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Wash basin drains as a Source of Pathogens and Infections: Prevention of Nosocomial Infections¹

Summary

Siphon traps under wash basins represent an open germ pool due to high levels of active bacteria in the barrier fluid and the distinct formation of biofilm. Based on the detection of germ emission on 106 basins at different wards of the Oberlausitz-Kliniken gGmbH in Bischofswerda, Germany, it was shown that germs are emitted as aerosols from the siphon traps into the ambient air during drainage of water. Siphon traps under wash basins are therefore "active" germ pools and potential sources of pathogens. It is to be investigated whether it is possible to prevent nosocomial infections by neutralizing the germ pool through continuous physical disinfection. The investigations are conducted during a 25-month to date trial at the interdisciplinary ICU of the Oberlausitz-Kliniken gGmbH in Bischofswerda, Germany. Statistics are maintained for 33 months at this ICU and the surveys of nosocomial infections are systematically conducted. In August 2002, all standard siphon traps under wash basins were replaced by BioRec® self-disinfecting siphons (BIOREC, Lauta-Dresden) for testing. Both pathogen statistics and surveys of nosocomial infections showed a distinct decrease of contaminated patients and the occurrence of nosocomial infections since the installation of test devices. Recent results show a renewed increase of the incident rate of nosocomial infections after removing the hygiene siphons and replacing them with standard siphon traps again. Thus it is shown that siphon traps under wash basins are sources of pathogens. The trials are to be continued. (Hyg Med 2004; 29 [12]: 451-455)

Introduction

For quite some time siphon traps under wash basins, bathtubs and showers have been considered reservoirs and potential sources for infection such as pseudomonas, for example (1, 2, 3, 4, 5, 6, 7, 8, 9, 10). Studies show that the barrier fluids in odor traps under wash basins in hospitals contain an average of 10^5 - 10^{10} CFU/ml. The siphon under the wash basin in the patient's room thus represents one of the largest pools of pathogens outside of and in immediate vicinity of the patient (10). Nutrient and oxygen supply as well as temperatures between 20°C and 40°C allow the formation of a biofilm and the rapid multiplication of micro-organisms in the barrier fluid. Different methods of typing have shown that patients have

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formation of a biofilm and the rapid multiplication of microorganisms in the barrier fluid. Different methods of typing have shown that patients have been contaminated with *P. Aeruginosa* from the siphon trap (1, 2, 8, 11). Döring et al. (10) found that the transmission of germs from the buffer fluid in the siphon trap onto the hands of the medical staff occurred at a bacterial count of $>10^5$ CFU/ml in the buffer fluid. *P. Aeruginosa*, which was transmitted from the siphon trap onto the hands of the medical staff remained up to 70 minutes on their hands and can therefore be transmitted alive onto the patient within this time frame. The intent of our research is the prevention of nosocomial infections from the trap. By sampling 106 basins under clinical conditions using the air sampler technology it was investigated whether the same germs are emitted from tap water in the siphon during the inflow. Furthermore it was investigated whether the number and spectrum of species of the emitted germs are in correlation with the germ content of the barrier fluid inside the siphons. The primary action of this potential issue is the formation of aerosols. Aerosols build up upon impact of fluid on the surface of the sealing fluid in the interior of the drain trap, whose individual droplets contain germs of the sealing fluid (9). Due to suppression of air above the sealing fluid these germ-containing aerosols are airborne around the basin and therefore contaminate hands and the surrounding air. By avoiding direct impact of the water jet into the drain, the formation of aerosols can probably be reduced but not eliminated. The frequency of occurrence of nosocomial infections were studied before and after the neutralization of the germ pool by the hygiene siphon BioRec®, in which the formation of a biofilm and thus the proliferation of microorganisms is suppressed by a combination of different disinfection mechanisms.

Materials and Methods

For the analysis of bacteria emissions from siphons an air sampler made by Klotz was used. The viable counts of germs in the air of the patient's room were quantified

- at 1.5 m distance from the basin,
- in the basin, 10 cm above the drain in non-operating state,
- in the basin, 10 cm above the drain during the drainage of water ,
- in the basin, 10 cm above the drain after the drainage of water.

To detect typical waterborne bacteria test plates containing MacConkey agar (from Heipha) were used. Prior to beginning the measurement samples were taken from the barrier fluid and the viable bacterial counts were semi-quantitatively determined via Cult-Dip Plus® immersion culture media (by Merck) .Through this experimental arrangement it was investigated whether germs are emitted from the siphon during the inflow of water into the siphon and whether the amount of emitted germs are in correlation to the viable count of germs in the buffer fluid (publication in preparation). The respective BioRec® self-disinfectant hygiene siphon is a fully automated, chemical and maintenance free device, whose effect consists of a novel combination of three different decontamination

and disinfection mechanisms: All germs in the barrier fluid are killed thermally at 85°C, while a vibration system and an antimicrobial coating of the inner wall are preventing the formation of a biofilm at the same time (10).

