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Jacobs Journal of Microbiology and Pathology

Research Article

Contamination of X-Ray Cassettes with MRSA during Portable X-Ray Examination

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Received: 08-27-2014

Accepted: 09-01-2014

Published: 09-27-2014

Abstract

Background: The patient-contact surface of X-ray cassettes used "within" the X-ray department was contaminated with bacteria, and the most common bacterium found was *Staphylococcus aureus*. To the best of authors' knowledge, similar study on "portable X-ray examination" in the hospital environment has not been studied.

Aim: To perform surveillance cultures of methicillin-resistant *Staphylococcus aureus*, methicillin-susceptible *Staphylococcus aureus* and bacteria on the patient-contact and non-patient-contact surfaces of X-ray cassette during portable X-ray examination.

Methods: The patient-contact and non-patient-contact surfaces of 80 X-ray cassettes used after portable X-ray examination from two hospitals were swabbed. Suspected methicillin-resistant and methicillin- susceptible staphylococcal colonies were analyzed by SA Select™ and MRSA Select™ medium plates. The overall bacteria count was analyzed by nutrient agar medium plates.

Findings: A total of 240 swab samples collected from the patient-contact and non-patient-contact surfaces of 80 X-ray cassettes were collected during four hospital visits. We found three X-ray cassettes (3.8%) had methicillin-resistant Staphylococcus aureus colonies isolated, and two other X-ray cassettes (2.5%) had methicillin-susceptible Staphylococcus aureus colonies isolated on their surface after cultured for 24 hours. Moreover, we found 63 cassettes (78.8%) had different degrees of bacteria colonies isolated on nutrient agar, and three swab samples even yielded more than 300 bacterial colonies.

Conclusions: In the hospital environment, the surface of x-ray cassettes may be contaminated by MRSA during portable X-ray examination. Further improvement in the routine preventive measures against pathogen contamination is therefore suggested.

Keywords: Methicillin-Resistant *Staphylococcus aureus*; X-ray Cassette; Contamination; Surveillance Cultures.

Introduction

Staphylococcus aureus is a potential pathogen commonly found on our skin and the respiratory tract. The asymptomatic infected patient can transmit these pathogens by direct and/or indirect contact to others and to the environment [1]. In particular, methicillin-resistant *Staphylococcus aureus* (MRSA) is regarded as one of the highly pathogenic bacteria which could lead to severe infections like pneumonia and infective endocarditis [2]. MRSA can be transmitted from infected patients to inanimate surfaces by contact, survive on the inanimate surfaces for longer than a month [3], and contaminate the hands and uniforms of healthcare personnel during health care procedures [4]. Therefore, MRSA is a potential threat for the

no socomial infection that poses burden for the management of hospitals.

Pathogen contamination of radiographic equipment and accessories are unavoidable. The radiology department receives a large number of patients from hospital wards and outpatient clinics every day. The pathogens are brought to the department by patients and due to the intimate contact between the surface of the radiographic equipment and staff with the patient, there is a high risk of disease transmission from patient-to-staff and from patient-to-patient through direct and/or indirect contacts within the crowded space of the radiological examination room. The high patient traffic in the radiology department also increases the opportunities for the spread of pathogens, including the spread of MRSA among patients and radiology staff.

Portable X-ray examination is essential to monitor the health status of the critically ill patients in wards. Fox and Harvey (2008) [5] found that the patient-contact surfaces of X-ray cassettes used "within" the X-ray department were contaminated with bacteria, and the most common bacterium found in their study was Staphylococcus aureus [5]. To the best of authors' knowledge, similar study on portable X-ray examination in the hospital environment has not been studied. Therefore, the aim of the present study was to perform surveillance cultures of MRSA, methicillin-susceptible Staphylococcus aureus (MSSA) and bacteria on both patient-contact and non-patient-contact surfaces of X-ray cassette during portable X-ray examination.

