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CROSS-CONTAMINATION WHEN USING FOLDED MICROFIBRE CLOTHS

Published by VSR

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CROSS-CONTAMINATION WHEN USING FOLDED MICROFIBRE CLOTHS

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Date: June, 2022

FOREWORD

This report can be interpreted in several ways. The research question is clearly answered and can be read in the report with all its nuances, details and preconditions. The part of the conclusion that cross-contamination is taking place to other surfaces through unused parts of the cloth may appear worrying. This conclusion led to the internal discussion of the report immediately asking the follow-up question of whether the cloth can then be safely used in this way.

This was not the research question for a multitude of reasons. The deployment of a methodology is appropriate with the prior risk assessment. Cleaning, disinfection and sterilisation are an extension of each other, but have their own scope.

When cleaning is required, the microfibre cloth (including folding technique) is extremely effective. With regard to the removal of microbial load, a reduction of 99.99% has been observed in the laboratory with humidification with demineralised water, in a single working step. That still does not make it disinfection, as there, killing off is the primary criterion and here it concerns removal. But the effectiveness of the microfibre cloth at this point remains impressive.

The degree of cross-contamination is also in an order of magnitude that this is not problematic from a cleaning perspective. If the risk profile calls for disinfection or sterilisation, then cleaning is no more than the essential preparation for that process.

Finally, the time-honoured adage of "leave clean what is clean" should certainly be maintained in a microbial sense. Barring the possible exception to the rule, cleaning a disinfected or sterile surface will always lead to an increase in the microbial load on that surface.

With these comments in mind, much reading pleasure.

The board of VSR

CONTENT

CHAPTER 1 INTRODUCTION

1.1 Research background

Within professional cleaning, microfibre cloths have been used since the 1990s. Their (correct) use has many advantages. Microfibres remove dirt more completely and retain it better compared to traditional materials, and the cleaned surface is left almost dry. Thereby, the use of water and detergent is mostly unnecessary [5].

For optimal use of microfibre cloths, the so-called folding method is recommended [5]. Here, a (damp) microfibre cloth is folded two or three times to create eight or sixteen sides. In this way, each time a clean part of the cloth can be used for cleaning. When all sides have been used, the cloth is replaced with a clean one.

In terms of hygiene, microfibre cloths remove bacteria at least as well as traditional materials [5]. Because the cloths are no longer rinsed out in a bucket of water, dirt and micro-organisms remain in the cloth and are not transferred via the rinse water to another surface to be cleaned. Spread of dirt and micro-organisms is further prevented by working from clean to dirty and by changing sides of the cloth or the entire cloth per task.

Bergen et al conducted research on the spread of micro-organisms when using folded microfibre cloths [1]. This study shows that although there is a reduction of micro-organisms after cleaning a contaminated surface with folded microfibre cloths, micro-organisms are also spread to successive surfaces. Cross-contamination occurs. The spread of micro-organisms could be a consequence of the repeated folding of the cloths where micro-organisms are transferred via the cloth to the hand (glove) (contact contamination) or via transfer of micro-organisms from dirty to clean parts of the cloth [6].

The Bergen study focuses on one specific surface (surgical drapes) and one type of microfibre cloth [1]. This surface is not representative of the surfaces to be cleaned within professional cleaning. The Technical Committee of Vereniging Schoonmaak Research therefore wonders whether, in situations closer to practice, microfibre cloths also spread micro-organisms when applying the folding method. In addition, the committee wants to know whether the type of microfibre cloth still plays a role here.

1.2 Purpose of the study

This study investigates the spread of micro-organisms from dirty to clean surfaces when cleaning different types of materials with different types of folded microfibre cloths.

For this purpose, the following research questions have been formulated:

1. When cleaning a dirty surface with a folded microfibre cloth, do micro-organisms spread to successive clean surfaces?
2. How do different types of microfibre cloths affect any spread of micro-organisms?
3. How do different types of materials affect any spread of micro-organisms?
4. If micro-organisms are spread by the application of the folding method, what contamination factors affect this process?

HOOFDSTUK 2
MATERIALS AND METHOD

2.1 Global design

A laboratory study investigated the spread of micro-organisms when cleaning with folded microfibre cloths. The study was conducted on surfaces of three different material types with three different types of microfibre cloths. The spread of three types of micro-organisms was determined from each combination. In addition, contact points on the researcher's hand and contamination of the cloth itself were examined. Each combination of material type and microfibre cloth was repeated 10 times (see schematic in Figure 2.1).

