Keywords
Liquid soap
Liquid soap dispenser
Reprocessing
Hand hygiene
Hospitals
Contamination

Sabine Gleich[1]*, Christiane Vieweg[2], Heike von Baum[2]

1 Referat für Gesundheit und Umwelt, Hauptabteilung Gesundheitsschutz, Abteilung Hygiene und Umweltmedizin Landeshauptstadt München, Bayerstr. 28a, 80335 München
2 Sektion Klinikhygiene, Institut für Medizinische Mikrobiologie und Hygiene, Universitätsklinikum Ulm, Albert-Einstein-Allee 23, 89081 Ulm

Investigation of microbiological contamination of liquid soap dispensers from different risk areas of a university hospital

Summary

Background: The German Commission for Hospital Hygiene and Infection Prevention (KRINKO) and the German Society for Hospital Hygiene (DGKH) published requirements for the maintenance of disinfectant and soap dispensers in hospitals. Soap dispensers should be regularly processed. In view of the large number of soap dispensers in hospitals, this requirement presents a logistical and financial challenge.

Methods: A total of 100 soap dispensers in different risk areas of our university hospital were randomly selected. We sampled the nozzle surfaces of the dispensers as well as the liquid soap. The nozzle was sampled using a sterile swab, and one portion of liquid soap each was aseptically collected in a sterile container and a suitable inactivation solution was added. All samples were processed directly after sampling.

Results: Cultures from the swabs of the dispenser nozzles yielded no bacterial growth. Contamination with a maximum of two CFUs/sample was shown in 10 % of the liquid soap samples and consisted of typical environmental species. *Staphylococcus aureus* or gram-negative rods could not be detected.

Conclusion: For wall-mounted liquid soap dispensers in hospitals, which are regularly cleaned with disinfectants further recommendations for maintenance should be evaluated. In departments with outbreaks caused by gram-negative bacteria such as *Acinetobacter baumannii*, *Serratia marcescens* or *Pseudomonas aeruginosa*, liquid soap dispensers might be considered, however, if looking for a possible source of the outbreak. Several publications of outbreaks due to contaminated hand washing lotions/liquid soaps are cited. The results and conclusions of these studies are not readily comparable with conditions, procedures and recommendations in German hospitals.

Hyg Med 2015; 40 [6]: 236–241.

Introduction

The German Commission for Hospital Hygiene and Infection Prevention (KRINKO) at the Robert Koch Institute (RKI) advocates the following in Chapter 8 of its Hand Hygiene Recommendation: *"Liquid soap, disinfectant and hand towel dispensers must be easy to clean and disinfect. Liquid soap dispensers must be thoroughly cleaned with hot water, removing all deposits, and then disinfected before being replenished"* [1].

The German Society for Hospital Hygiene (DGKH) published in 2011 a recommendation compiled by Assadian et al. on the requirements addressed to soap and hand disinfectant dispensers in hospitals, stating: *"The dispensers as well as all permanent components should be able to have to tolerate automated thermal reprocessing while assuring an A0 value of at least 60 (e.g. 80 °C/1 min)"* [2].

In view of the large number of wall-mounted soap dispensers installed in hospitals implementation of that requirement presents a logistical and financial challenge even bearing in mind that, while embracing the motto "clean dispensers"

***Corresponding author**
Dr. med. Sabine Gleich
Referat für Gesundheit und Umwelt
Hauptabteilung Gesundheitsschutz
Abteilung Hygiene und Umweltmedizin
Landeshauptstadt München
Bayerstr. 28a
80335 München
E-Mail: sabine.gleich@muenchen.de

similar to the clean hands campaign, the leading manufacturers of soap dispensers and of reprocessing equipment have jointly developed an automated cleaning programme to that effect. In 2013 Trautmann et al. published an article on the practical problems encountered and on the results achieved at a tertiary care hospital [3].

