Relationship between the Contamination of the Nurse’s Caps and Their Period of Use in Terms of Microorganism Numbers

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Nosocomial infections are a great problem in the health care facilities. The white uniforms of nurses are often washed to keep them clean, but the nurse’s caps are not washed as frequently in comparison. It could be that the importance of these caps is being overlooked. If these caps are providing a residence for microorganisms causing nosocomial infection in the health care facility, then they should be washed as frequently as the uniforms. So far, the relationship between the contamination of the nurse’s caps and nosocomial infection has not yet been studied. Therefore, this study was conducted to confirm if relationships exist among factors regarding the number of microorganisms on the nurse’s caps, the period in which caps were used without being washed, and the individual characteristics of nurse wearing the caps. Results showed that the degree of contamination of the nurse’s caps depended on individual characteristics and the period of use. Finally, results led to the conclusion that the nurse’s caps should not be worn if their only purpose is to symbolize female workers in the health care facilities because, in actually, they provide a resistance for microorganisms causing nosocomial infections.

Key words : Nurse’s cap/Nosocomial infection/Contamination/Period of use.

INTRODUCTION

Recently nosocomial infections are a great problem at the health care facilities (Noble and Somerville, 1974; Wenzel, 1985; Colins, 1988; Mayon-White et al., 1988; Wenzel 1991; Haley et al., 1992; Coates and Hutchinson, 1994; Philpott-Howard and Casewell, 1994; Mayhall 1996, Wenzel 1997, Barbeau et al., 1998; Weist et al., 2002; Alcon et al., 2003; Ruef, 2004). As microorganisms causing nosocomial infections, *Serratia* spp., *Pseudomonas* spp., *Burkholderia* spp., *Staphylococcus* spp., *Legionella* spp., *Mycobacterium* spp., *Bacillus* spp., *Clostridium* spp., MRSA, and VRE have often been discussed (Duboux et al., 2005; Cullen et al, 2005; Goenaga Sanchez et al., 2005; Trautmann et al., 2005; Moreira et al., 2005; Otaga et al., 2005; Allen and Griffith, 2005; Hsueh et al., 2005; Willems et al., 2005; Banning, 2005; Bissett, 2005; Exner et al., 2005; O’Neill and Humphreys, 2005; Duckro et al., 2005; Matsuki et al., 2005; Arrich et al., 2005; Ohangela et al., 2004; Pai et al., 2004; Conger et al., 2004; Kline et al., 2004; Wang et al., 2004; Tambyah et al., 2004; Axon et al., 2004; Shintani et al., 2004; Hernaiz et al., 2003; Moore et al., 2002; Barbeau et al., 1998; LaForce, 1997). Nosocomial infections are
speculated to be due to direct contamination via hands from health care employees to immunodeficient patients, but this has not been completely clarified yet.

We have studied airborne and surface microorganisms in the dialysis room of Namiki clinic at Nagoya, Japan and confirmed that the origins of these microorganisms were mostly from people including doctors, nurses, and patients (Miki, 2003a, Shintani et al., 2004).

White uniforms and preventive robes are so often washed to keep clean. However, compared with them the nurse's caps are not washed so frequently. In this respect, the degree to which the nurse's caps may be contaminated may be more than that of white uniforms, preventive robes and other protective clothings. There is a possibility that the nurse's caps may serve as an appropriate residence for microorganisms causing nosocomial infections. The relationship between the contamination of the nurse's caps and nosocomial infections has not been studied so far.

This study was conducted to clarify if there was any relationship between the microorganisms contaminating the nurse's caps and those causing nosocomial infections. If the result is positive, it is necessary to consider stopping or avoiding the use of the nurse's caps because they may provide residence for microorganisms causing nosocomial infections in the health care facilities. This experiment was carried out to clarify whether the nurse's caps provide residence for microorganisms causing nosocomial infections in the health care facilities.

**MATERIALS AND METHODS**

Ten caps from 10 female nurses working in the dialysis room at Namiki clinic in Nagoya, Japan were used. There were two periods in which the nurse's caps were worn. In one period, they were worn for one day and in the other, they were worn for 7 consecutive days only during working time. Outside of working time, 10 caps were kept individually in the clean boxes sterilized in advance to avoid any contamination. Each nurse individually wore two sorts of period of use of the nurse's caps to avoid variation in individual customs regarding the use of the nurse's caps.

