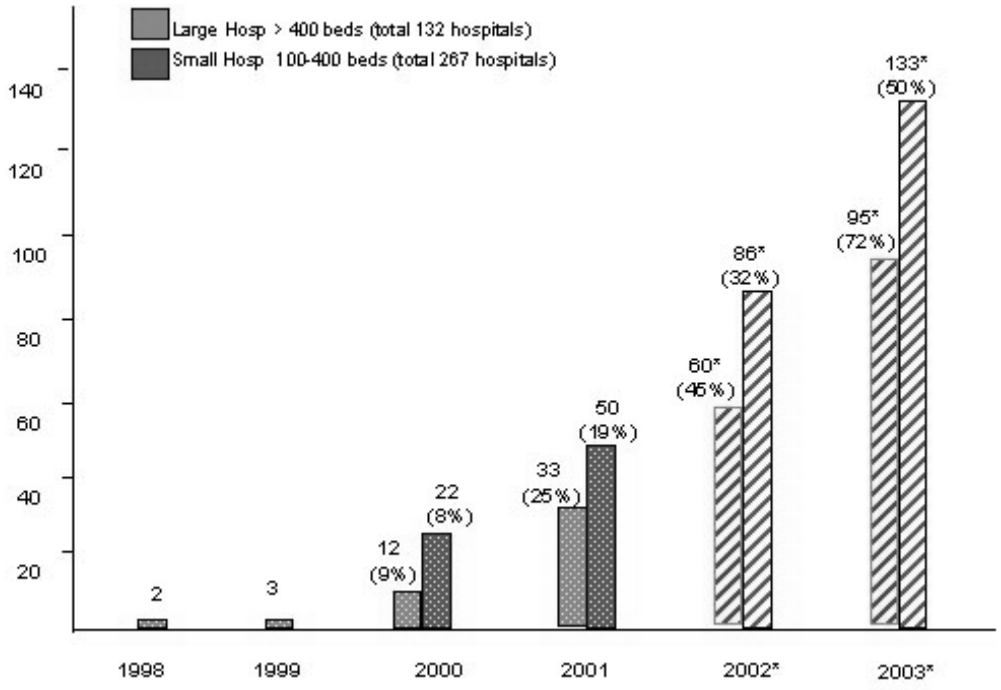
From the year 2000 to the year 2001, the growth rates of filmless PACS were 134% for large hospitals and 27% for small hospitals (Table 1). If the annual growth rate of the Korean PACS market is supposed to be 30%, 27 large hospitals and 36 small hospitals are expected to implement filmless PACS in the year 2002 and 35 large hospital and 47 small hospital installations are forecasted for the year 2003. Therefore, 60 (45%) out of 132 large hospitals and 86 (32%) out of 267 small hospitals are to be installed for the year 2002. And for the year 2003, 95 (72%) large hospitals and 133 (50%) small hospitals are expected to implement filmless PACS in their facilities (Figure 3).

Table 1. Expected number of filmless PACS in Korea

Year	No. of large hospital	GR* of large hospital	No of small hospital	GR* of small hospital	Cumulative No. of large hospital	Cumulative No. of small hospital
1998	2				2 (1%)	
1999	1	-50%			3 (2%)	
2000	9	800%	22		12 (9%)	22 (8%)
2001	21	134%	28	27%	33 (25%)	50 (19%)
2002**	27	30%**	36	30%**	60 (45%)	86 (32%)
2003**	35	30%**	47	30%**	95 (72%)	133 (50%)

* GR: growth rate

** 30% growth rate supposed in year 2002 and 2003



* 30% growth rate supposed in year 2002 and 2003

Figure 3. The cumulative No. of hospitals installing filmless PACS and its expectation

According to the demand of domestic PACS companies and medical doctors, the Korean Societies of PACS and Diagnostic Radiological have put all their efforts to attain the medical insurance reimbursement on PACS. Eventually on November 1999, the Ministry of Health and Welfare approved the medical insurance reimbursement on PACS based on paperwork prepared by the Korean Society of PACS. From that time, domestic PACS companies with 4-5 years' experiences of PACS began their sales and marketing activities with cost-benefit strategies, as many hospitals began to recognize their economic remuneration through cost-benefit analysis and as hospitals changed their views to accept filmless PACS.