The University Hospital where the following investigations were carried out is a tertiary care hospital with 1100 beds. It has installed over 4000 wall-mounted hand disinfectant and liquid soap dispensers. At present the liquid soap dispensers are not fully reprocessed because of this large number of dispensers and (scarcity of) human resources available to hospital's services' company. However, the wall-mounted dispensers and readily accessible components are regularly cleaned with a disinfectant. The hospital uses mainly liquid soap (wash lotion) from one single manufacturer. In accordance with the manufacturer's instructions the container is replaced only once its contents have been fully consumed.

As part of a curricular advanced training project in Hospital hygiene it was planned to take 100 samples from the dispenser nozzles and liquid soap from hospital areas with different levels of risk and test them for growth of pathogenic bacteria. These areas were subject to different risks, and the period of time since the dispenser was replenished with liquid soap varied from one dispenser to another. The aim was following evaluation of the results to review if there was any evidence to support when and whether deviation from the aforementioned recommendations in clinical routine operations could be justified.

Materials and Methods

In our university hospital the liquid soap is dispensed from wall-mounted Euro dispensers by means of an arm-activated lever. The amount of liquid soap dispensed per stroke is 2 ml.

Validation of the neutralizer solution

Since the preservatives contained in the liquid soap are able to inhibit bacterial growth a suitable neutralizer solution (NS) was first of all prepared to neutralize the preservative effect.

The manufacturer revealed upon request the combination of inactivation substances needed to neutralize the preservatives contained in the liquid soap. The solvent recommended was demineralized water. Accordingly, a neutralizer solution composed of 3 % Tween, 0.3 % lecithin, 3 % saponin, 0.1 % histidine and 0.5 % sodium thiosulphate was prepared in demineralized water. The demineralized water / neutralizer solution was validated as a single and a double concentrate, while preparing the following solutions:

Solution A: one portion liquid soap in 50 ml sterile water plus 50 ml sterile single concentrate of demineralized water / neutralizer solution

Solution B: one portion liquid soap in 50 ml sterile water plus 50 ml sterile double concentrate of demineralized water / neutralizer solution

The solutions were brought to suspension by stirring for 30 min.

The reference samples (positive controls) were prepared in each case from *Escherichia coli* (ATCC 25922) and *Pseudomonas aeruginosa* (ATCC 23853), with each bacterial suspension containing a microbial count of 10^6/ml with respect to the optical density as per the McFarland standard 0.5. In each case 500 µl aliquots of this bacterial suspension were mixed with sterile solutions A and B and designated as controls A and B.

100 ml aliquots of the samples were passed through a bacterial filter with pore size 0.45 µm. The filter was transferred to a blood agar plate (trypticase soy agar with 5 % sheep blood) and incubated for 48 h at 37 °C. After 24 and 48 h ± 4 h the number of colony forming units (cfus) on the plates was determined.

Validation revealed that the neutralizer solution used was effective: whereas no bacterial growth was detected in the uninoculated solutions, a microbial count of more than 10^6 cfu was determined for the inoculated controls (Table 1).

Table 1: Test batches for validation of the neutralizer solution (cfus = colony forming units).

Test batch	Number of cfus after 24 h incubation	Number of cfus after 48 h incubation
Solution A	No growth	No growth
Solution B	No growth	No growth
Control A	> 10^6 cfu	> 10^6 cfu
Control B	> 10^6 cfu	> 10^6 cfu

Selection of the sampling points

The sampling points within the hospital were selected during an initial inspection. Any dispensers with noticeably dusty surfaces and soiled dispenser nozzles were recorded in the sampling protocol and photographed. Whether the soap solution had a brownish colour and the type of dispenser were also documented in the protocol. Dispenser type 1 had a flat nozzle, while the dispenser nozzle of dispenser type 2 consisted of a metal spike (Figures 1 and 2).

Based on Table 6 "*Classification of measures /patients in terms of infection risk*" of the KRINKO Recommendation regarding the personnel and organizational requirements for prevention of healthcare-associated (nosocomial) infections, 100 sampling points were selected within the hospital and classified as areas with high, moderate or low risk (Table 2) [4].