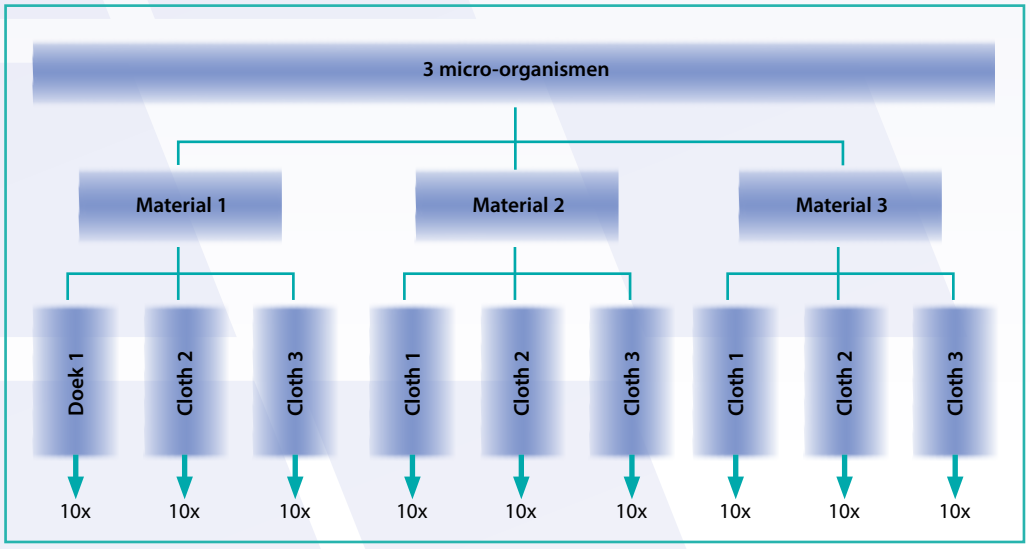


Figure 2.1: Schematic representation of research design

For each material type, the first of a series of 16 surfaces was soiled with a bacterial mix and cleaned with a three-folded, damp, sterile microfibre cloth. A successive sterile surface was then cleaned with a clean side of the microfibre cloth each time (schematically shown in Figure 2.2). The surfaces, the hand and the microfibre cloth used were sampled after a short drying period to determine the amount of micro-organisms. The numbers found give an indication of the extent to which micro-organisms are dispersed.

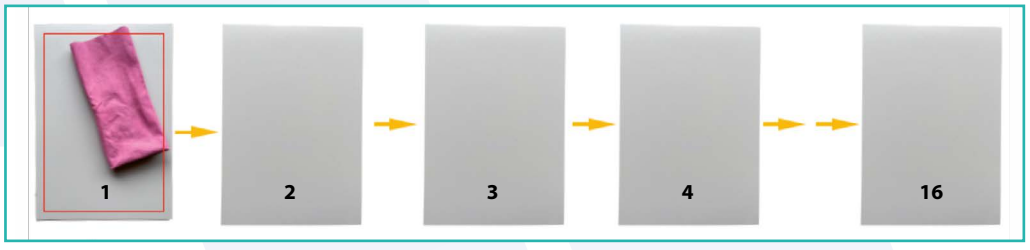


Figure 2.2: Schematic representation of cleaning

2.2 Materials

2.2.1 Microfibre cloths

Three different types of microfibre cloths were used in this study (table 2.1

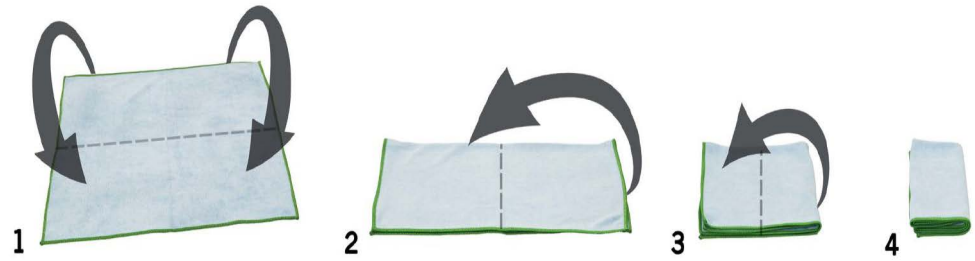
Tabel 2.1: Microfibre cloths in the study

Code	Type	Quality	Composition
R	non-woven, fine split	100% microfibre (0.075 Dtex)	70% PE, 30% PA,
B	non-woven, normal split	100% microfibre (0.16 Dtex)	70% PE, 30% PA, <1 % nano-silver
G	knitted	100% microfibre	80% PE, 20% PA

Prior to the study, the microfibre cloths were washed with colour detergent on a 60 °C main wash cycle in a domestic washing machine and air-dried.
During the study, the cloths were washed on a 60 °C main wash cycle without detergent before each trial. Immediately after washing, the damp cloths were folded, sterilised in an autoclave and kept sterile. The sterility of the cloths was randomly checked by microbiological examination.

Folding is done using the three-fold method (see diagram in Figure 2.3): the first time along the long side, the second and third times along the short side of the cloth.