Materials and Methods

All X-ray cassettes (Agfa Healthcare, Mortsel, Belgium) of size 34 ^{cm} x 43 ^{cm} from the Radiology departments of two hospitals were cleaned before the start of each portable X-ray examination session. After the end of four portable X-ray examination sessions, we randomly swabbed 80 X-ray cassettes from (1) the center of patient-contact surface (area A), (2) the four corners of the patient-contact surface (area B), and (3) the center of non-patient-contact surface (area C) individually by sterile cotton wool buds. Each cotton wool bud wiped an area of 100 cm^2 over the area A and C, and wiped the four corners of the patient-contact surface (area B) for 25 cm^2 on each corner to reach 100 cm^2.

All swab samples were then inoculated and cultured on nutrient agar medium plate, SA Select™ medium plate and MRSA Select™ medium plate (Bio-Rad Laboratories, Inc., Hercules, California, USA) at 37 ^{o}C for 24 hr. The number of colony forming units formed on the nutrient agar plates, SA Select™ medium plates, and MRSA Select™ medium plates represents the number of bacteria, MSSA, and MRSA colonies respectively.

We also observed the procedure of before, during and after the portable X-ray examination in the two hospitals, and noted down the possible means of MRSA contamination route.

Results

We have performed a random check on eight of the total 80 X-ray cassettes for the presence of any bacteria before the starts of the portable X-ray examination session, and the result indicated that the sampled X-ray cassettes were free from any bacteria contamination before use. After the end of the portable X-ray examination, we have collected a total of 240 swab samples from 80 X-ray cassettes. The number of colony forming units isolated on nutrient agar medium plates, SA Select™ medium plates, MRSA Select™ medium plates from this study were presented in Table I.

Table I. Bacteria Surveillance Test. Surveillance cultures of bacteria, MSSA and MRSA on surfaces of X-ray cassettes.

	No. of Cassettes (A)	No. of Swab Sample collected	No. of Cassettes with Bacteria (B)	Bacterial Contamination Rate (B/A x 100%)	No. of Cassette with MSSA (C)	MSSA Contamination Rate (C/A x 100%)	No. of Cassette with MRSA (D)	MRSA Contamination Rate (D/A x 100%)
Hospital A	40	120	23	57.5%	1	2.5%	1	2.5%
Hospital B	40	120	40	100%	1	2.5%	2	5%
Total	80	240	63	78.75%	2	2.5%	3	3.75%

In our present study, MRSA was isolated from three X-ray cassettes (3.78%): one of the MRSA colony was isolated on the center of non-patient contact side (area C), and the other two MRSA colonies were isolated at the four corners of patient-contact surface of X-ray cassettes (area B). MSSA was also isolated from two other X-ray cassettes (2.5%): both of the MSSA colonies were isolated on the center of non-patient contact surface (area C). Of the total 80 X-ray cassettes sampled in this study, 63 of them had bacteria colony isolated on nutrient agar plates from at least one of the surface of X-ray cassettes, with three of the positive samples yielded more than 300 bacterial colonies.

The overall bacteria contamination rate in Hospital A and Hospital B was 57.5% and 100% respectively. Hospital A disinfects the X-ray cassettes with alcohol after each examination, and radiation technologists would change their gloves after handling patients. The X-ray cassettes used in Hospital B were wrapped with a disposable plastic bag cover before and during examination, and the cover would be removed and disposed immediately after examination. In both hospitals, radiation technologists would wash their hands after examination. A summary of the infection control measures taken in the two hospitals was summarized in table II.

	Hospital A	Hospital B
Wearing gloves	✓	×
Hand washing after case	✓	✓
Plastic bag covers	×	✓
Disinfection of cassettes	✓	×
Wearing surgical mask	✓	✓
Warning sign noticing risk of infection in ward	✓	✓

Table II. The Infection Control Measures Implemented in Hospital A and B. A summary of various infection control measures that implemented (✓) or not implemented (✗) in Hospital A and B

Discussions

Although standard preventive measures, such as hand hygiene, use of protective barrier and antiseptic cleaning of the contaminated environmental surfaces are practiced by radiation technologists, neither contact precautions nor antiseptic cleaning could totally eliminate all bacteria in the hospital [6,7]. A recent survey showed that within the first day of admission, 18% of those MRSA-infected inpatients would contaminate the ward with MRSA [8]. Nowadays, in order to minimize pathogen contamination during portable X-ray examination, disposable plastic bag covers were employed to cover the X-ray cassette to act as a barrier to prevent direct contact between the patient and the work surface (as in Hospital B). However, improper way of disposing of plastic bag cover may increase the risk of pathogen transmits onto the "clean" work surface.

