

Divergent opinions on surface disinfection: myths or prevention? A review of the literature

Die Auseinandersetzung zur Flächendesinfektion: Mythos oder Prävention? Ein Rückblick auf ein Lehrstück

Abstract

Virtually no prevention strategy in hospital hygiene has been the focus of such frequent controversial discussions as the role of surface disinfection. Set against that background, the Commission for Hospital Hygiene and Infection Prevention at the Robert Koch Institute founded a working group comprising members with divergent views of risk evaluation as regards the role of disinfection. This working group produced a most carefully drafted guideline on how to deal with various risk areas and also incorporated a new provision into the guideline, stating that: *“Cleaning and disinfection procedures must be organized and implemented such that there is no increase in the microbial load or spread of facultatively pathogenic or pathogenic microorganisms on surfaces.”* Numerous studies have come to the conclusion that surface disinfection constitutes a basic infection control measure with which the spread of pathogens can be controlled. Conversely, when using only detergents such a form of control is not possible, something that must be taken into account in future when engaging in risk evaluation and formulating infection control measures. In view of the burgeoning trend in, for example, norovirus outbreaks, also in hospitals and nursing homes, such insights are of paramount importance and attest to the need for disinfection of surfaces and of areas with frequent hand and skin contacts. This discussion about the need for surface disinfection has, in addition to causing confusion among users, led to a decline in the willingness to accept hygienic practices, thus increasing the risk of occurrence of nosocomial infections as well as of antibiotic-resistant microorganisms.

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Zusammenfassung

Kaum eine Präventionsstrategie in der Krankenhaushygiene war so häufig Gegenstand kontroverser Diskussionen wie die Bedeutung der Flächendesinfektion. Vor diesem Hintergrund wurde seitens der Kommission für Krankenhaushygiene und Infektionsprävention beim Robert-Koch-Institut eine Arbeitsgruppe gebildet, die die Vertreter der unterschiedlichen Auffassungen zur Risikobewertung der Bedeutung der Desinfektion einschloss. Das Ergebnis war eine äußerst sorgfältig erarbeitete Verhaltensrichtlinie für unterschiedliche Risikobereiche wie eine neue Anforderung in der Richtlinie, *„dass Reinigungs- und Desinfektionsverfahren so organisiert und durchgeführt sein müssen, dass es nicht zu einer Erhöhung der Keimzahl und zu einem Verteilen fakultativ-pathogener oder pathogener Mikroorganismen auf der Fläche kommt.“* Zahlreiche Untersuchungen kommen zu der Schlussfolgerung, dass die Oberflächendesinfektion eine Basishygienemaßnahme ist, durch die die Ausbreitung von Krankheitserregern kontrolliert werden kann. Eine derartige Kontrolle ist hingegen durch Anwendung von Detergenzien alleine nicht möglich, was zukünftig bei der Risikobeurteilung und bei der Entwicklung von Hygienemaßnahmen berücksichtigt werden muss. Vor dem Hintergrund z.B. der Zunahme von Norovirus-Ausbrüchen auch in Krankenhäusern und Pflegeheimen sind derartige Erkenntnisse von

außerordentlicher Bedeutung und zeigen die Notwendigkeit, Desinfektionsverfahren zur Behandlung von Flächen und häufigen Hand- und Hautkontakten einzusetzen. Es ist festzustellen, dass die Diskussion um die Sinnhaftigkeit der Flächendesinfektion neben einer Verunsicherung der Anwender zu einer fehlenden Akzeptanz der Hygiene geführt und das Risiko für das Auftreten nosokomialer Infektionen wie die Zunahme antibiotikaresistenter Mikroorganismen erhöht hat.

Introduction

Virtually no prevention strategy in hospital hygiene has been the focus of such frequent controversial discussions as the role of surface disinfection. An argument put forward against routine surface disinfection claims that surface disinfection

- has no implications as far as the rate of hospital infections is concerned
- gives rise to disinfectant allergies among patients and staff
- environmental pollutants (negative effects on waste water) mediated by disinfectants must be borne in mind
- there is a risk of resistance development among nosocomial pathogens
- the increased costs must be taken into account [1], [9].