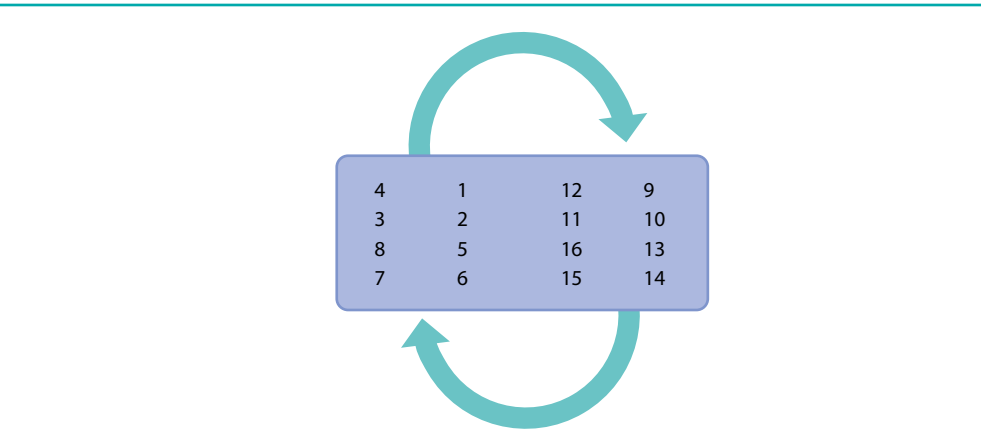
Figure 2.3: Folding method (three-fold)



Source: www.thuisschoonmaken.nl

The result is a folded cloth with 16 sides. These sides are numbered: 8 on the front (1 to 8) and 8 on the back (9 to 16). Figure 2.4 schematically shows the 16 sides on the front and back of the cloth. Here, side 12 is the back of side 1.

Figure 2.4: Front (left) and back (right) of a 16-sided microfibre cloth



2.2.2 Material types

Three material types representative within professional cleaning were examined:

- Plastic (HPL - High Pressure Laminate): 21 x 30 cm
- Metal (nickel-plated and chrome-plated): 40 x 20 cm
- Porcelain: 20 x 25 cm

Sixteen surfaces of each material type were used; one surface for each of the 16 sides of the cloth. Prior to testing, the surfaces were first cleaned and then wiped with alcohol (95 % ethanol).

2.2.3 Micro-organisms

The following micro-organisms were used in this study:

- *Staphylococcus aureus* (ATCC 25923)
- *Enterococcus faecalis* (ATCC 14506)
- *Bacillus cereus* (ATCC 10876)

2.3 Method

The study was divided into three phases:

- soiling, or the application of micro-organisms to the first surface;
- cleaning the first soiled surface and the 15 consecutive sterile surfaces with the folded microfibre cloth;
- the microbiological examination either sampling all cleaned surfaces, microfibre cloth and hand, incubating and determining germ counts.

2.3.1 Phase 1: Fouling

Each bacterial strain was propagated in a TSB broth for 18 hours at 35 ºC (*S. aureus* and *E. faecalis*) or 30 °C (*B. cereus*). The obtained bacterial suspensions (10^8 /ml) were mixed to form a bacterial mix. 1ml of this bacterial mix was spread on the first surface with a sterile drigalskisspatula and air-dried for 5 minutes.

2.3.2 Phase 2: Cleaning

Cleaning was performed by several investigators, with cleaning pressure and movement standardised as much as possible. The researchers wear sterile gloves during this process.

The researcher cleans the soiled surface (surface 1) with side 1 of the folded microfibre cloth by moving over the surface with a smooth zig-zag motion in a single pass. The researcher then turns the microfibre cloth and cleans surface 2 with side 2 of the cloth. All subsequent surfaces are cleaned in the same way, each time with a new, clean side of the microfibre cloth.

2.3.3 Phase 3: Microbiological examination

In advance

Of the bacterial mix, duplicate dilution series of each micro-organism on specific nutrient media (Baird Parker and KAA) were used to determine the germ count after incubation (35 ºC and 30 ºC, 48 hours).

Surfaces 1 to 16

The surfaces were sampled after a drying time of 5 minutes. Contact plates (25 cm^2) with specific food soils (Baird Parker and KF) were used for this purpose. These contact plates or

stamping plates are suitable for a simple way to get an impression of the hygienic quality of a surface. The contact plates were printed on the surface with standard pressure and time (16 g/cm^2, 15 sec) at a predetermined location. Each surface was sampled in singles.
After printing, contac plates were incubated (35 ºC, 48 h) and colonies were counted.

Surface 1
As more micro-organisms are expected to remain on the first surface than can be quantified with the contact plates, this surface was also sampled using a swab. At a predetermined location on surface 1,25 cm^2 was blotted with a sterile swab. The swab was shaken out in 5 ml of PFZ. In duplicate, the germ count was determined from a dilution series on specific agars (Baird Parker and KAA) after incubation (35 ºC, 48 h).