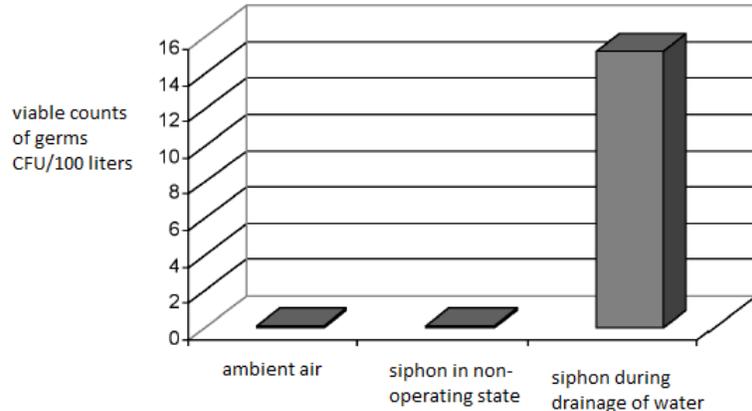


Figure 1: Germ counts of the air in the room and the air around the basin at non-operating state and at drainage of the water (average values from 18 individual studies with MacConkey agar)

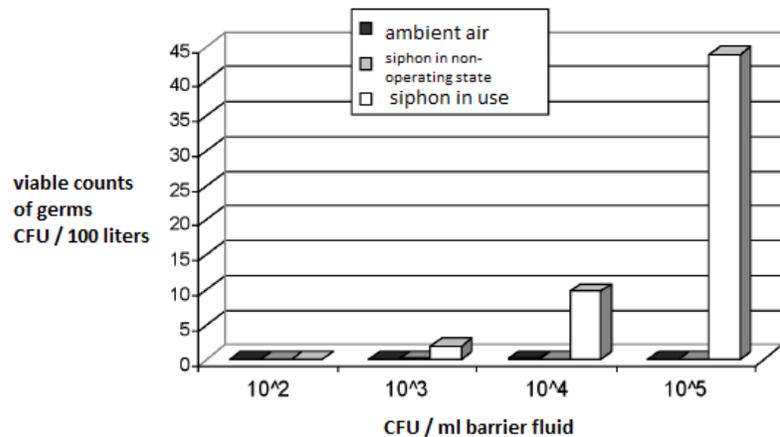


Figure 2: Emission of germs from the siphon trap depending on the viable count of bacteria in the barrier fluid of the siphon.

Results

Emission of germs from siphon trap

The viable counts of typical waterborne bacteria in the air of the examined patients' rooms are on average small (0.5-1KBE / 100 liters of air) around the wash basin. In the immediate vicinity of the siphon the viable counts are also at 0.5-1KBE / 100 liters of air with the siphon at non-operating state. The content of typical waterborne bacteria in the air surrounding the wash basin increases if the faucet is opened and the water drains from the basin through the

siphon. The results illustrated in Figure 1 show a massive, 30 to 50 fold increase in counts of typical waterborne bacteria in the air surrounding the wash basin during the drainage of water. This shows that germs are emitted from the siphon into the air during the use of the basin. Samples were taken from the sterile barrier fluid in the siphon traps and the viable bacterial counts were determined prior to measuring with the air sampler. It was found that the amount of waterborne bacteria which was emitted upon usage depends on the viable count of waterborne germs in the barrier fluid of the respective siphon trap (Fig. 2). During the 25 months to date of trials germ counts of 0 up to a maximum of 10^3 CFU/ml were measured in BioRec® self-disinfecting siphon traps. An emission of germs from the siphons with viable counts of 10^5 or more per ml of buffer fluid was detected for this germ density between 0% up to a maximum of 15% of the emission.

Nosocomial Infections

Over a period of 33 months the frequency of occurrence of nosocomial infections per patient group (incidence rate) or per patient day (incidence density) was recorded in the clinical trial. Between January 2002 and August 2002 both incidence rates and incidence densities of nosocomial infections showed strong fluctuations during the utilization of standard siphons. Maximum values occurred in the summer months of June to September. All standard siphons were replaced by BioRec® self-disinfectant hygiene siphons in the eighth month of trials (August 2002). All other hygiene policies at the ward remained the same throughout the trial period. After installation of the disinfection apparatus (Fig. 3, arrow down) in August 2002 a reduction in the incidence rates was significant. In particular, the seasonal summer peaks from May to September did not occur anymore.