With a strong PACS technology with clinical experience of several years, domestic PACS companies have begun their PACS installation at various hospitals, smoothly providing the HIS interface and integration along with the full Korean language support. During the year 2000, 31 hospitals installed PACS with a tremendous market growth. In the year 2001, many hospitals progressively and actively plan or install filmless full PACS competitively and PACS market of Korea grew remarkably to replace the existing hardcopy film market. Furthermore, some large hospitals, such as Seoul National University Hospital (1,500 inpatient beds), Asan Medical Center (2,200 inpatient beds) and Kil Hospital (2,000 inpatient beds, Incheon Korea), have started to implement filmless full PACS. The market competition became more intensified, as the number of the new PACS companies increased (Agfa, Daesung, GE, Infomed, Marotech, Medical Standard, Mediface, NeoBit, ICM, PeopleNet, RayPax, SC&J, Techeim and etc.).

4. NEW TREND OF FILMLESS PACS IN KOREA

The new trend of filmless PACS in Korea is as follows:

4.1. ONE-PHASED IMPLEMENTATION STRATEGY

Because the medical insurance reimbursement only applies to the filmless PACS hospitals, most of hospitals would like to implement filmless PACS at once. PACS companies with a lot of experiences are installing filmless PACS in large hospitals within 3~4 months and in small hospitals with 400 inpatient beds or less within 1~2 months.

4.2. MULTI-SYSTEM (MULTI-COMPANY) APPROACH

The conventional PACS have used centralized approach, where single company provided large single server of database and file management. However, at Anyang Metro Hospital (Anyang, Korea) with 450 inpatient beds and Ilsan Hospital (Ilsan, Korea) with 750 inpatient beds a multi-system approach was used with products of Agfa and Medical Standard. Agfa's Impax server and viewing workstations were placed around the department of diagnostic radiology and Medical Standard's PACSPLUS server and viewing workstations were placed around the outpatient clinics and inpatient wards for clinicians. This configuration can be considered as an initiative step for the future system configuration, where servers are distributed to clinical departments adapting various departmental demands.

4.3. HL7 BASED HIS-PACS INTERFACE

Most of the existing HIS (Hospital Information System) in the Korean hospitals are using proprietary protocols. The HIS-PACS interface using HL7 (Health level 7), which is already approved as a standard by ISO (International Standard Organization), is being implemented at Ilsan Hospital (by Medical Standard) and Seoul National University Hospital (by Marotech).

4.4. JOINT BUSINESS OF PACS AND HIS VENDORS

As the distribution of PACS become active, newly built hospitals are planning simultaneous operation of PACS and HIS from the commencement day.

4.5. PACS SOFTWARE SALES

Medical Standard and Mediface are selling PACS in software by the product names of PACSPLUS and PiView respectively. This was possible by packaging the software with the intention of introducing self-install PACS. Hospitals can purchase PACS components in software and install by themselves after preparing necessary hardware and network using user-friendly company guidelines on hardware and network preparation.

5. IN SUMMARY

The current Korean filmless PACS market has grown remarkably over the recent 2 years. By the end of year 2001, 21% (83 installation out of 399 hospitals) of the total hospitals have implemented filmless PACS in their facilities. The turning point of this outstanding growth was due to the approval of the medical insurance reimbursement on filmless PACS. The roles of the Korean Society of PACS and the government were also vital to this great achievement. The filmless PACS implementation in Korea for the next 2~4 year is expected to reach more than 70% of the total hospitals and this market expansion and the proliferation of filmless PACS distribution is surely believed to be the fastest in the worldwide medical history.

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