

Study of Application of Mobile DR Detector for Hospital Acquired Infection

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Abstract

Objectives: Generally, hospitals have a special condition easily causing environment pollution, cross infection, contact infection and droplet infection the patients, for it is the place for hospitalized patients who are strongly susceptible to disease and there is a high possibility of that diagnostic tools, hygienic materials in a hospital is infected by disease causing germs. **Methods/Statistical Analysis:** This study obtained a chest image with using medical radial rays by the thickness of disposable plastic packing paper, surgical instrument sterilization wraps for the prevention of hospital acquired infection from repetitive use of portable digital x radiation generator detector and compared and evaluated the definition of the images. **Findings:** According to qualitative analysis result analyzing the images by each types of disposable plastic, disposable plastic with air layer, sterilization sheet, 0.2 mm and 10 mm cotton materials, there was no statistical difference in the group, which did not use an infection prevention protecting product, in terms of contrast, occlusion detection rate and clarity of the boundary. **Improvements/Applications:** The study result suggests that it needs to actively use the materials for certain conditions to obtain optimal medical images and prevent hospital acquired image and to work on developing various protecting products for infection management.

Keywords: Convergence, Image Quality, Infection, Mobile, Radiation

1. Introduction

With the recent economic growth, as the society is rapidly aging and preference for well-being is increasing, the interest in medical devices has been rising. Medical device business is a new growth engine with economic growth potential promoting job creation and new value added and it has a characteristic of that various element technologies such as new material, IT and BT develop as being convergent with clinical medicine. Also, there is a consistent convergence satisfying the demand for high-precision, mobile and low level¹.

Generally, hospitals have a special condition easily causing environment pollution, cross infection, contact infection and droplet infection the patients for it is the place for hospitalized patients who are strongly susceptible to disease and there is a high possibility of that diagnostic tools, hygienic materials in a hospital is infected by disease causing germs^{2,3}.

Hospital acquired infection or nosocomial infection is an infection that is contracted during the period of being hospitalized or after discharged from hospital. The standard and widely used global definition of hospital acquired infection was announced by Center for Disease Control and Prevention or CDC in United States and to satisfy the official definition of hospital acquired infection, the infection has to cause some symptoms in the infected part or whole body and these symptoms have to be caused by infectious agents or toxin by the infectious agents and the infection causes during being hospitalized or not cause for incubation period^{3,4}.

The delay in recovery from this hospital acquired infection results in raised medical bill, expanded period of being hospitalized which not only leads to physical and psychological pain to the patients but it is also an important health related problem including an ethical problem of occurrence of hospital acquired infection and

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it doubles the financial burden on both of patients and government and wastes medical resources and decreases the quality of medicine⁴⁻⁶.

As computed radiography or CR using image plate, IP, was introduced, general X-ray image is transformed into a digital system. As CsI, which digital radiography technology, advanced based on CR, transforms image information to a digital signal is recently developed, the age of digital radiography have begun. Recently, portable X-ray device, which makes easy and simple to have fast radioactive images through wireless LAN communication service and images by detecting X-ray irradiated without connection with X-ray generator and detector is developed and it provides convenience in many aspects⁷⁻¹¹.

Portable examinations are used for first-aid patients and in the occasion of that the patients are in a critical period and hard pressed situation, chest AP which is a basic X-ray examination for first-aid diagnosis and abdomen AP are conducted. However, the role of current medical service is not restricted to simple provision of medicine to patients but the service is now provided to fulfill patient's satisfaction and to impress them by giving some of authorities to choose and intervene in overall parts of the medical process. Thus, when a patient refuses to go all the way down to an examination room, choose a portable examination or complain about difficulty in breathing, the doctor orders a portable examination. Therefore, the recent number of the cases using portable examination is not small anymore. As the cases using mobile portable examination is increasing from day to day, the repetitive use of the detector in wards, intensive care wards, operation rooms and recovery rooms because of the portable examination became the chance of increasing unwanted hospital acquired infection¹².