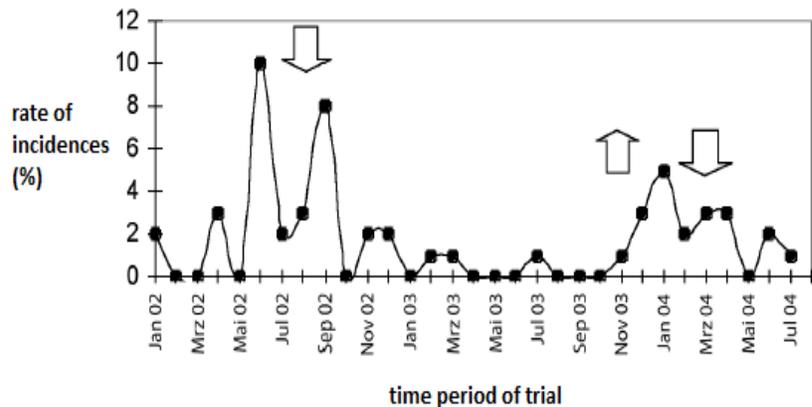


Figure 3: Process of the incidence rate of nosocomial infections in investigated ICUs depending on the exclusion of the germ pool siphon by the installation of BioRec® self-disinfectant hygiene siphon.

Arrow down: Installation of test equipment in August 2002

Arrow up: expansion of the test equipment in November 2003

Arrow down: replacement in March 2004

After removing the self-disinfecting hygiene siphons (Fig. 3, arrow up) in November 2003 the incidence rates of nosocomial infections increased again. In March 2004 the BioRec® test equipment was taken back into operation (Fig. 3, arrow down). In the further course a reduction in the incidence of nosocomial infections was reported.

Discussion

After Sissoko et al. (10) was first able to show in 2004 that the removal of the germ pool siphon at a multidisciplinary ICU led to a decrease of infection rates and a reduction of incidence rates and incidence density of nosocomial infections, the continuation of the trials showed that the re-installation of standard siphons instead of BioRec® self-disinfecting hygiene siphons resulted in a renewed increase of nosocomial infections (Fig. 4). Microbiological studies on the emission of germs from siphon traps (Fig. 1 and 2) showed that standard siphons form active bacterial pools from which germs emerge during the washing process. The content of typical waterborne germs in the air surrounding the basin during use of the siphon is increased by approximately 30 to 40 times compared to the content of germs in the ambient air and the air around the basin in non-operating state. A positive correlation was found between the viable count of typical waterborne bacteria in the barrier fluid of the siphon and the number of germs emitted from these respective siphons. It was shown that higher numbers of germs are emitted from the barrier fluid of siphons with greater viable counts of germs. The higher the microbial contamination of the barrier fluid of the siphon, the more germs are released into the ambient air through formation of aerosols during the use of the siphon (Fig. 2). These results confirm Döring's et al. (9) report from 1991 about *P. Aeruginosa*, which found that a minimal microbial contamination of the barrier fluid of the siphon ($\text{LGC } 10^5 \text{ CFU/ml}$) is necessary for an effective transfer of germs from the barrier fluid to the hands of the medical staff. The current results of microbiological trials provide the scientific base for evaluating the hygienic efficiency of the respective BioRec® self-disinfecting hygiene siphons in hospitals. The testing of these devices, which were neutralized by the use of the siphon as an active bacterial pool, revealed during the 25 months to date of trials a significant hygienic relevance for the incidence of nosocomial infections in an interdisciplinary ICU. The replacement of the usual standard siphons for the BioRec® self-disinfecting hygiene siphons resulted in a decline of contaminated patients. Incidence rates and incidence density of nosocomial infections were as well greatly reduced by using the test devices (10). Since the trials in an ICU without direct contact of the patient to the basin show very strong evidence for the possibility of reducing the occurrence of nosocomial infections by neutralizing the siphon as a source of germs, it is likely that this influence can be even more established in wards with immunocompromised patients who wash themselves and thus have direct contact to the wash basin. The trials are to be continued.

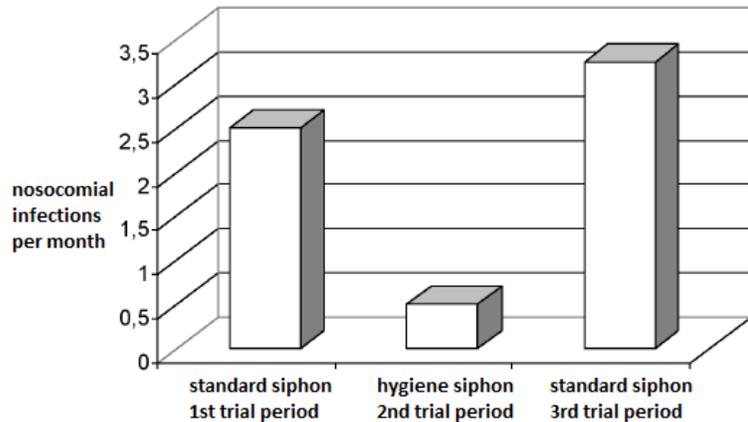


Figure 4: Occurrence of nosocomial infections (count per month) in different sections of the trial with standard siphons (1st and 3rd trial period) and with the BioRec® hygiene siphon (2nd trial period).

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