Microfibre cloths
After cleaning the final surface, the entire microfibre cloth was shaken out in a sterile stomacher bag containing PFZ. In duplicate, the germ count was determined from a dilution series on specific agars (Baird Parker and KAA) after incubation (35 ºC, 48 hours).

Hand (glove)
After cleaning the final surface, the cleaner's hand (glove) is printed on a PCA culture medium. After incubation (35 ºC, 48 hours), the germ count is determined. Colonies are confirmed on specific agars (Baird Parker and KAA).

Germ count
Germ count was determined by counting colonies and was calculated using the following formula:

$$N = \frac{\sum a}{(n1 + 0{,}1n2)d}$$

N = number of cfu per sample
Σa = sum of the number of colonies counted
n1 = number of countable plates least diluted sample
n2 = number of countable plates most diluted sample
d = dilution factor n1

Check
Sterilised surfaces, microfibre cloths or other objects were randomly sampled for verification.

CHAPTER 3 RESULTS

3.1 Test conditions

The tests were carried out under controlled laboratory conditions at an ambient temperature of 22 °C ± 1.5 °C and a humidity of 55% ± 3% RH.
Various checks showed that materials and supplies were sufficiently sterile.

Trials on *B. cereus* were started but were not completed because the methodology used could not sufficiently detect this micro-organism.

3.2 Bacterial mix

The first surfaces were contaminated with a mixed suspension of about 10^8 to 10^9 of both micro-organisms (see table 3.1).

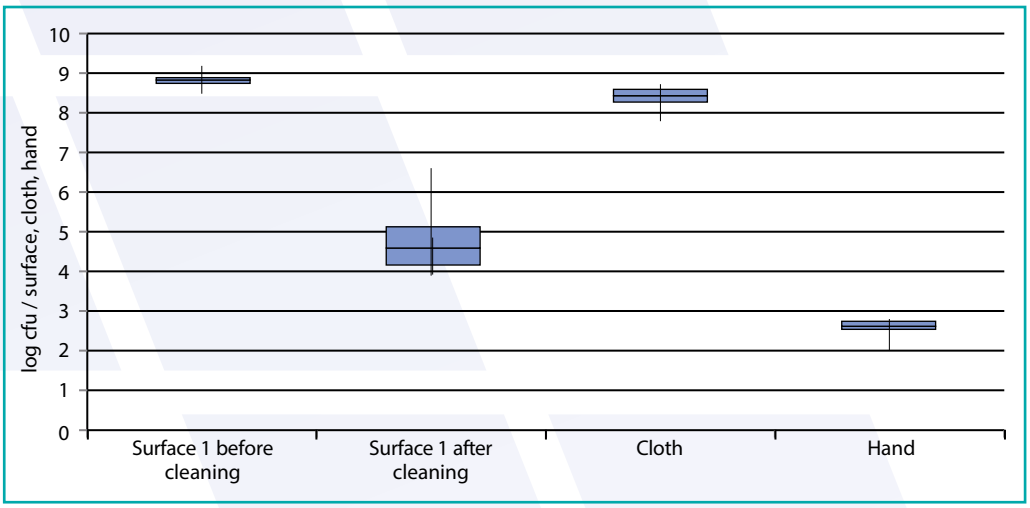
Micro-organism	Average	Range
S. aureus	8.9	8.7 – 9.2
E. faecalis	8.8	8.5 – 9.1

Table 3.1: Germ count of the bacterial mix [log cfu/ml]

Based on the spot checks of the amount of micro-organisms on the contaminated surface, the germ count of the bacterial mix is assumed to be equal to that of the contaminated initial surface in all cases.

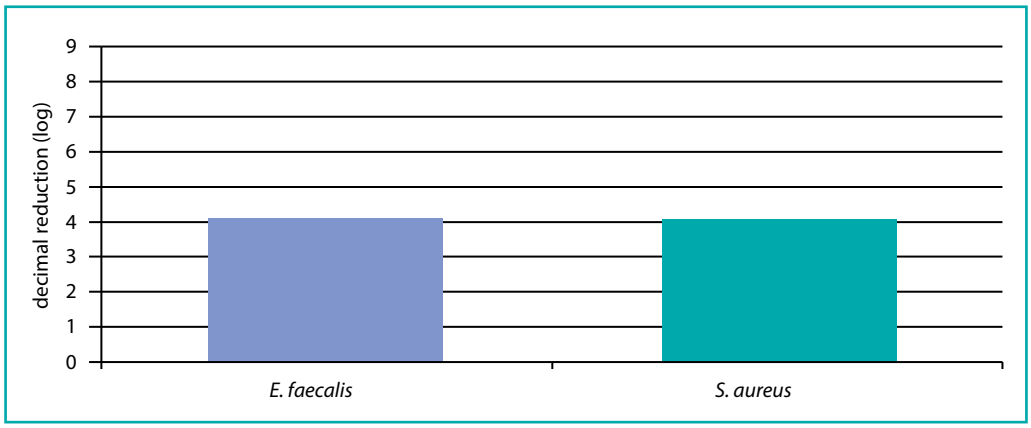
3.3 Spread of micro-organisms

Graph 3.1 shows that the number of micro-organisms (*S. aureus* and *E. faecalis*) on the first surface, regardless of the type of material or type of cloth, decreases. The average decimal reduction is about 4 log units (Chart 3.2). The micro-organisms remain largely in the cloth and to a lesser extent on the hand.



