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| Author(s) | 小田切, 邦雄; 中前, 晴夫; 大越, 隆文 他 |
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Clinical Evaluation of a Teleradiology System Utilizing Personal Computers and Public Telephone Line

Kunio Odagiri¹⁾, Haruo Nakamae¹⁾, Takafumi Ohkoshi¹⁾, Kazuo Andoh¹⁾, Yoshinori Kinno¹⁾, Yukio Hyodo²⁾, Shikibu Chiyasu³⁾ and Kazutaka Ano⁴⁾

1) First Department of Radiology, Kanagawa Cancer Center

2) Division of Infection and Immunology, Kanagawa Children's Medical Center

3) Department of Radiology, Ashigarakami Hospital

4) Canon Sales Co., Inc.

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パソコンと公衆電話回線を使用したテレラジオロジー システムの臨床評価

小田切邦雄¹⁾ 中前 晴雄¹⁾ 大越 隆文¹⁾ 安藤 和夫¹⁾
金野 義紀¹⁾ 兵頭 行夫²⁾ 千安 式部³⁾ 阿部 和隆⁴⁾

1) 神奈川県立がんセンター放射線第1科

2) 神奈川県立こども医療センター小児科

3) 神奈川県立足柄上病院放射線科

4) キヤノン販売株式会社

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CCDカメラ、パーソナルコンピュータおよび電話回線を用いた簡単なテレラジオグラフィシステムを開発し、日常診察においてその有用性を検討した。このシステムで伝送された単純X線像を含めた診断画像の画像評価では、大多数の病変が診断可能であった。同じ市内および約50Km離れ

た病院からのコンサルテーション42件の有用性評価では38件(90%)が有用と判定された。このように簡便なシステムを用いたテレラジオグラフィは、遠隔地のみでなく都市部の医療においても有用であると思われる。

Summary

Practical usefulness of a teleradiology system using CCD camera, personal computer and telephone line was evaluated in a daily clinical practice. Image quality of this system is diagnostic for the majority of abnormalities on radiological images including plain radiographs. Radiological consultation between hospitals in the same city as well as between distant cities using this moderately priced system was thought to be useful in 90% of cases. Teleradiology using compact systems like ours is expected to be useful in the urban clinical environment as well as in distant areas.

Introduction

Transmission of radiological images from a remote location to a radiologist is referred to as teleradiology. This technology has been used mainly in isolated locations. Many teleradiology systems involve expensive equipments such as film digitizers and high definition TV monitors. We developed a relatively inexpensive system using personal computers and telephone line, and evaluated its usefulness in radiologic consultation between hospitals in the same city, as well as between remote locations. Clinical trial of such a system has not been described in the literature.

Material and Method

(1) Equipments

The transmission system, which is also used as a receiver, consists of an image assembly, monitor assembly and a personal computer (Figs. 1, 2). The image assembly consists of a light box and a CCD camera (Canon Ci 20). Image information of a film placed on the light box is converted into video signals. The video signals are digitized by the image processor in the monitor assembly (Canon FI-750). The cathode ray tube (CRT) of the monitor assembly displays a picture of 640 dots \times 480 dots. With the maximal close up, the camera covers an area of 3 cm \times 4 cm. A 32 bit personal computer (Macintosh II) performs operation of the system, file management and transmission of the image and text information via a high speed (14K bps) MODEM. On the receiver side, information is received and filed by a personal computer, and the received images are displayed on a CRT monitor. The hard disc memory of the computer can store up to 200 images. Image compression was not employed. Up to 50% of the image can be deleted to save transmission time by eliminating a part of the film, such as the portion of a radiograph which does not



Fig. 1 Transmission system.

From left to right: image assembly, monitor assembly with CRT on top of the image processor, film recorder (FR-300, Nippon Avionix, not included in the standard system), personal computer and telephone on top of MODEM.