Sampling procedure

First of all a sample was taken with a sterile swab (COPAN Transystem culture swab transport system, Firma Copan Italia) from the dispenser nozzle. Then the liquid soap sample dispensed with the first stroke was discarded and that obtained with the second stroke was collected in a sterile sampling vessel. The samples were then immediately processed at the infection control laboratory of the Hospital Hygiene Section in a Heraeus Lamin Air HLB 2448 safety workbench.

Definitive test batch

For each sample of the definitive test batch one portion of liquid soap was suspended in 50 ml sterile water plus 50 ml sterile demineralized water / neutralizer solution, single concentrate. For the reference samples (positive controls) 200 µl aliquots of bacterial suspension made from E. coli (ATCC 25922) and *P. aeruginosa* (ATCC 23853) with a microbial count of 10^6/ ml

Table 2: Specification of risk areas for sampling.

Risk areas	High risk areas – Hematology-oncology with immunosuppressed patients – Intensive care unit – OP area	Moderate risk areas – IMC ward – Interventional radiology – Dialysis – Outpatient invasive diagnostics (endoscopy, bronchoscopy)	Low ris areas – Day clinics – Outpatients dept. – Internal medicine – Non patient areas (discharge rooms, kitchen, bed decontamination, staff recreation and changing rooms, visitor toilets)
Number of sampling sites	23	29	48
Dispenser nozzle	9 × dispenser type 1 14 × dispenser type 2	7 × dispenser type 1 22 × dispenser type 2	17 × dispenser type 1 31 × dispenser type 2

with respect to the optical density as per the McFarland standard 0.5 were added to each reference sample.

100 ml aliquots of the test batch samples were passed through a bacterial filter with pore size 0.45 µm and the filter transferred to a blood agar plate and incubated for 48 h at 37 °C. The number of cfus on the plates was determined after 24 and 48 h ± 4 h.

The reference swabs were immersed in the bacterial suspension that had been prepared as described above and plated onto blood agar plate using a three-eyelet smear procedure, and then incubated for 48 h at 37 °C. The number of cfus on the plates was determined after 24 and 48 h ± 4 h. Where cfus were detected after 24 h or 48 h subcultures were grown on blood agar plates and MacConkey plates and incubated for 24 h at 37 °C to identify the implicated bacteria.

Results

The swab test results revealed that none of the dispenser nozzles was contaminated – despite on average one quarter of these having a soiled appearance throughout the hospital (Table 3).

It was mainly liquid soap samples from dispenser type 2 which were contaminated. That dispenser type was the most commonly used in all areas of the hospital with different levels of risk.

The time since the various liquid soap solutions were first used in the hospital after replenishing the respective dispenser ranged from two to 224 days, with a median value of 61 days. No correlation was identified between that period of time and degree of contamination in the various risk areas. The respective time periods in the different risk areas was 44 (high risk), 39 (moderate risk) and 64 days (low risk) with a range of 2–201, 6–157 and 4–224 days. However, when interpreting the data it should be borne in mind that the date of initial use was not given for all the sample dispensers in the risk areas investigated. That was missing in 26 % (high risk), 21 % (moderate risk) and 15 % (low risk) of cases.

In total 10 % of the liquid soap samples tested revealed non-significant contamination of maximum two cfus per sample with environmental bacteria (coagulase-negative staphylococci, micrococci, sporulating aerobes). The bacterial contamination detected was in the following risk areas: high risk 0.2 %, moderate risk 14 % and low risk 10 %.

Almost 10 % of dispensers had dusty surfaces but did not differ between the various risk areas. 3 % of the liquid soap samples also revealed optical discoloration. But this was not observed in the high risk areas.

Diskussion

We carried out spot checks of the dispenser nozzles and liquid soap solution, from one single manufacturer, from all risk areas of a tertiary care hospital to establish whether they harboured contamination of clinical relevance. The dispensers investigated had not been fully reprocessed as per the KRINKO and DGKH recommendations each time they were replenished. Instead, the wall-mounted dispensers and the parts thereof that could be accessed without dismantling had been regularly cleaned with a disinfectant and the liquid soap used in accordance with the manufacturer's instructions with no limit set on that period of use.