Surface disinfection has been deemed to be an inadvisable measure by various German-language publications when used for routine disinfection of the floor and of surfaces close to the patient, for routine disinfection in sanitary areas as well of bathtubs and washbasins and for routine disinfection of bed frames and mattresses when they were occupied by non-infectious patients, and its efficacy as a prevention strategy has been questioned in the case of immunosuppressed patients [9]. Routine surface disinfection has been viewed as superfluous and as an irresponsible waste. After all, the Environmental Prize 2000, valued at 500,000.- DM (German marks) was awarded to Prof. Daschner by the Federal German President. This award was explained as follows: "In several publications that have been applauded in myriad scientific circles he was able to demonstrate that it is possible to reduce the consumption of pollutant substances, e.g. detergent and disinfectant chemicals, drugs and antibiotics without disregarding the required hygiene standard, while at the same time reducing hospital operating costs." These topics and viewpoints gave rise to a common statement on surface disinfection being issued by the specialist societies responsible for infection control, science and medicine, which pointed out that there was a risk of an increase in antibiotic-resistant microorganisms, in particular of MRSA, while on the other hand jeopardizing the high standard of hospital hygiene achieved to date, by routine use of surface disinfection [13].

This discussion created much confusion and, in some cases, led to a marked reduction in detergent and disinfection procedures, with overall unfavorable implications

for acceptance of infection control recommendations being expected.

In line with the warnings issued by the specialist societies responsible for infection control, science and medicine, the European Antibiotic Resistance Surveillance Study (EARSS) noted that among all European countries, Germany and Austria had the highest increase in MRSA rates between 1999 – 2002.

One argument put forward in international discussions in favor of disinfection procedures was that to date no sufficiently large studies had been published that could show corresponding effects on the infection rate. Detergents without a disinfectant effect could easily become contaminated and be used in close proximity to the patient. Conversely, disinfectants were more efficient at reducing microbial loads. The environment could serve as a reservoir for transmission of MRSA/VRE and viruses, and this risk could be contained only through disinfection. To date, there has been only inadequate evidence to support the role of disinfection procedures in the genesis of allergies. Furthermore, the cost benefits conferred by dispensing with disinfection procedures were limited. The costs incurred on occurrence of nosocomial infections were by far higher than those savings made by renouncing the use of disinfectants [7].

Guideline drafted by the Commission for Hospital Hygiene and Infection Prevention: Requirements for hygienic cleaning and disinfection of surfaces

Set against a background of growing confusion in specialist public circles, the Commission for Hospital Hygiene and Infection Prevention at the Robert Koch Institute set up a working group comprising members with divergent views of risk evaluation on the role of disinfection. The working group first of all reviewed the current literature and compiled an in-depth risk evaluation, on the basis of which the recommendations for the use of detergent and disinfection procedures were ultimately compiled [4]. No recommendation issued by the Commission so far has needed so much time (more than 3 years) despite intensive input. This attests to the meticulous care and balancing of all arguments for and against the use of cleaning and disinfection procedures. The Commission summarized the recommendation in two tables. First of all, Table 1 defined the risk area for cleaning and disin-

Table 1: Risk areas with regard to the specification of cleaning and disinfection measures

Areas without infection risk ¹	Areas with possible infection risk	Areas with special infection risk	Areas with patients harboring microbes in or on their body such that there could be a risk of transmission	Areas where infection risk posed to personnel ²
Stairways, corridors, administrative areas, offices, dining rooms, lecture/teaching rooms, engineering rooms	General wards, outpatient departments, radiology, physiotherapy, sanitary areas, dialysis, obstetrics, intensive care/surveillance	OR department, surgical procedures rooms, areas used for: special intensive care (long-term ventilated patients (>24 h); patients suffering from extensive burns, transplants (BMT, stem cells); hemato-oncology (e.g. patients undergoing aggressive chemotherapy, preterm babies)	Isolation wings, nursing functional units where aforementioned patients are treated	Microbiology laboratories, pathology, disposal. Unclean areas of: Laundries, functional departments, e.g. CSSD