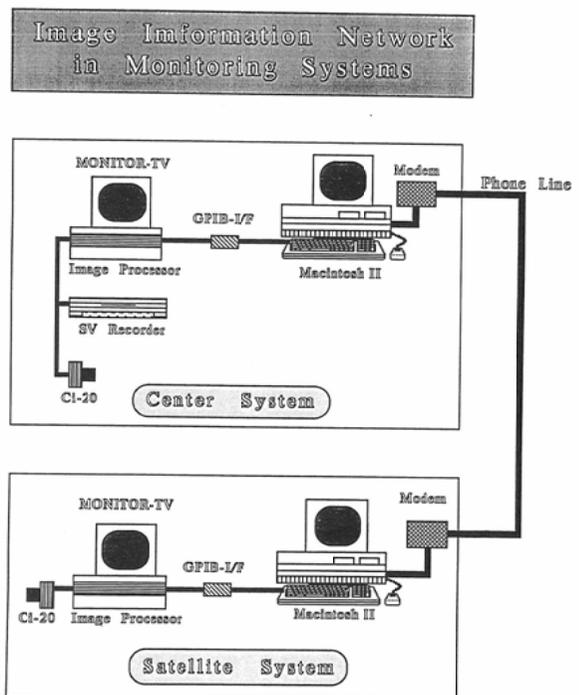


Fig. 2 Block diagram of the teleradiology system.

Fig. 3 Computer display of clinical data and questions entered by a clinician.

Fig. 4 Computer display of a report from radiologist.

cover the body of the patient. Transmission time for a full image is about three minutes. Texts of clinical information, questions from the clinicians, and reports from the radiologists are entered into the computer by a keyboard. Draw line pictures can be entered by a "mouse" of the computer. Pass words are used to access the communication system to protect the privacy of the patients. These data are stored and transmitted by the computer (Figs. 3, 4).

(2) Evaluation of image quality

CRT images of lesions selected from our teaching file were reviewed by three radiologists. In addition to the image of the entire film, a close up magnification view of the lesion was shown if it was thought to be necessary. In CT and MRI, a CRT image covering one to four slices were evaluated. They were compared with the original films and were scored on a four-step scale:

Excellent: image quality satisfactory with no diagnostic difficulties.

Fair: transmitted image diagnostic with a level of confidence lower than that of the original film.

Unsatisfactory: lesion visible but diagnostically unsatisfactory.

Poor: lesion not visible on CRT.

This system can transmit color images. But only black and white images were evaluated in this study.

(3) Clinical trial

A radiology conference using telephone conversation and transmitted CRT images (teleconference) was held by the clinicians of Kanagawa Children's Medical Center and the radiologists of Kanagawa Cancer Center on a daily basis. Both of the institutions are located in Yokohama City. This conference intermittently lasted for two years. In addition, occasional consultation was made in the later phase of the project by the clinicians of Ashigarakami Hospital, a community hospital about 50 km from Yokohama City. The images were sent prior to the conference with a text containing clinical information and specific questions to the radiologists from the clinicians. A magnification view of the area of interest was added if it was felt to be necessary by the referring clinician or the radiologist. The original films were reviewed by the radiologists on a later date.

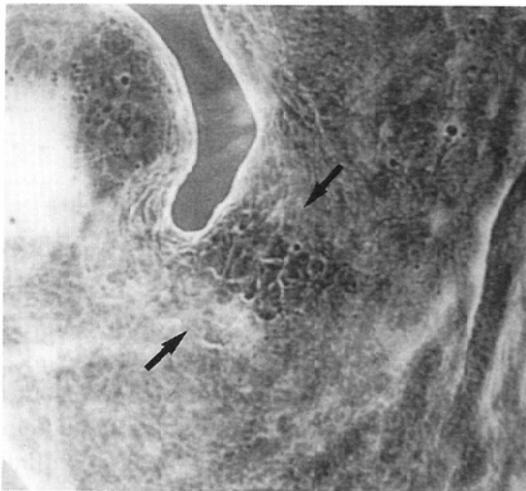
The usefulness of consultations on 42 cases was evaluated retrospectively by all the participants and rated on a three-step scale. Most of the transmitted images were those of plain radiographs.