The investigations did not find any evidence of systemic contamination of the liquid soap with pathogenic bacteria. That was true for the three different risk areas as well as for infrequently used dispensers. No significant difference was identified between the various dispenser systems. Nor did the extent of visual contamination of the nozzles

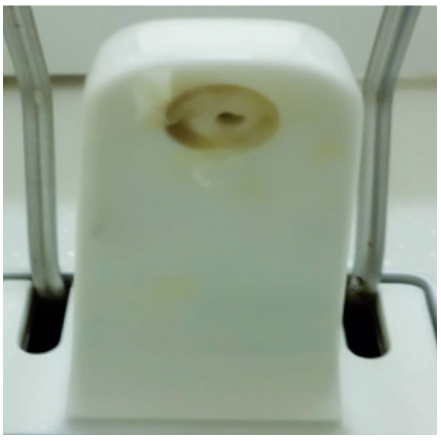

Figure 1: Dispenser type 1 with soiled nozzle .

Figure 2: Dispenser type 2 with soiled nozzle .

Table 3: Results of swab and liquid soap tests (CNS= coagulase negative staphylococci).

	High risk areas	Moderate risk areas	Low risk areas	Overall evaluation
Swabs from dispenser nozzles				
Number of swabs	23	29	48	100 (100 %)
Number (of swabs) microbially contaminated	0 (0 %)	0 (0 %)	0 (0 %)	0 (0 %)
Liquid soap samples				
Number of liquid soap samples tested	23 (100 %)	29 (100 %)	48 (100 %)	100 (100 %)
Dispenser types *Dispenser type 1* *Dispenser type 2*	 3 (13 %) 20 (87 %)	 8 (28 %) 21 (72 %)	 17 (35 %) 31 (65 %)	 28 (28 %) 72 (72 %)
Number of microbially contaminated liquid soap sample *Dispenser type 1* *Dispenser type 2*	1 (0,2 %) 0 1	4 (14 %) 1 3	5 (10 %) 2 3	10 (10 %) 3 7
Bacterial species detected	CNS	Micrococci Sporulating aerobes	CNS Micrococci Sporulating aerobes	CNS Micrococci Sporulating aerobes
Maximum number cfu per sample	1	2	2	2
Time in days between initial use and sampling *Median* *Mean value* *Range*	 44 100 2–201	 39 55 6–157	 64 82 4–224	 61 79 2–224
Date of initial use of liquid soap not documented	6 (26 %)	6 (21 %)	7 (15 %)	19 (19 %)
Dusty dispenser surfaces	2 (9 %)	2 (7 %)	5 (10 %)	9 (9 %)
Soiled nozzle	5 (22 %)	9 (31 %)	12 (25 %)	26 (26 %)
Discoloured soap solution *Dispenser type 1* *Dispenser type 2*	0 (0 %) 0 0	1 (0.3 %) 0 1	2 (4 %) 1 1	3 (3 %) 1 2

or brown discoloration of the liquid soap have any impact on the results.

Analysis of the time periods since the liquid soap was first used highlighted the need to install hand washbasins or commercial liquid soap dispensers only in those hospital areas where needed and hence also used [5].

The microbial contamination detected in a number of the liquid soap samples involved bacteria from the immediate environment. Similar findings following microbiology testing of commercial disinfectant dispensers were recently published by Schulz-Stübner [6].

Even though the test results based on a single type of liquid soap as presented here give only a snapshot of the overall situation and may not be applicable in all respects to other hospitals, the authors believe that in view of these findings and the immense logistical and financial challenges implied it is reasonable in justified cases to omit routine reprocessing and microbiology testing of liquid soap dispensers as stipulated by the recommendations cited above. That view is supported by the fact that where the aforementioned reprocessing recommendations are implemented there is (still) a risk of secondary contamination from manipulation of the dispensers or from rinsing with bacterially colonized tap water.