¹Based on the general risk in the population

²More information on risk evaluation can be consulted in the Technical Regulations on Biological Substances e.g. TRBA 250 "Biological Substances in the Health Services and Welfare Services" (75)

Table 2: Cleaning and disinfection measures in different risk areas

Areas without infection risk ¹	Areas with possible infection risk	Areas with special infection risk	Areas with patients harboring microbes in or on their body such that there could be a risk of transmission	Areas where infection risk posed to patients ²
All surfaces: Cleaning	Surfaces with frequent hand/skin contact: Disinfection (Cat. II) Floors: cleaning Other surfaces: cleaning	Surfaces with frequent hand/skin contact: Disinfection (Cat. IB) Floors: disinfection (Cat. II) Other surfaces: cleaning	Surfaces with frequent hand/skin contact: Disinfection (Cat. IB) Floors: disinfection (Cat. II) Other surfaces: cleaning	See Technical Regulation on Biological Substances (TRBA) (Cat. IV)

When deciding whether routine cleaning or detergent surface disinfection is to be carried out, practicability and safe conductance must also be taken into account

¹Based on the general risk in the population

²More information on risk evaluation can be consulted in the Technical Regulations on Biological Substances e.g. TRBA 250 "Biological Substances in the Health Services and Welfare Services" (75)

fection procedures. In Table 2 the recommendation for cleaning or for disinfection was assigned to the risk areas. Whereas cleaning is deemed sufficient in areas where there is no risk of infection, Category II disinfection is recommended for surfaces where there is frequent hand and skin contact in areas with a potential risk of infection, such as normal wards, outpatient departments, radiology, physiotherapy, sanitary areas, dialysis, intensive care/surveillance, with cleaning recommended for the floors. Category I B disinfection is recommended in areas facing a special infection risk such as OR department, surgical

procedures' rooms, areas used for special intensive care (long-term ventilated patients for more than 24 hours, patients suffering from extensive burns, transplants, hemato-oncology) and for surfaces where there is frequent hand and skin contact. Here Category II disinfection is recommended for the floors.

In areas with patients harboring microbes in or on their body such that there could be a risk of transmission, such as in isolation units/nursing functional areas, where the aforementioned patients are undergoing treatment, the

same recommendations apply as in areas with a special infection risk.

In addition, a fundamentally new requirement has been incorporated into the guideline, and this has major implications for investigation and evaluation of cleaning and disinfection procedures. The recommendations state: "Cleaning and disinfection procedures must therefore be organized and implemented such that there is no increase in the microbial load or spread of facultatively pathogenic or pathogenic microorganisms on surfaces." Furthermore, it is pointed out that for routine disinfection measures in the field of human medicine the Disinfectants Commission of the German Society for Hygiene and Microbiology (DGHM) has compiled a list or issued a certificate as per the DGHM guidelines for testing and evaluating chemical disinfection procedures deemed effective. Conversely, no criteria have been defined for detergents and detergent procedures.

One argument put forward time and again against the use of disinfection procedures has been the possibility of resistance development to disinfection procedures. In this respect the Commission has noted that the data available hitherto show that on using the prescribed concentrations of surface disinfectants with a broad spectrum of action and careful implementation of the disinfection procedure there has been no selection of disinfectant-tolerant/resistant microorganisms. Nor has selection of antibiotic-resistant bacteria been observed to date when conducting surface disinfection as prescribed.

The recommendation takes an in-depth look at how to guard against the side effects arising from detergents and disinfectants. Noteworthy here is that the Commission, for its part, has also ascribed a potential irritation effect to cleaning procedures, relating especially to the upper respiratory tract, eye as well as, when there is direct contact with the skin or mucosa, irritations or irritative contact dermatitis as well as allergic reactions in the case of substances generating a sensitizing effect. The main disinfectants implicated here are aldehydes such as glutaraldehyde and formaldehyde. It is therefore recommended that before opting for a cleaning or disinfection process the use conditions, including health and safety regulations, be reviewed.

As regards any potential negative repercussions on the environment, it is pointed out that the effects of detergents and disinfectants on communal clarification plants and their biodegradability must be borne in mind.