Very useful: consultation affected the patient management in a positive manner.

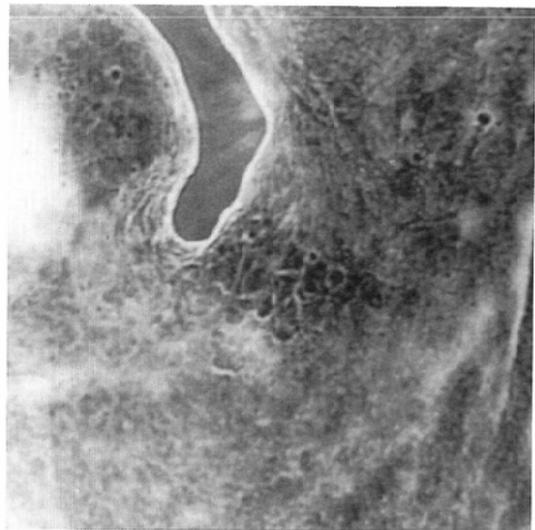
Useful: consultation useful in making a diagnosis rapidly, but did not change the course of the patient care.

Not useful: consultation not useful for the clinicians.

The scores for image quality and for usefulness of teleconference were arrived at by consensus.



A



B

Fig. 5A. Early gastric cancer. 56 years old male.

Original double contrast film from upper GI series shows an aggregation of small mucosal elevations near the gastric angle (arrows).

Fig. 5B. Transmitted CRT image of A.

Reproduction of the details of the mucosal lesions is felt to be satisfactory.

Results

(1) Image quality

Images of CT, MRI, scintigram, ultrasonogram and angiogram were scored as excellent or fair except for small calcifications on CT, and subtle tumor stains are well as abnormalities of small vessels on angiogram which were barely visible on the original film. These findings were scored either unsatisfactory or poor. Images from other contrast studies including barium study (Fig. 5), excretory urography, and cystourethrography were scored either as excellent or fair. Scores for plain radiography are shown in table