Graph 3.1: Spread of micro-organisms by cleaning- regardless of material or cloth [median and spread of germ counts in log cfu].

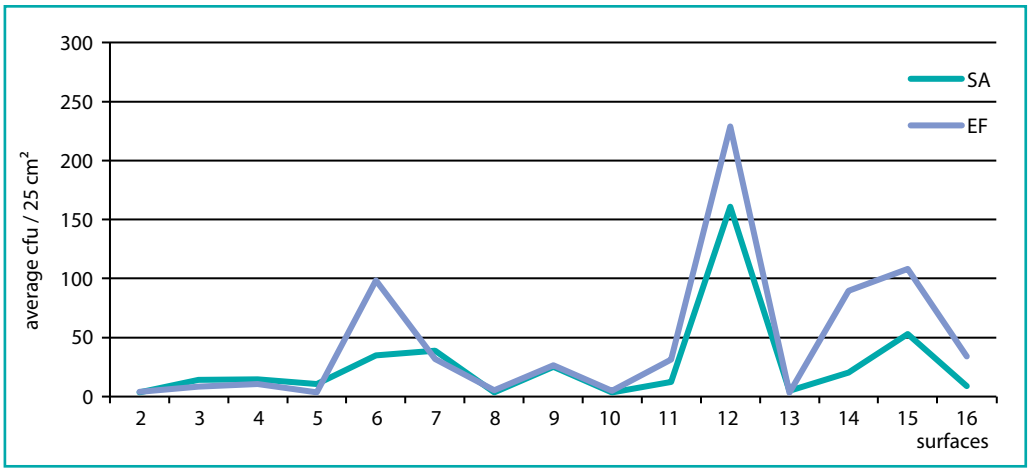
Graph 3.2: Decimal reduction on the first surface [log]]



The decimal reduction when cleaning the first surface, is almost the same for *S. aureus* and *E. faecalis* (graph 3.2).
Both S. *aureus* and *E. faecalis* were found on the cleaned surface in 100% of cases. Thus, not all micro-organisms are removed.

The spread of micro-organisms to successive surfaces (surfaces 2 to 16), is shown in Chart 3.3. Although the numbers of micro-organisms are significantly lower in relation to the first surface, it is clear that micro-organisms are spread to the successive surfaces; *S. aureus* was found on 80% and *E. faecalis* on 72% of the originally clean surfaces.

Graph 3.3: Dispersal of micro-organisms across surfaces [average number of micro-organisms per 25 cm² regardless of cloth or material type, max = 300].

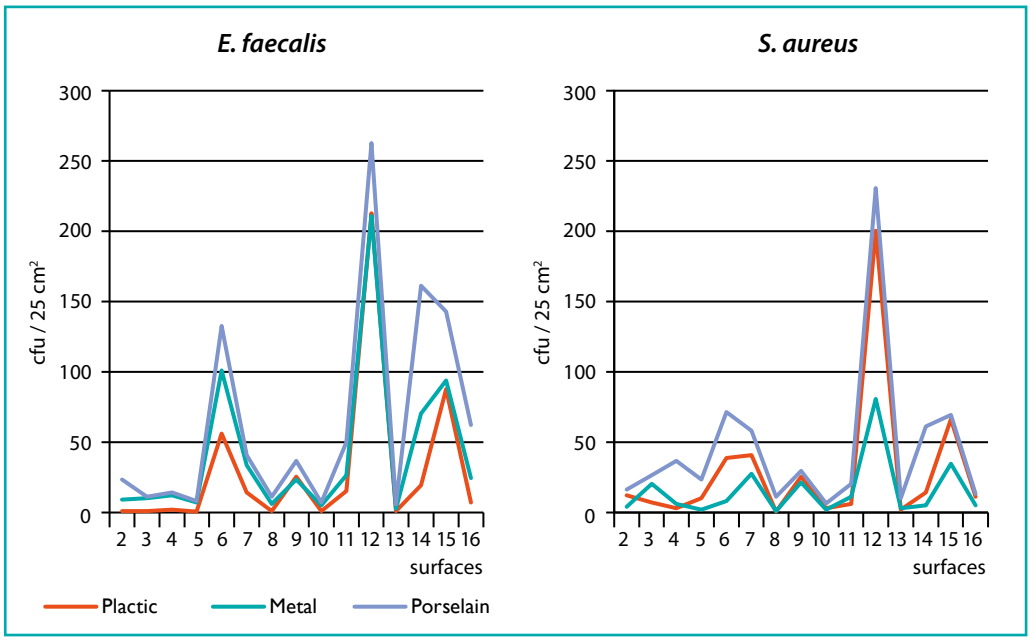


The amount of micro-organisms found is not the same on all surfaces. Significantly more *S. aureus* and *E. faecalis* were found on surface 12 than on the other surfaces (Duncan, α = 0.95). More micro-organisms were also found on surfaces 15 and 7 (*S. aureus*) and 15 and 6 (*E. faecalis*) compared to the other surfaces (Duncan, α = 0.95).