Figure 1. Radiation generator and phantom.

For this reason, this study conducted a test to obtain a chest image with using medical radial rays by the thickness of disposable plastic packing paper, surgical instrument

sterilization wraps for the prevention of hospital acquired infection from repetitive use of portable digital radiation generator detector and to compare and evaluate the definition of the images so that the device preventing infection of portable X-ray generator can be developed and basic data of infection control are provided.

2. Study Subject and Method

2.1 Material and Device

Portable digital radiography generator and FPD (Flat Panel Detector) system used 80 kVp 3.2 mAs scan condition by using SHIMAZU DK Elmec-T6 Mobile Art Evolution. Phantom for whole body ((Model PBU-31, Kyoto Kagaku, Japan) consisting of body-equivalent materials was used to obtain a medical image of the examinee (Figure 1).

2.2 Manufacture of Mobile Detector Protecting Product for Infection Prevention

5 different kinds of protecting products were manufactured and used for the test to prevent hospital acquired infection caused by repetitive use of the portable digital x radiation generator detector (Figure 2). The disposable plastic protecting product having a function of preventing hospital acquired infection caused by the general repetitive use of the device, disposable plastic product preventing the damage of detector by absorbing external impact and having air layer to prevent infection caused by the repetitive use of the device, cotton-material surgical instrument sterilization wrap which can be utilized for infection prevention in operation room or emergency room, woolen yarn protecting products which can be used for cross infection in a general ward were selected for this study. The test was conducted as chest images of phantom were taken by the selected protecting products for infection prevention.

2.3 Qualitative Evaluation of the Images

The images were taken by each of the protecting products for infection prevention with setting a phantom for whole body to 80 kVp, 3.5 mAs, SID 100 cm by using the phantom for whole body and setting the scanning option to 80 kVp, 3.5 mAs, SID 100 cm and then, qualitative analysis on the images was conducted to confirm clinical practi-

cality (Figure 3). For the qualitative analysis, 1 medical specialist of radiology, 4 radiological technologists who have over 10 years of experience in this field evaluated image contrast, occlusion detection rate and clarity of boundary by using Likeret Scales.



Figure 2. Portable digital radiation generator detector.



Figure 3. Portable digital chest X-ray image obtained by radiation generator detector.

2.4 Statistical Analysis

Wilcoxon signed ranks test which is a nonparametric statistical analysis was conducted, for the data processing can be done no more than 5 times. Significance level of the all statistics is $p<0.05$.

3. Conclusion and Discussion

3.1 Result of Image by Type of Infection Prevention Protecting Products

Portable digital x radiation generator detector system has a special feature to obtain, send and process digital images and this feature makes possible to identify details of diagnosis data which used to be difficult to identify with the existing analog technology. Because of these various special features, it is possible to apply this to any parts of image test which is conducted by a radiology department and it is also possible to check, evaluate and send the data of tube operation for patients in intensive

care unit, operated patients and infant patients and their results straightly, as a result, application of this system is growing^[17-18].

However, since the portable digital x radiation generator detector system is an expensive equipment using advanced science technology-cumulative semiconductor, it has a disadvantage such as a difficulty to reuse after sterilizing just like other surgical devices or use and throw away as a disposable, expendable medical supply. For these reasons, the purpose of this test was to prove whether it can be used in a hospital by manufacturing a protecting product for detector for the purpose of hospital acquired infection prevention caused by the repetitive use of detector.

Since it is easy to purchase a disposable plastic infection prevention product in many stores and the price is reasonable and its superiority in the clinical application for bleeding patients in an emergency room is proved, this test manufactured and used it for image scanning and the result is shown in (Figure 4). This suggests the potential for the application of disposable infection prevention protecting product for mobile radiology examination.



Figure 4. Disposable plastic protecting product and chest image.