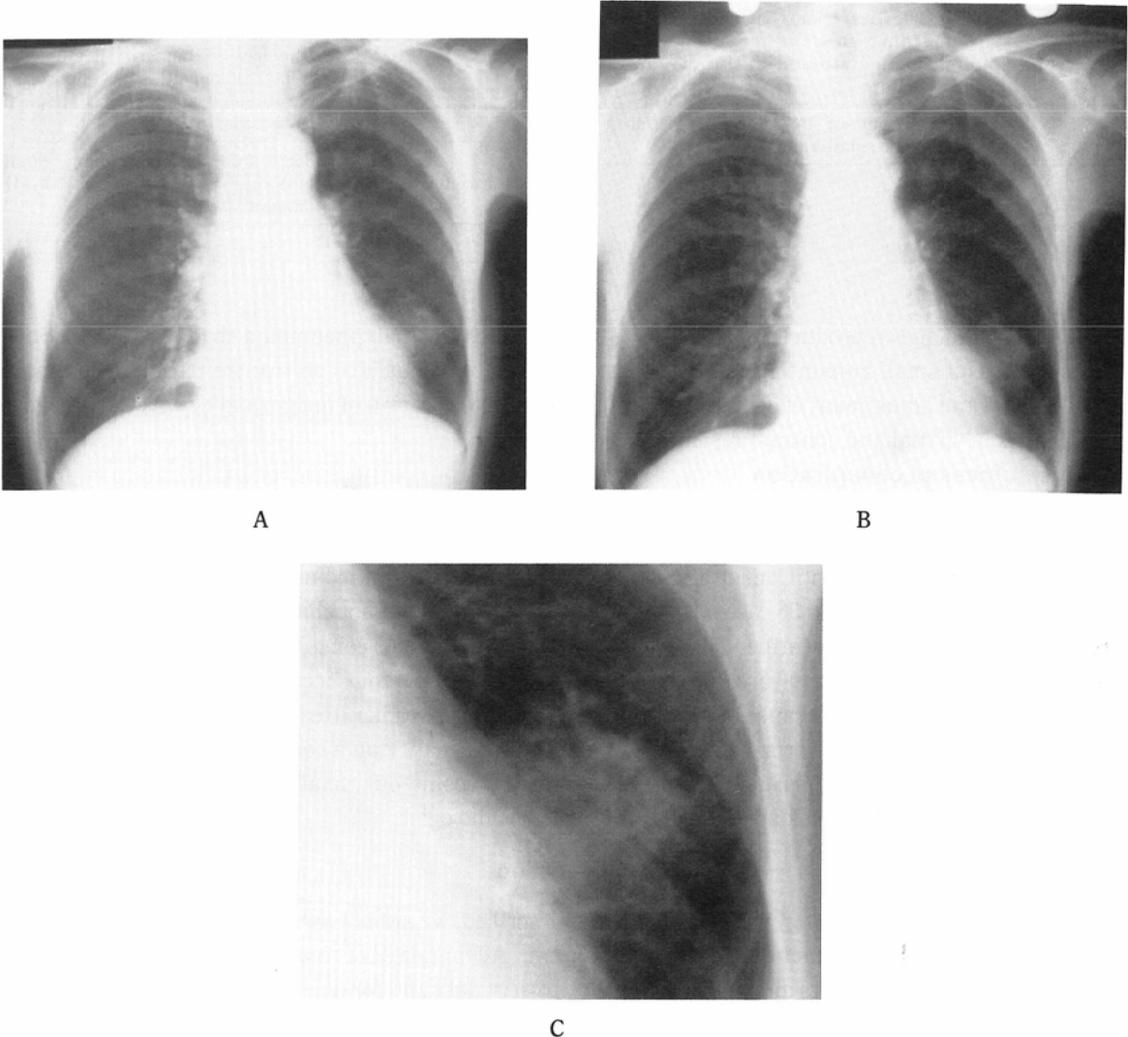


Fig. 6A. Air space pneumonia.

Original chest radiograph of a 76 years old female shows a fluffy shadow of increased density in the left lower lung zone obliterating the cardiac border (arrow).

Fig. 6B. Transmitted CRT image of A. There is no difficulty in detecting the abnormal lung density.

Fig. 6C. Close up CRT image of the pneumonic shadow. The confluent nature of the lung density is well reproduced.

Table 1 Quality of Plain Radiographic Image

| | |
|----------------|---|
| Excellent | normal chest; paranasal sinusitis; normal cervical vertebrae; normal femurs; atelectasis; interstitial pneumonia, alveolar pneumonia; overaeration of the lung. |
| Fair | normal chest; osteomyelitis of the humerus and tibia; hilar adenopathy; alveolar pneumonia; interstitial pneumonia; distention of the pulmonary vessels; demineralization of the carpal bones; pneumoperitoneum (small amount); calcifications (small). |
| Unsatisfactory | Knee joint effusion; small fluffy pneumonia; small nodules (less than 5mm); subtle air-bronchogram; pneumothorax (moderate amount); pneumomediastinum (small amount). |
| Poor | subtle thickening of the interlobar fissure; pneumothorax (small amount). |

Table 2 Usefulness of consultation

| | number of cases | Findings |
|-------------|-----------------|--|
| Very useful | 2 | pseudotumor of kidney; normal maxillary sinus with bony shadow mimicking mucosal thickening |
| Useful | 36 | normal chest, pneumonias; lung masses, skin folds; pleural effusions; overaeration of the lungs; atelectases; hilar adenopathy; prominent thymus; intrathoracic kidney; maxillary sinusitis; blow out fracture of the orbit; pathological fractures of humerus, femur and tibia; osteomyelitis osteoporosis; parathyroid adenoma (CT); spinal cord tumor (MRI) |
| Not useful | 4 | deep soft tissue swelling, joint effusion, pneumothorax (small amount) |

1. Transmitted images reproduced many delicate changes such as small pneumonia shadows (Fig. 6). Some lesions such as a small amount of pneumothorax could not be visualized on transmitted images despite magnification and adjustment of contrast and brightness. Deterioration of image quality was thought to be due to limits in spatial and contrast resolution of the system.