The procedure to sample microorganisms on the surface of the nurse's caps were as follows using Petancheck™ 25 from Eiken Co., Ltd.: one nurse's cap was spread out and divided into three portions. A nurse's cap had 75cm² area as a whole. One portion was used for bacteria sampling using Petancheck™ 25 SCDL (SCDALP, Soybean casein digest agar lecithin polysorbate) with incubation for 5 consecutive days at 30°C. Another portion was for MRSA sampling using Petancheck™ 25 MRSA (Methicillin-resistant *Staphylococcus aureus*) with incubation for 5 consecutive days at 30°C. The last portion was used for sampling for fungi, yeast and mold using Petancheck™ 25 SAB (SDA, Sabouraud dextrose agar) with incubation for 7 consecutive days at 22°C. MRSA was also identified using Denka Seiken MRSA kit. Three portions from each nurse's cap were sampled for the respective microorganisms from 10 individual nurses (n=10).

The biochemical identification of the microorganisms was conducted with both API™ (Biologue Co. Ltd., Lion, France) and BBL Crystal™ (Becton Dickinson Co. Ltd, Loveton Circle, Md) (Miki et al., 2003a,b; Shintani et al., 2004). When both results indicated the same microorganism, the result was judged to be valid and otherwise defined to be invalid.

The number of colonies in the culture media were counted and expressed as CFU (colony forming unit).

**RESULTS AND DISCUSSION**

The generally known microorganisms associated with nosocomial infections have been reported in the paper (Barbeau et al., 1998).

The CFU results for SCDL, SAB and MRSA from the nurse's caps worn for one day by 10 individual nurses are presented in Figure 1. The results from the nurse's caps worn for 7 consecutive days are presented in Figure 2. In Figure 3, CFU of microorganisms from the nurse's caps after being worn for one day is compared with those after being worn for 7 consecutive days. Among the bacteria detected,
FIG. 2. The results for CFU in SCDL, SAB and MRSA after the nurse’s caps worn for 7 consecutive days of use.

FIG. 3. Comparison of detected colony numbers of bacteria.

There were spore formers (mainly Bacillus spp. and Clostridium spp.) and vegetative cells including MRSA. In Figure 4, results for CFU of spore formers from the nurse’s caps worn for one day are compared with those from the nurse’s caps worn for 7 consecutive days.

Statistically significant difference (p<0.05) can be observed between the results from the nurse’s caps worn for one day of use and from those worn for 7 consecutive days.

The types of surface microorganisms detected and identified were almost identical to those reported by the papers (Miki et al., 2003a; Shintani et al., 2004), indicating if the health care employees working in the health care room are almost identical, the types of environmental and surface microorganisms are also identical. These microorganisms were mostly Staphylococcus spp., Micrococcus spp., Bacillus spp., and Corynebacterium spp (Miki et al., 2003a; Shintani et al., 2004).

From the identification results, it can be said that microorganisms on the nurse’s caps worn for one day were mainly the vegetative cell types and the spore types were quite rare, if any were found at all (Figure 3).

The number of spore formers on the nurse’s caps worn for 7 consecutive days was significantly greater

Photo 1. The detection of MRSA by a slide latex agglutination assay.
than that on the nurse's caps worn for one day (Figures 3 and 4). This is because spore formers such as *Bacillus* spp. or *Clostridium* spp. can withstand and survive in situations in which there is a lack of nutrition. However, *Bacillus cereus* or *Clostridium difficile*, for example as spore formers in the health care facilities, must be completely sterilized to avoid nosocomial infectious diseases (Matsuki et al., 2005; Arrich et al., 2005; Changela et al., 2004; Hernaiz et al., 2004).

Several colonies grew in MRSA selective culture medium, but only 1 colony was identified to be exactly MRSA and others were not MRSA. This analysis was carried out simultaneously using the Denka Seiken MRSA kit and the Eiken MRSA selective medium procedure. Only one colony was positive in both procedures. The results from the MRSA kit procedure from the Denka Seiken are shown in Photo 1.

As shown in Figure 1, the number of colonies on the nurse’s caps differed depending on the characteristics of individual persons’ customs and habits. If the contamination of the nurse’s caps mainly originated from the environment in the form of airborne microorganisms, significant differences in numbers of microorganism on individual 10 nurse caps would not have been observed. However, it was observed significant difference individually.