The following prerequisites should be met before engaging in any debate about dispensing with the above cited (more elaborate) recommendations:

- Regular cleaning with a disinfectant of the external surfaces and all readily accessible parts of the wall-mounted liquid soap dispenser
- A well-established surveillance system of healthcare-associated infections for early detection of any outbreaks with gram-negative bacteria such as *Acinetobacter baumannii*, *Serratia marcescens* or *Pseudomonas aeruginosa*. As part of the outbreak management policy the search for the source of the outbreak must include microbiology testing of the liquid soap solutions.

Since liquid soap dispensers harbouring gram-negative bacteria may be implicated in outbreaks a search of the literature was carried out in the database PubMed [http://www.ncbi.nlm.nih.gov/pubmed] and the Outbreak Database [http://www.outbreak-database.com] within the framework of a project conducted by the Institute of Hygiene and Environmental Medicine of the Charite Hospital. The search terms "hand washing lotion", "bacterial contamination" and "outbreak" came up with the findings illustrated in Table 4.

As can be inferred from the remarks not all the studies cited referred to medical institutions [7, 8]. Open refillable dispenser systems [7–9] or open soap bottles had been used in the patient rooms [11]. From the cited literature sources it can be concluded that the alcohol-based products used for hand disinfection had not been used routinely prior to the cited outbreak or were only introduced at the time of the outbreak [9–11]. Nor did the hand washbasin facilities meet the valid German standards [5].

Table 4: Results of literature search.

Lead author	Title of publication	Area, country	Remarks
Lorenz [7]	Evaluation and remediation of bulk soap dispensers for biofilm	Public toilets, USA	Open refillable soap dispenser system
Zapka [8]	Bacterial Hand Contamination and Transfer after Use of Contaminated Bulk-Soap-Refilled Dispensers	Primary school study among pupils and teachers, USA	Open refillable soap dispenser systems vs closed soap dispenser systems artificially contaminated with *Serratia marcescens*
Buffet-Bataillon [9]	Outbreak of *Serratia marcescens* in a neonatal intensive care unit: contaminated unmedicated liquid soap and risk factors	Neonatology intensive care unit, France	Open refillable soap dispenser system; in outbreak setting changeover to closed soap dispenser systems and alcohol-based hand disinfection
Lanini [10]	Molecular Epidemiology of a *Pseudomonas aeruginosa* Hospital Outbreak driven by a Contaminated Desinfectant-Soap Dispenser	Haematology, Italy	Open refillable soap dispenser system operated only by manual contact, use of Triclosan
Rabier [11]	Hand washing soap as a source of neonatal *Serratia marcescens* outbreak	Neonatology intensive care unit, France	Open soap bottles left in patient rooms, in outbreak setting changeover to closed dispenser systems and training in the use of alcohol-based hand disinfection
Klausner [12]	Outbreak of *Stenotrophomonas maltophilia* bacteremia among patients undergoing bone marrow transpalantation: association with faulty replacement of handwashing soap	Bone marrow transplant, USA	Use of moisturizer instead of handwashing when caring for ventilated patients, no alcohol-based hand disinfection

In summary the publications identified in the literature search either did not relate to medical establishments or their general conditions cannot be extrapolated to German settings: in Germany hand washing lotions / liquid soaps are in principle dispensed from closed Euro dispensers. Alcohol-based disinfection is the standard.

Schlussfolgerung

The general requirement that the non-readily accessible components of wall-mounted liquid soap dispensers be routinely reprocessed in hospitals should be evaluated in the light of the findings of our pilot project. However, in the event of outbreaks with gram-negative bacteria the dispenser system and liquid soap used should be included in the scope of environmental testing set out in the outbreak management policy.

Acknowledgements

Thank you very much to the entire team of the Clinic Hygiene Section for the excellent cooperation and to Gabi Kupke, Wolfgang Hänle and Ali Riza Durmus for the energetic support during sampling.