Dancer [15] study suggested a standard to evaluate the hygiene of environmental objects. If MRSA and MSSA colony count was smaller than 1 colony per 1cm^2(or 100 per 100cm^2) and the total aerobic colony count was below 5 per cm^2 (or 500 per 100cm^2), the surface of an object can be regarded as hygienic [15]. In our present study, only three X-ray cassettes had isolated with MRSA, and the largest MRSA colony count was only 3 per 100cm^2. Similarly, the total microbial colony count on X-ray cassettes was generally little, except two swab samples had the colony count exceeding 300 per 100 cm^2, and another one exceeding 500 per cm^2.

MRSA on the X-ray cassette increases the risk of its spread in hospital setting, since it could survive on nearly all surfaces, including inanimate ones [9] and from the environmental surfaces to the radiology and nursing staff [10]. During portable X-ray examination, the X-ray cassette had made contact with the environmental objects. We observed the X-ray cassettes were being placed on tables, on the ground or even with the body contact of the radiation technologist during the portable X-ray examination. All these acts may directly or indirectly contaminate the X-ray cassettes with pathogens, especially if the environmental objects had already contaminated by pathogen-carrying patients [4,11]. Nevertheless, the MRSA contamination rate in our study was only 3.75%, which was far lower than a previous study reported by Kim et. al [12] (16.2%).

The two hospitals in the present study had adopted different infection control measures during portable X-ray examination. The radiation technologist in Hospital A wore gloves during portable X-ray examination. Additional preventive measures, including cleansing the X-ray cassettes, wearing surgical mask and changing gloves in between handling of patients, were performed in this hospital in order to further reduce the chance of pathogen contamination when handling with very ill patients. In Hospital B, the radiation technologist had used a plastic bag cover to protect X-ray cassette before and during examination. However, all these measures taken by radiation technologist cannot totally eliminate bacteria contamination.

The results of the present study were agreed with a systematic review of healthcare workers' knowledge about MRSA and/or frequency of cleaning practices, in which they concluded that the cleaning practices to ensure minimization of MRSA contamination of equipment by healthcare workers were generally insufficient and non-appropriate [13]. Indeed, neither contact precautions nor cleaning could get rid of all pathogens in the hospital setting [6,7]. With this in mind, it is a no wonder that radiographic equipment and accessories are at a high risk of being contaminated by MRSA, and potentially becomes microbial-contaminated fomites for transmission of MRSA.

A recent article has updated the National evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England [14]. This updated guideline emphasis the contamination prevention measures should be based on reliable evidence of efficacy, and combined with quality improvement methods. Concerning to the recommendation of these guidelines, the radiographic equipment and accessories should be cleaned and decontaminated after use with proper cleaning agents recommended by the manufacturer. Most significantly, all healthcare workers should be educated about the importance of maintaining a clean and safe care environment for patients, and recognize their specific responsibilities for cleaning and decontaminating their hand, the clinical environment and the equipment used in portable X-ray examinations [14]. Further improvement in the routine preventive measures against pathogen contamination is therefore suggested [5].

Conclusion

In conclusion, we found X-ray cassettes can be contaminated with MRSA during portable X-ray examination in the hospital setting. The direct contact with the radiation technologist and patient, and the indirect contact with the environment objects with X-ray cassette were the possible means for MRSA and other pathogen contamination during portable X-ray examination.

Acknowledgements

The authors would like to thank the two Radiology departments participated in this study. Special thanks are extended to Mr. Hami LAU for his technical support in the whole study. This research was funded by the FHSS research fund from the Hong Kong Polytechnic University.

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