3.4 Effect of material type on the spread of micro-organisms

Graph 3.4 shows the distribution of *S. aureus* and *E. faecalis* on the cleaned surfaces by material type. The trend is similar to that of graph 3.3, with peaks and troughs at the different surfaces.

Higher germ counts of *E. faecalis* were found on porcelain surfaces compared to plastic surfaces (Duncan, α = 0.95). S. *aureus* was found more on porcelain surfaces compared to metal surfaces (Duncan, α = 0.95).

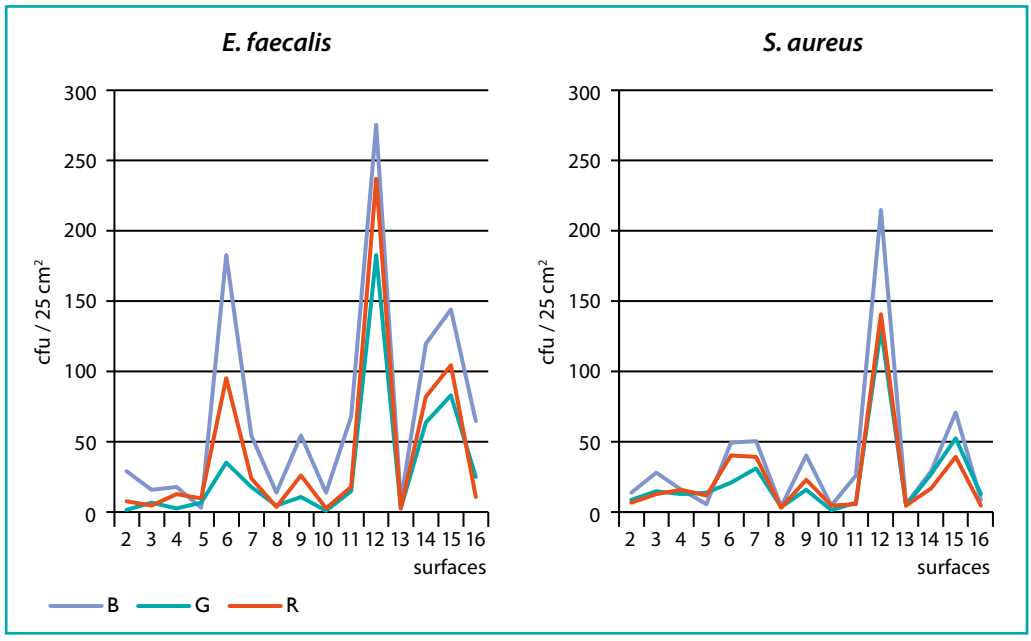


Graph 3.4: Average number of micro-organisms on the different surfaces broken down by material type [cfu/25cm²]

3.5 Effect of cloth type on the spread of micro-organisms

Graph 3.5 shows the distribution of *S. aureus* and *E. faecalis* on the cleaned surfaces by type of cloth. The trend is again similar to the results found earlier.

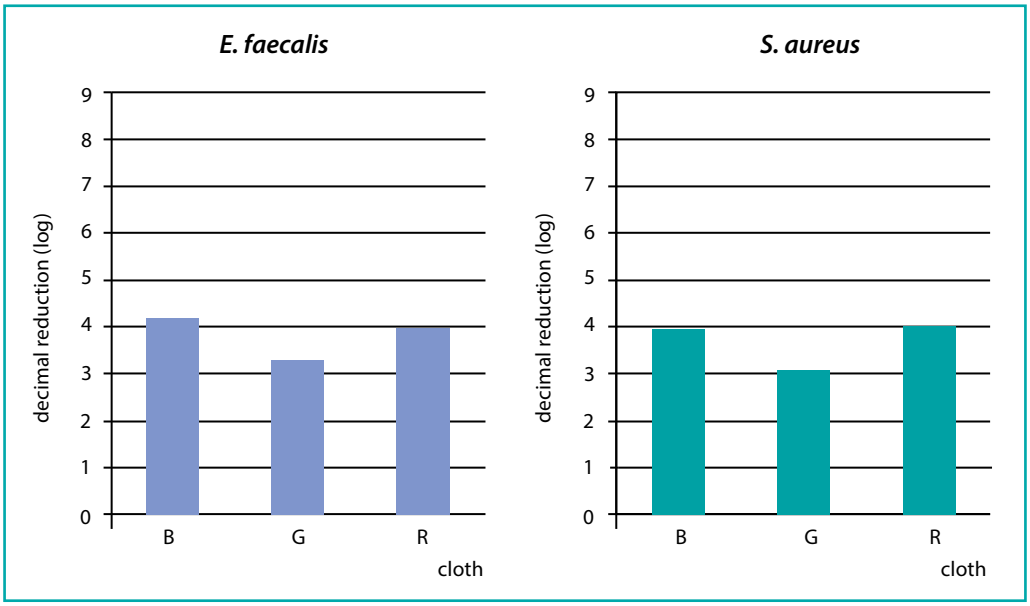
More *E. faecalis* were found on the surfaces cleaned with cloth B than on the surfaces cleaned with cloth G (Duncan, α = 0.95). For the distribution of *S. aureus*, no difference was found between the cloth types (Duncan, α = 0.95).