(2) Usefulness of consultation

Evaluation of the usefulness of the consultation is shown on Table 2. In two cases, normal variations, were initially thought to be pathological changes. A correct diagnosis was made on consultation, and the patients were treated as such. Consultation on these cases were classified as very useful. The clinicians obtained useful information in 36 cases. However, the consultation did not change the course of the patient care because of timing, i.e. treatment had been started at the time of consultation, and/or the nature of information given, e.g., exact nature and location of pneumonia. On four occasions, the consultation was not useful for the clinicians because of poor quality of the images transmitted.

It was difficult for the interpreter to detect a subtle abnormality on a complex image such as a chest radiograph. Usually it was necessary for the clinician to point out small lesions oftentimes with a magnified close up view and ask specific questions to the radiologist.

Discussion

Although many teleradiology systems have been described, we are not aware of a report of clinical trial of a transmission system using personal computers. Advantages of using personal computers for teleradiology include that texts and line drawings for patient data and for questions to and reports from the radiologist can be transmitted and also stored in a file for future references. The computer can be used for other purposes when the system is not serving for teleradiology. This is convenient for small private clinics where cases requiring radiological consultations are encountered only occasionally.

Teleradiology has been used mostly to assist clinicians in the isolated locations such as islands¹⁾, rural areas^{2,3)} or military facilities⁴⁾. Our study suggests that instant consultation to a specialist using a teleradiology system is useful in the urban institutions as well as in rural areas. A medical image communication network among hospitals, outpatient clinics, and associated professional groups has been

constructed⁵⁾. Compact teleradiology systems like ours may be a useful tool for such a network, because instant consultation to experts in every subspecialty of diagnostic radiology is not always available even in the major institutions.

In many cases, especially with the use of plain radiograph, image quality of our system is not good enough to maintain the same confidence level as with original films due to limitations in the spatial and density resolution. Also we found it difficult to detect a subtle abnormality on a CRT image. This agrees with the experience of Page et al²⁾ who found that the detection of small lesions was an important source of error. This drawback of CRT diagnosis was at least partially compensated by a proper adjustment of contrast and brightness of the image, magnification view, and dialogue between the participants using computer message and telephone conversation. With these limitations consultation using this system was thought to be useful in about 90% (38/42) of our clinical trial cases. In other words, this relatively inexpensive system combined with telephone conversation and a double check of the original films, on a later date could meet the objectives of providing instant assistance by radiologists to clinicians. Only few emergency cases are included in our trial. However one can expect that this system will prove to be more useful in an emergency situation. Our system will be also useful for postgraduate education of medical and comedical professionals.

In conclusion, our teleradiology system using readily available equipments, can be used for timely delivery of radiological services with an acceptable cost performance ratio in the urban clinical environment as well as in rural areas.

References

- 1) Amamoto Y, Ochi M, Isomoto, I, et al: Transimission of medical images to an outlying island—An application for medical support system. *IRYO* 42 (10): 916—922, 1988 (in Japanese).
 - 2) Page G, Gregoire A, Galand C, et al: Teleradiology in Northern Quebec. *Radiology* 140: 361—366, 1981
 - 3) Suzuki M, Takashima T, Nishijima H, et al: distant telephone transmission of CT images: Its clinical application. *Nippon Act. Radiol* 45: 1540—1547, 1985 (in Japanese).
 - 4) Curtis DJ, Gayler BW., Gitlin JN, Harrington MB: Teleradiology: Results of a field trial. *Radiology* 149: 415—418, 1983
 - 5) Siebert JE, Rosenbaum TL, Oosterwijk H: Experience and insights with a metropolitan area medical imaging broadband network. *Proc SPIE* 626: 562—569, 1986
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