Overall it can be noted that the recommendation, which has enjoyed a broad consensus, will provide the user and patient with an orientation and thus confer a sense of confidence. It can be noted additionally that as per the Commission's recommendation disinfection procedures are needed in the hospital and cannot be dispensed with. Moreover, it was been possible to demonstrate that there is no evidence to support the arguments put forward hitherto regarding resistance to disinfectants or to antibiotics or a rise in the hazard potential posed by disinfectants when used as prescribed.

New insights into the role of surface disinfection in prevention of nosocomial infections

Various publications have attested to the pronounced tenacity and persistence of nosocomial microorganisms, in particular of *Staphylococcus aureus*, enterococci, acinetobacter, *Clostridium difficile* as well as of non-enveloped viruses, e.g. noroviruses.

Shiomori et al. revealed that after making beds widespread contamination of the immediate environment with MRSA was seen, especially of those surfaces with frequent hand and skin contact [14].

Studies conducted by Verity et al. [15] have revealed extensive contamination of floors, bed frames, windows, washbasins, tables and light switches with *Clostridium difficile*.

Investigations by Bhala et al. [3] impressively showed, in the case of staff members exiting from rooms of patients harboring multi-resistant microbes, the incidence of contamination with *Staphylococcus aureus*, VRE, Gram-negative bacteria and *Clostridium difficile* on the hands of medical personnel. The incidence of hand contamination with the aforementioned bacteria was markedly lower in rooms in which disinfection had been effected with quaternary ammonium compounds.

However, to date no experimental studies have been carried out into the provisions of the recommendation formulated by the RKI Commission, stipulating that cleaning and disinfection procedures be organized and implemented such that they do not give rise to an increase in the microbial count or to propagation/spread of facultatively pathogenic or pathogenic microorganism. Studies by Dharan et al. [5] had demonstrated that in the case of routine disinfection with cleaning and disinfection procedures using quaternary ammonium compounds it was not easy to meet this requirement and that only when carrying out surface disinfection using a product based on glutaraldehyde was a marked reduction seen.

To that end, new test procedures were devised by Exner, Gebel et al. [7] which produce experimental data to ascertain and quantify the reduction in microbial counts using by way of example *Staphylococcus aureus*. The results demonstrated that based on these experimental investigations there was no spread in *Staphylococcus aureus* when using aldehydes and peroxides, whereas the use of only water and detergents as well as of an insufficient concentration of quaternary ammonium compounds and alkylamines resulted in inadequate reduction of *Staphylococcus aureus* and in its continued spread contrary to the requirements stipulated by the KRINKO recommendation. Using test procedures tailored to the respective field conditions it will therefore be possible in future to conduct experiments to verify the requirements of the recommendations.

The corresponding studies came to the conclusion that surface disinfection constitutes a basic infection control measure with which the spread of pathogens can be controlled. Conversely, when using only detergents such a form of control is not possible, something that must be taken into account in future when engaging in risk evaluation and formulating infection control measures.

A study similar to that of Gebel and Exner [7] was published by Barker et al. [2] to investigate the impact of cleaning and disinfection on reduction in noroviruses. They demonstrated that detergent-based cleaning, despite visible cleaning of surfaces, was not capable of reliably eliminating norovirus contamination. While a significant reduction was achieved in the burden of noroviruses on using a combined hypochlorite/detergent solution with 5000 ppm free available chlorine, the presence of norovirus could be demonstrated on 28% of surfaces. To assure adequate infection control it was necessary to first wipe off the surfaces with a cloth impregnated in a detergent solution and then use a combined hypochlorite/detergent solution. Likewise it was possible to demonstrate that the virus spread to other surfaces and to the hands of the cleaning personnel following inadequate cleaning or cleaning alone. Norovirus spread was prevented only when the surfaces were treated with hypochlorite. Set against this background of a burgeoning trend in norovirus outbreaks, also in hospitals and nursing homes, such insights are of paramount importance and attest to the need for disinfection of surfaces and of areas with frequent hand and skin contacts.