Graph 3.5: Average number of micro-organisms on the different surfaces broken down by type of cloth [cfu/25cm²]

Graph 3.6 shows the decimal reduction on the first surface for the different cloths. The reduction is less when cleaning with the green cloth for both *E. faecalis* and *S. aureus* than for the blue and red cloth.

Graph 3.6: Decimal reduction by cloth type after initial surface cleaning [log]]



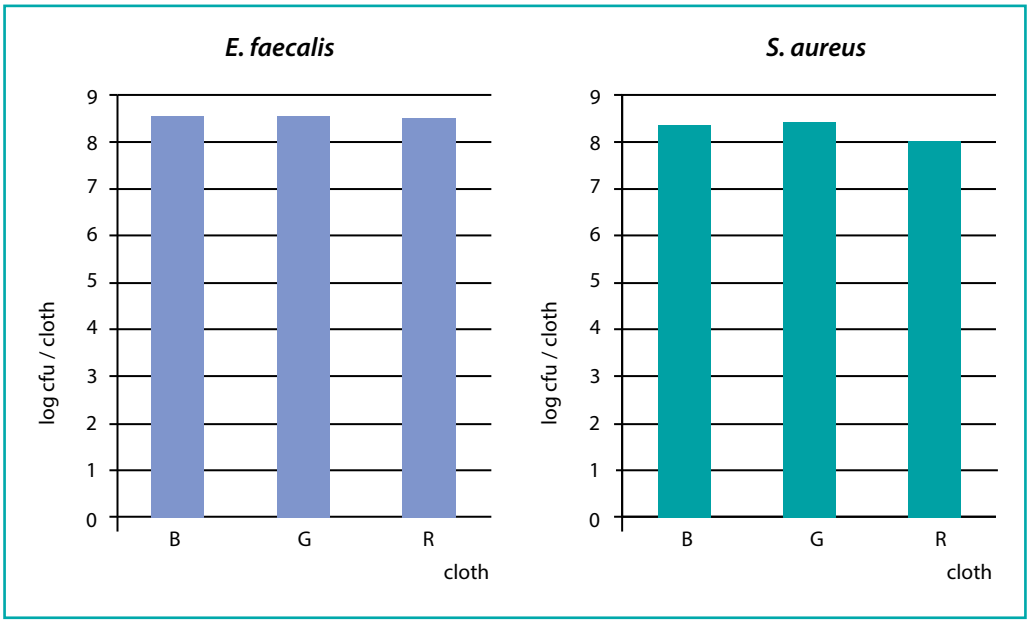
3.6 Hand

In all cases, micro-organisms were found on the hand (glove) after cleaning; an average of 2.6 log cfu (range: 2.0 - 2.8). All but one of these were confirmed as *S. aureus* or *E. faecalis*.

3.7 Cloth

An average of 10^8 micro-organisms remain on the cloth after cleaning. Chart 3.7 shows minimal differences between cloth types.

Graph 3.7: Average number of micro-organisms on different types of cloth after cleaning [log cfu / cloth]



CHAPTER 4
DISCUSSION

4.1 Method

The swab method used to investigate the spread of *B. cereus* on the cleaned surfaces proved inadequate. No colony was recovered on the spread plates. The numbers were probably lower than could be detected with the dilution series. This was confirmed by positive control plates. Stamping plates with a specific medium for the detection of *B. cereus* were not available at the time of the study.
Very low numbers of *B. cereus* were also found on surfaces in the Bergen study [1].

In principle, the stamping plates give a good indication of the hygienic situation. In this study, one stamping plate per cleaned surface was used. To get an impression of the distribution of the amount of micro-organisms on the same surface, more stamp plates per surface should be used.

4.2 Removal of micro-organisms

The study showed a decimal reduction of about 4 log units when cleaning a micro-organism-contaminated surface with damp microfibre cloths. This is in line with what, in laboratory tests, has been found more often [5].

