The Practical Use and Evaluation of Picture Archiving and Communication System in the Department of Orthopaedic Surgery

Isao Yamamoto and Kiyoshi Kaneda

A picture archiving and communication system (PACS) was started in June 1989 in the outpatient clinic of the Department of Orthopaedic Surgery, Hokkaido University, Sapporo, Japan. The PACS system has several advantages: space savings for storage of images, safe custody and quick access to image data, simultaneous access to image data, the possibility of obtaining good quality data on utilization of images, and applications for medical education and resident training. However, this system has just begun, and several problems must still be solved. In this article, we describe our experiences with the PACS system in the outpatient clinic of the department of orthopaedic surgery.

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IN THE DEPARTMENT of orthopaedic surgery of Hokkaido University, the hospital information system (HIS) was started in March 1989 and the picture archiving and communication system (PACS) was started in June 1989. Nine image data terminals (IDTs) have been installed and are used daily in the outpatient clinic of the Department of Orthopaedic Surgery. The IDT workstation can display a maximum of two $1K \times 1K^2$ images. The main characteristics of the PACS are a filmless image data system and a computerized outpatient clinic system. The number of x-ray films taken in the outpatient clinic of the Department of Orthopaedic Surgery in 1 year is more than 100,000. Finding room to store so many x-ray films in the hospital is difficult, and finding a radiographic study among these many studies is also difficult. PACS is expected to solve these problems.

Table 1. Picture Quality of PACS

Quality	Upper Limb, Hand (%)	Hip (%)	Spine (%)	Lower Limb, Foot (%)
Good	18	17	19	20
Average	67	57	70	55
Bad	15	26	11	25

Table 2. Picture Quality of PACS as Compared With CR X-ray Images

Quality	Percent
Better	20
Equal	54
Less	26

EVALUATIONS OF PACS

PACS is a revolutionary system. The physician must view x-ray images on IDT display instead of the usual x-ray films. We performed a study of PACS, interviewing by questionnaire 23 orthopaedic doctors who have been using PACS in their daily outpatient clinic work. The questions concern PACS hardware, software, and other issues.

Image Quality

The most important feature of PACS is the image quality. We questioned the doctors about the image quality of bones and joints in PACS. Table 1 shows the doctors' impressions of the image quality of upper limb and hand, hip, spine, and lower limb and foot studies in PACS. Mostly, they evaluated the picture quality of PACS as average. The picture image quality of PACS as compared with computed radiography (CR) x-ray film is shown in Table 2. Twenty percent is equivalent to "better," 54% to "equal," and 26% to "less." From these data, we believe that we can use PACS images in daily outpatient clinics. Table 3 shows the main reasons for the less than excellent image quality of PACS. The following

From the Department of Orthopaedic Surgery, Hokkaido University, School of Medicine, Sapporo, Hokkaido, Japan.

Address reprint requests to Isao Yamamoto, MD, Department of Orthopaedic Surgery, Hokkaido University, School of Medicine, Kita 12 Jyo Nishi 3 Chome, Kita-ku, Sapporo, Hokkaido, Japan.

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Table 3. Comments on Picture Quality of PACS

The following pictures are sometimes indistinct
Fine changes of bone matrix
Small fracture line
Bone atrophy
Callus (initial stage of bone healing)
Range of femoral head necrosis
Initial stages of tumors and infections

Table 4. Suggested Improvement Functions for Picture Quality in PACS

Window change
Gamma correction
Edge correction
Black and white inversion
Magnification of picture

findings are sometimes not clear in PACS: fine changes of bone matrix, small fracture lines, bone atrophy, callus (initial stage of bone fracture healing), range of femoral head necrosis, initial stage of tumors and infections, and grade of osteoporosis (Table 3). These conditions may also be difficult to see in conventional x-ray films. At present, we do not know whether these problems derive from the film image of Fuji Computed Radiography (FCR) film image (ie, film that predated PACS implementation) or PACS itself.

The PACS system contains functions to improve image quality. These are window change, gamma-correction, edge correction, black and white inversion, and magnification of pictures (Table 4). After use of these image improvement functions, the picture quality of PACS is much improved (Table 5). The final question about the image quality was: Do you think the PACS needs improved images? The answers were as follows: no need, 26%; needs a little more improvement, 58%; and needs much improvement, 16%. We expect image quality in PACS to improve in the future.

Table 6. Data Transfer Time to IDT

Transfer Time	Percent
Very fast	5
Fast	22
Slightly slow	53
Very slow	21

Handling of PACS Hardware

In answer to our question about the ease of handling hardware (mainly computer mouses), 65% of doctors responded that it was easy to use and 35% responded that it was difficult to use.

Data Transfer Time

Table 6 shows the impressions of the doctors about the data transfer time. Theoretically, data transfer time from host magnetic computer disk to IDT is about 20 or 30 seconds. About 50% of doctors think that the data transfer time is slightly slow. This may result from some problem in the computer program of PACS.

Handling of PACS Software

The outpatient clinic was reorganized to use the computer-based PACS system. Medical doctors must use the computer software of PACS when they are engaged in outpatient clinics. Of the 23 doctors who operated PACS software in outpatient clinics, 15% had no difficulty in operating PACS software, 65% sometimes had difficulty, and 20% always had difficulty. The reasons for difficulty in operating PACS software were as follows: shortage of training time, insufficient understanding of software, complicated software, and insufficient functions of software. Doctors want more easy "help" functions.

Table 5. Picture Quality of PACS After Using Improvement Functions of Pictures

Quality	Window Change (%)	Gamma Correction (%)	Edge Correction (%)	Black and White Inversion (%)	Magnification of Picture (%)
Good	58	31	31	29	52
Average	40	65	65	71	26
Bad	2	4	4	0	21

Table 7. Expectations for PACS

Space savings for storage of image data
Safe custody and quick reference of image data
Multiple display of image data
Good quality of image data
Efficient management and labor savings in outpatient clinic
Utilization for medical education and resident training

Additional Functions of PACS

The measurement functions of angles and distances on CRT are very useful in outpatient clinics of orthopaedic surgery.

CONCLUSIONS

We have described our brief experience with PACS. PACS is believed to be the most advanced system that manages image data. We expect the following things of this system (Table 7): (1) space savings for storage of image data, (2) safe custody and quick reference of image data, (3) multiple simultaneous displays of image data, (4) good-quality image data, (5) efficient management and labor saving in the outpatient clinic, and (6) utilization and application for medical education and resident training.