French et al. [8] carried out studies into contamination of the hospital environment with MRSA as well as comparative studies of the effectiveness of surface cleaning and decontamination with hydrogen peroxide. Here environmental studies were conducted prior to and after cleaning and disinfection, revealing the presence of MRSA in all isolation rooms and bathrooms. 74% of 359 swabs tested positive for MRSA before cleaning as well as 70% of contact-plating samples. All surfaces continued to harbor contamination after cleaning, with 60% of 124 swabs and 74% of surfaces tested using contact cultures showing the presence of MRSA. Conversely, following disinfection of 6 rooms with hydrogen peroxide vapor MRSA was found in only one of 85 rooms (1.2%). French et al. noted that the immediate environment of hospitalized MRSA patients was extensively contaminated with MRSA, while, showing concordance with the findings of Exner und Gebel [7], it was not possible to eliminate MRSA using standard cleaning procedures. As opposed to this, disinfection with hydrogen peroxide vapor proved highly effective at elimination of MRSA from rooms, surfaces and items of furnishing.

Another study on the role of disinfection also in the domiciliary setting with respect to decolonization of MRSA patients was published by Kniel et al. [11]. Within the framework of an investigation conducted into 87 members of the medical staff who were colonized with MRSA, decolonization efforts were also directed at the domiciliary setting. The staff members were requested to disinfect

their bathrooms and items of personal hygiene and to wash their bed linen and pillows. Successful decolonization was noted in 84% of personnel investigated. However, decolonization failed in 14 cases, in 11 of these MRSA-colonized staff members, MRSA was found only in subsequent nasopharyngeal swabs, pointing to recolonization. Investigation of the domiciliary environment revealed extensive contamination with MRSA in 7 of 8 cases. Only after disinfection of the domiciliary environment could successful decolonization of these staff members be accomplished. Where there was massive contamination of the domiciliary environment, eradication took up to 2 years despite adequate medical treatment. Since these members of staff were engaged in the direct care of patients, these 14 staff members accounted for approx. 70% of the lost working days due to unsuccessful attempts at decolonization following the first treatment. The authors concluded that control measures should not be confined to antibiotic and antiseptic treatment of long-term carriers but should also include cleaning and disinfection of the domiciliary environment.

Martin et al. [12] carried out investigations into surface disinfection in nursing homes; this study carried out in three nursing homes in Duisburg, Germany, investigated the effectiveness of cleaning and disinfection of surfaces in close proximity to residents and of sanitary surfaces. In addition, swabs were taken from the nose, throat and mouth, and the utensils used for cleaning were examined. The findings pointed to major lacunae in the provisions in place to counter microbial spread, attributable in some cases to ineffective cleaning and disinfection with marked differences being noted between the different nursing homes. One of the sources of contamination was the cleaning utensils, harboring very high microbial loads. Detection of MRSA in 6 of 31 of the residents examined and the presence of identical strains in the environment emphasized their role as indicator bacteria. The results of the microbiological studies, in particular of MRSA typing, enabled the Public Health Office to take selective interventions. Noteworthy here was the fact that high microbial loads were detected, in some cases also after disinfection and the emergence of facultative microorganisms after disinfection, which was imputed by the authors to methodical errors in cleaning. In addition, massive contamination of reprocessed mops was seen in some cases, showing the presence of *S. aureus* and of fecal bacteria. The authors pointed out that only after microbiological investigations was it possible to detect weak links in the cleaning and disinfection methods employed in these establishments and to compare the putative and actual working practices of staff with those stipulated by the Public Health Office. This investigation confirmed the pivotal role played by verification of infection control measures and, in line with the recommendation by the RKI Commission, verification of infection control measures with respect to disinfection and cleaning procedures and of the procedures used for decontamination of cleaning utensils are part of the quality assurance system. As such, it might be advisable to carry out such investigations not

only in hospitals but also in homes for the elderly. This appears to be all the more important in view of the fact that pursuant to the Commission's imminent recommendation: "Infection prevention in nursing homes", in the case of MRSA-colonized residents of homes for the elderly social contacts with relatives, visitors and co-residents are not subjected to any restrictions and only daily cleaning of surfaces of residents' rooms, including of those with MRSA, is advocated. Only where there is contamination with blood, secretions or excretions is selective disinfection deemed necessary.