4.3 Spreading of micro-organisms

Research by Bergen [1] showed cross-contamination to subsequent surfaces when folded microfibre cloths were used: *E. faecalis* was found on 11 to 15 of 16 surfaces tested (73 - 94%). The findings in this study with other cloths and materials confirm this; *S. aureus* was found on 80% and *E. faecalis* on 72% of the originally clean surfaces. Micro-organisms thus spread when cleaning with folded microfibre cloths. There is therefore cross-contamination.

Statistical analysis shows that the extent to which micro-organisms are spread to subsequent surfaces is not random. This was also observed in Bergen's study [1]. The 'pressing' or displacement of micro-organisms by the folded microfibre cloth or contamination via the hand were mentioned as possible explanations.
Graph 3.3 shows that significantly more micro-organisms were found on surface 12 than on all other surfaces except the soiled surface (surface 1). At the beginning of the test, side 1 of the cloth becomes dirty due to cleaning the soiled first surface. As Figure 2.4 shows, side 12 of the folded microfibre cloth is the back side of side 1. Micro-organisms could be squeezed by the pressure of the hand, through the different layers. Surface 12 is cleaned later in the test with side 12 of the cloth. Moving micro-organisms through the layers of the microfibre

cloth could also explain the relatively higher numbers of micro-organisms on surfaces 15 and 6. These sides of the folded cloth follow side 12 (see schematic in Figure 4.1).

Afbeelding 4.1: Schematic representation of the sides of the folded microfibre cloth at the start of the test from the investigator's hand to the soiled surface.

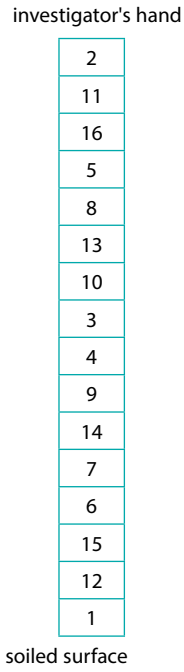


Chart 3.3 shows low numbers of micro-organisms on sides 2, 5, 8, 11, 13 and 16. These sides of the folded microfibre cloth are on the opposite side of the soiled surface at the start of the test (see Figure 4.1). This could support the explanation that micro-organisms move inside the cloth due to hand pressure. With this, the influence of folding and unfolding the cloth during cleaning (contamination by the act itself) on the spread of micro-organisms seems to be less significant. Perhaps micro-organisms are spread but also removed again. After all, micro-organisms are found in the cloth and on the hand after cleaning.

Effect of material type

Significantly more micro-organisms were found on porcelain compared to other materials. An explanation for this was not found.

Effect of cloth type

Previous research has shown that reduction levels vary between different types of microfibre cloths [2]. In this study too, the type of cloth was found to affect the numbers of micro-organisms on different surfaces. Significantly more *E. faecalis* were found on surfaces cleaned with the non-woven cloth with normal cleavage than on surfaces cleaned with the knitted cloth. An explanation for this may lie in the removal of micro-organisms on the first surface. Chart 3.6 shows that with the knitted cloth, more micro-organisms remain on the first surface. This is the case for both *S. aureus* and *E. faecalis*.

CHAPTER 5
CONCLUSION

In this study commissioned by the Technology Committee of Vereniging Schoonmaak Research, the spread of micro-organisms from dirty to clean surfaces when cleaning different types of materials with different types of folded microfibre cloths was investigated.

Four research questions were examined in the process:

When cleaning a dirty surface with a folded microfibre cloth, do micro-organisms spread to successive clean surfaces?

While this laboratory study showed a substantial reduction of micro-organisms by cleaning with damp microfibre cloths, it also showed that micro-organisms are spread from a dirty surface to clean surfaces when applying the folding method. Cross-contamination occurs. Transmission is uneven. More micro-organisms are found on some, originally sterile, surfaces after cleaning than on others.

How do different types of microfibre cloths affect any spread of micro-organisms?

When cleaning a dirty surface with a knitted microfibre cloth, more micro-organisms are left behind than when cleaning with non-woven cloths. This does not mean that more micro-organisms are also spread when cleaning with knitted cloths. On the contrary; more micro-organisms are spread when using the folded non-woven cloth with a normal split.

How do different types of materials affect any spread of micro-organisms?

The type of material seems to influence the spread of micro-organisms. More micro-organisms are found on porcelain than on plastic and metal surfaces.

If micro-organisms are spread by the application of the folding method, what contamination factors affect this process?

The microfibre cloth itself seems to be the main source of transmission. It is plausible that micro-organisms move through the different layers in the folded cloth. Contamination via the hand seems to be less of an influence.

CHAPTER 6
LITERATURE

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VSR (the Association for Cleaning Research) is the independent platform for the professional cleaning industry. As the knowledge institute for all market parties in the field of cleaning maintenance, VSR strives to objectively add focus and professionalize the cleaning profession by means of research, information and training.

ISBN/EAN:

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