The residual number of colonies after the nurse’s caps worn for 7 consecutive days in Figure 2 does not indicate the sum of colony numbers for 7 days, but only the residue after 7 days. Therefore, the residual colony number after 7 days was in appearance less than that from the nurse’s caps worn for one day (Figure 1 vs. Figure 2). The speculated reason why CFU from the nurse’s caps worn for 7 consecutive days was less than that from the nurse’s caps worn for one day is as follows. During wearing the nurse’s caps for 7 days, the residual microorganisms on the nurse’s caps may not survive due to starvation, change to the airborne microorganisms and so on. The CFU of spore formers such as *Bacillus* spp. or *Clostridium* spp. after 7 consecutive days of use was significantly greater than that after one day of use (p<0.05, Figure 4). It is also true that if the vegetative cells had received sufficient nutrition condition on the nurse’s caps, the number of vegetative cells after 7 consecutive days might have been greater than that after one day of use of the nurse’s caps.

In addition, the preservative, carboxyl methylcellulose (CMC) in a detergent may have inhibited growth of vegetative cells on the nurse’s caps used for 7 consecutive days. However, it is important to note that spore formers are tolerant to CMC, so any inhibition of spore formers by CMC has not been observed (Stewart and Leatherwood, 1974; Swintosky and Kaufman, 1955).

If part of the microorganisms remaining on the nurse’s caps were spore formers, they might have been changed from the vegetative cells to spores to survive for prolonged periods to withstand stresses, starvation and prevent growth inhibition by preservatives and disinfectants.

If the total colony number had been counted daily for 7 days and accumulated as a whole, the total colony numbers accumulated might have been significantly greater than those after one day of use, especially in case of vegetative cells. This speculation may be true regarding both vegetative cells and spore formers.

As shown in Figures 1 and 2, there exists a significant difference in the numbers of microorganisms depending on the individuals in both cases of the nurse’s caps being worn for one day of use as well as for 7 consecutive days of use. This may be due to difference of individual characteristics of nurses wearing the nurse’s caps. For example, nurse number 5 had a skin allergy, which caused significant amount of colonies as shown in Figure 1. Other nurses (numbers 7, 9 and 10) had long and not frequently washed hair and a habit of often touching their hair and their nurse’s caps, perhaps resulting in great amounts of CFU from their nurse caps (Figures 1 and 2). From these results, there is a possibility that nosocomial infections may be passed from the hands of health care employee to patients, and it may be possible that the nurse’s caps provide residence for environmental microorganisms causing nosocomial infectious disease.

All 10 nurses studied were working under the same circumstances in the same environmental situation. Therefore, if the environmental factors had been involved in a major way in the contamination of the nurse’s caps, there probably would not have been observed any significant differences in the types and counts of microorganisms among individual cases. However, there was in fact a significant difference in the variation of CFU depending on who was wearing the nurse’s caps (Figures 1 and 2). This can be explained from the difference in individual characteristics of the nurses who used the nurse’s caps rather than from the environmental factors. The individual characteristics might include, for example, how clean their hair was, how uncontaminated their skin was, how often they washed their hair and how frequently they touched their hair and their nurse’s caps. These mean that decreasing contamination and frequent washing of the nurse’s caps are important tasks to prevent nosocomial infection in health care facilities.
during nursing should be avoided and skin, hair and hands should be kept clean with running water or with soap to avoid contamination with microorganisms causing nosocomial infections. Frequent washing of hands with running water and soap is a simple thing to do, but the most effective procedure to prevent nosocomial infection in health care facilities. In addition, washing one’s hair and body with a hot bath on a daily basis is also an important task. These mean that humans are the major source for microorganisms causing nosocomial infections. Environmental microorganisms can find a most appropriate residence on human skin.

The wearing of the nurse’s caps is thought to be an unnecessary and even negative practice because they may serve as a residence for microorganisms causing nosocomial infections in the health care facilities. If it is deemed necessary to use the caps to protect patients from falling hair or skin flakes, the caps used by the health care personnel in the operating rooms might be more appropriate; otherwise, the wearing of the nurse’s caps is an unnecessary practice in the health care facilities. If the currently used nurse caps are only a symbol of female health care employees, it is totally unnecessary and should be taken off in the health care facility to avoid providing a residence for microorganisms causing nosocomial infectious disease in the health care facilities.

This paper supplies the scientific rationale for eliminating the practice of wearing the nurse’s caps in the health care facilities as has been done in Europe and USA.

REFERENCES