Conflict of interest

The authors declare that they have no conflict of interests as understood by the guidelines of the International Committee of Medical Journal Editors.

References

1. Kommission für Krankenhaushygiene und Infektionsprävention (KRINKO) am Robert Koch-Institut (RKI). Händehygiene. Bundesgesundheitsbl Gesundheitsforsch Gesundheitsschutz 2000;43:230–233. http://www.rki.de/DE/Content/Infekt/Krankenhaushygiene/Kommission/Downloads/Haendehyg_Rili.pdf?__blob=publicationFile (Letzter Abruf 21.5.2015).
2. Assadian O, Kramer A, Christiansen B, Exner M, Martiny H, Sorger A, Suchomel M. Empfehlungen zu Anforderungen an Seife- und Händedesinfektionsmittelspender in Einrichtungen des Gesundheitswesens. HygMed 2011;36:407–408. http://www.krankenhaushygiene.de/pdfdata/hm/HM_10_2011_spender.pdf (Letzter Abruf 21.5.2015).
3. Trautmann M, Palle N, Bobic R. Loh U, Radke E. Standardisierte Aufbereitung von wandmontierten Dosierspendern: Vorstellung eines neuen maschinellen Prozesses. Abstractband 10. Ulmer Symposium Krankenhausinfektionen 2013, S. 60, V–118.
4. Kommission für Krankenhaushygiene und Infektionsprävention (KRINKO) beim Robert Koch-Institut (RKI). Personelle und organisatorische Voraussetzungen zur Prävention nosokomialer Infektionen. Bundesgesundheitsbl 2009 52;52:951–962. http://www.rki.de/DE/Content/Infekt/Krankenhaushygiene/Kommission/Downloads/Rili_Hygmanagement.html (Letzter Abruf 21.5.2015).
5. Technische Regel für Biologische Arbeitsstoffe 250 (TRBA 250). Ausgabe: März 2014. GMBl. 2014 Nr. 10/11 vom 27. März 2014, S. 206. 1. Änderung: GMBl. Nr. 25 vom 22.05.2014, S. 535. http://www.baua.de/de/Themen-von-A-Z/Biologische-Arbeitsstoffe/TRBA/TRBA-250.html (Letzter Abruf 21.5.15).
6. Schulz-Stübner S, Zimmer P, Leonards P, Schaumann R. Ergebnisse der mikrobiologischen Überprüfung von Händedesinfektionsmittelspendern im Alltag. HygMed 2014; 39: 226–230.
7. Lorenz LA, Ramsay BD, Goeres DM, Fields MW, Zapka CA, Macinga DR. Evaluation and remediation of bulk soap dispensers for biofilm. Biofouling 2012;28:99–109.
8. Zapka CA, Campbell EJ, Maxwell SL et al. Bacterial Hand Contamination and Transfer after Use of Contaminated Buk-Soap-Refilled Dispensers. Appl Envir Microbiol 2011;45:2898–2904.
9. Buffet-Bataillon, Rabier V, Betremieux P et al. Outbreak of *Serratia marcescens* in a neonatal intensive care unit: contaminated unmedicated liquid soap and risk factor. J Hosp Infect. 2009; 72:17–22.
10. Lanini S, Darezzo S, Puro V et al. Molecular Epidemiology of a *Pseudomonas aeruginosa* Hospital Outbreak driven by a Contaminated Desinfectant-Soap Dispenser. PloSone 2011;6(2).e17064.
11. Rabier V, Bataillon S, Jolivet-Gougeon A et al. Hand washing soap as a source of neonata *Serratia marcescens* outbreak. Acta Paediatr. 2008; 97:1381–1385.
12. Klausner JD, Zukerman C, Limaye AP, Corey L. Outbreak of *Stenotrophomonas maltophilia* bacteremia among patients undergoing bone marrow transplantation: association with faulty replacement of handwashing soap. Infect Control Hosp Epidemiol. 1999;20:756–8.