For portable digital x radiation generator detector system, two types of detector, separable detector and single-unit detector are used in a clinical field. Even though single-unit detector has an advantage in the aspect of usability in management and physical impact in use, it has a disadvantage such as a difficulty to maintain patient's posture.

Separable detector is advantageous in maintaining patient's posture but it is vulnerable to physical impact in use, therefore, the hospital acquired infection prevention plastic protecting product containing air layer to absorb physical impact were used for image scan and the image result is shown in Figure 5. The result from this attempt suggests the method to relieve physical impact from the separable detector and help to effectively manage infection.

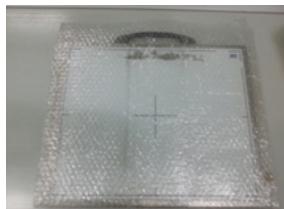


Figure 5. Air layer contained plastic protecting product and chest image.

The image obtained by using reusable sterilized sheet used in an operation room or intensive care unit for hospital acquired infection is shown in Figure 6. This has a cost saving effect in the aspect of hospital management, as a result, if there is no significant difference in the definition of the image, it will have a high potential of application.



Figure 6. Sterilized sheet protecting product and chest image.

The image obtained by manufacturing cotton sheet by thickness for hospital acquired infection prevention in a ward is shown in Figure 7 and Figure 8.



Figure 7. 0.2 mm cotton sheet and chest image.



Figure 8. 10 mm cotton sheet and chest image.

It is considered to be the cotton sheet for infection prevention is not largely influenced by thickness. Because tube voltage of X-ray generator is high so it is suggested that it does not influence on transmission.

3.2 Result of Image Evaluation by Types of Infection Prevention Protecting Products

Qualitative analysis was conducted with the image obtained for analyzing clinical implication by manufac-

turing and using protecting products for hospital acquired infection prevention.

Table 1. Evaluation of the clinical image

Infection prevention product	Contrast	Lesion discovery rate	Clarity of boundary
non	5	5	5
Disposable plastic	5	5	5
Air layer contained plastic	5	5	5
Sterilized Sheet	5	5	5
0.2 mm cotton	5	5	5
10 mm cotton	5	4.5	4.5

The result from qualitative analysis categorizing contrast of image, lesion discovery rate and clarity of boundary into five groups (1: Very poor, 2: Poor, 3: Average 4: Good 5: Excellent) was evaluated by one expert in radiology and four radiological technologists who have 10 years experience in the field and according to the result, all the images obtained by sizes gained a satisfactory result in the contrast question (Table 1).

However, there was no statistical significance in types of protecting products for hospital acquired infection in terms of lesion discovery rate and clarity boundary. The possible reason of this is that high tube voltage is used to obtain a chest image and this tube voltage controls penetrating power^{19,20}.

Hospitals have a special condition easily causing environment pollution, cross infection, contact infection and droplet infection the patients, for it is the place for hospitalized patients who are strongly susceptible to disease. It was found that when conducting mobile radiation test by using digital portable radiation generator detector, it is possible to actively use condition-specific materials to prevent hospital acquired infection. Furthermore, it is suggested that many future studies of infection management and development of medical device for infection prevention need to be conducted.

4. Conclusion

This study obtained a chest image with using medical radial rays by the thickness of disposable plastic pack-

ing paper, surgical instrument sterilization wraps for the prevention of hospital acquired infection from repetitive use of portable digital x radiation generator detector and compared and evaluated the definition of the images.

According to qualitative analysis result analyzing the images by each types of disposable plastic, disposable plastic with air layer, sterilization sheet, 0.2 mm and 10 mm cotton materials, there was no statistical difference in the group, which did not use an infection prevention protecting product, in terms of contrast, occlusion detection rate and clarity of the boundary. The study result suggests that it needs to actively use the materials for certain conditions to obtain optimal medical images and prevent hospital acquired image and to work on developing various protecting products for infection management.

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