Investigations of outbreaks of nosocomial infections in the absence of disinfection procedures

The recommendations by the RKI Commission point out that outbreaks, e.g. with antibiotic-resistant enterococci, MRSA, *Acinetobacter baumannii*, pseudomonads, Norwalk-like viruses and *Clostridium difficile* could be contained by using extensive cleaning and disinfection measures. A study by Engelhart et al. [6] serves to demonstrate this. An outbreak involving 6 cases of nosocomial *Pseudomonas aeruginosa* infection (2 cases of pneumonia, 2 of septicemia, 2 skin-wound infections) occurred in an hemato-oncological hospital ward. In line with the Commission's recommendations for hospital hygiene and infection prevention, systematic outbreak management system was initiated. Several samples were taken from the patient's immediate environment to investigate for the presence of *Pseudomonas aeruginosa*. 20% of the samples from surfaces and cleaning utensils showed contamination with *Pseudomonas aeruginosa*. Genotyping using pulse field gel electrophoresis showed different types for all 6 patient isolates. Nonetheless 2 of the patient isolates were identical with environmental isolates from cleaning utensils. The investigation revealed that the cleaning personnel, contrary to service instructions, had used only a cleaning solution instead of the prescribed disinfectant solution for cleaning the patient's immediate environment. The rationale put forward for this approach was that in a television program a professor of infection control had allegedly stated that disinfectants could have negative effects on health and need not be used in all areas of the hospital. It was possible to control the outbreak after re-introducing surface disinfection, installation of sterile filters in water outlets and shower heads as well as chemical disinfection of washbasin drains and reappointment of an infection control nurse, a position that had formerly been left vacant. After introduction of these measures, there were no further cases of pseudomonas infections, two of which had a mortal outcome. This investigation highlights the pivotal role of meticulous cleaning and disinfection of the environment in patient care, in particular of neutropenic patients.

Concluding remarks

Experimental and epidemiological data as well as outbreak investigations carried out to an extent after publication of the recommendations "Hygiene requirements for cleaning and disinfection of surfaces" have highlighted the pivotal role of surface disinfection.

In the discussions focusing on the significance of surface disinfection the absence of evidence of the efficacy of surface disinfection has been pointed out. However, it must be called to mind that absence of evidence of a health risk is not evidence of absence, hence the lack of evidence of a preventive measure can be evaluated. In the event of absence of convincing evidence despite a corresponding indication of a health risk, measures based on the "principle of circumspection" should serve as the legitimate policies of consumer protection. This means that in such cases one should wait in future for an evaluation by the Commission for Hospital Hygiene before dispensing with surface disinfection measures.

Finally, it must be pointed out that these discussions about the role of surface disinfection have, in addition to causing confusion among users, resulted in a lack of acceptance of hygienic measures and have augmented the risk of occurrence of nosocomial infections with, in turn, an increase in antibiotic-resistant microorganisms. Retrospectively viewed, the author of this paper believes that the joint statement on surface disinfection by the specialist societies responsible for infection control, science and medicine [13] has proved necessary and correct.

Curriculum Vitae

Univ. Prof. Dr. med. habil Martin Exner

Figure 1



Figure 1: Univ. Prof. Dr. med. habil Martin Exner

Director of the Institute of Hygiene and Public Health (Collaborating Center of the WHO for Health Promoting Water Management and Risk Communication)
Professor Exner obtained his doctorate at the Bonn University in 1977 and started as a scientific assistant at first. He habilitated in environmental hygiene, and at the same time took over the direction of the Infectious Dis-

eases Department and Environmental Hygiene Department of Public Health of the City of Cologne together with the *venia legendi* at the Bonn University. He joined as Managing Director the Hygiene Institute of the Ruhrgebiet in Gelsenkirchen in 1988, which was founded by Robert Koch in 1901. Since 1994 he is Professor of Hygiene and Public Health at the Medical Faculty of Bonn and since 2002 Managing Director of the Center of Infectiology and Infection Prevention at the University of Bonn.

The many functions Professor Exner is fulfilling today show the international credit he receives. From the beginning of his activities in the area of environmental hygiene his special interest was in food hygiene and drinking water as well as public health. He is active in a leading position for numerous international scientific committees busying themselves with the subject and also in the important national boards.

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