

Effective reprocessing of reusable dispensers for surface disinfection tissues – the devil is in the details

Wirksame Aufbereitung von wiederverwendbaren Spendern für Flächendesinfektionstücher – der Teufel steckt im Detail

Abstract

Background: It has recently been reported that reusable dispensers for surface disinfection tissues may be contaminated, especially with adapted *Achromobacter species 3*, when products based on surface-active ingredients are used. Fresh solution may quickly become recontaminated if dispensers are not processed adequately.

Methods: We evaluated the abilities of six manual and three automatic processes for processing contaminated dispensers to prevent recolonisation of a freshly-prepared disinfectant solution (Mikrobac forte 0.5%). Dispensers were left at room temperature for 28 days. Samples of the disinfectant solution were taken every 7 days and assessed quantitatively for bacterial contamination.

Results: All automatic procedures prevented recolonisation of the disinfectant solution when a temperature of 60–70 °C was ensured for at least 5 min, with or without the addition of chemical cleaning agents. Manual procedures prevented recontamination of the disinfectant solution when rinsing with hot water or a thorough cleaning step was performed before treating all surfaces with an alcohol-based disinfectant or an oxygen-releaser. Other cleaning and disinfection procedures, including the use of an alcohol-based disinfectant, did not prevent recolonisation.

Conclusions: These results indicate that not all processes are effective for processing reusable dispensers for surface-disinfectant tissues, and that a high temperature during the cleaning step or use of a biofilm-active cleaning agent are essential.

Keywords: surface disinfection, tissue dispenser, processing, *Achromobacter* spp.

Zusammenfassung

Hintergrund: Kürzlich wurde berichtet, dass wiederverwendbare Tuchspender für Flächendesinfektionsmittel kontaminiert sein können, besonders mit adaptiertem *Achromobacter species 3*, wenn Produkte auf Basis oberflächenaktiver Wirkstoffe verwendet werden. Frisch angesetzte Lösung kann schnell rekontaminiert werden, wenn die Tuchspender nicht sachgerecht aufbereitet werden.

Methode: Wir untersuchten die Wirksamkeit von sechs manuellen und drei maschinellen Aufbereitungsverfahren für kontaminierte Tuchspender mit dem Ziel, die Rekontamination der frisch angesetzten Desinfektionsmittellösung (Mikrobac forte 0,5%) zu vermeiden. Die Tuchspender wurden bei Raumtemperatur über 28 d stehen gelassen. Proben der Desinfektionsmittellösung wurden alle 7 d quantitativ auf bakterielle Kontamination untersucht.

Ergebnisse: Alle maschinellen Verfahren verhinderten die Rekontamination der Desinfektionsmittellösung, wenn eine Temperatur zwischen 60–70 °C über mindestens 5 min sichergestellt wurde, sowohl mit als auch ohne Zusatz chemischer Reinigungsmittel. Manuelle Aufbereitungs-

Günter Kampf^{1,2}

Stina Degenhardt³

Sibylle Lackner³

Christiane Ostermeyer³

1 Bode Science Center, Bode Chemie GmbH, Hamburg, Germany

2 Institut für Hygiene und Umweltmedizin, Ernst-Moritz-Arndt Universität Greifswald, Germany

3 Microbiology, Bode Chemie GmbH, Hamburg, Germany

verfahren verhinderten die Rekontamination der Desinfektionsmittellösung, wenn heißes Wasser oder ein gründlicher Reinigungsschritt vor der Desinfektion aller Flächen mit einem alkoholischen oder sauerstoffabspaltenden Flächendesinfektionsmittel erfolgte. Andere Reinigungs- bzw. Desinfektionsverfahren einschließlich der Anwendung eines alkoholischen Flächendesinfektionsmittels verhinderte nicht die Rekontamination.

Schlussfolgerungen: Die Ergebnisse zeigen, dass nicht alle Verfahren zur Aufbereitung wiederverwendbarer Tuchspender für Flächendesinfektionsmittel wirksam sind. Eine hohe Temperatur in der Reinigungsphase bzw. die Anwendung eines biofilmwirksamen Reinigers sind essentiell.

Schlüsselwörter: Flächendesinfektion, Tuchspender, Aufbereitung, *Achromobacter* spp.

Background

It has recently been reported that 42% of surface disinfectant solutions based on surface-active ingredients taken from poorly processed reusable tissue dispensers were heavily contaminated with Gram-negative species, mainly *Achromobacter* spp. [1]. The cell count in the disinfectant solution was as high as 10^7 per mL [1]. These isolates were adapted to multiplying in the disinfectant solution at room temperature, and were also able to create a biofilm in the presence of various disinfectant formulations [1]. The original source of the contamination, however, is still unknown. It is therefore essential to ensure that tissue dispensers are processed adequately before refilling to prevent recontamination of the solution over the recommended usage time, which is 28 days for most products. We therefore investigated the efficacies of various manual and automatic procedures for processing reusable, contaminated dispensers to determine which ensured that surface disinfectant solutions remained free of contamination over 28 days.

Methods

Types of contaminated dispensers

Two types of contamination were distinguished. One group of dispensers ('old contamination') were contaminated and left for at least 4 weeks. These were likely to be contaminated on all inner surfaces, including by biofilm formation, as described previously [1]. These dispensers were either routinely used in healthcare facilities and had been identified as contaminated (some were used directly, and some were unsuccessfully processed manually, resulting in contaminated disinfectant solution), or were new dispensers that were artificially contaminated by filling for at least 4 weeks with contaminated disinfectant solution (*Achromobacter species 3* or *Achromobacter species 3* plus *Serratia marcescens*). The other group of dispensers ('new contamination') was contaminated for 3 days using 25 mL of contaminated disinfectant solution containing approximately 10^6 cells per mL of

Achromobacter species 3. These dispensers were turned in all directions to allow the liquid to contact all inner surfaces, left for 3 days at room temperature, turned again, emptied and then used to test the processes.

Manual processing procedures

Six different manual procedures were evaluated.

Manual procedure 1: The dispenser, including all components, was thoroughly cleaned inside and outside with a wipe soaked with an alcohol-based surface disinfectant (Bacillol AF; Bode Chemie GmbH, Hamburg, Germany). The procedure was repeated with another wipe on the inside of the dispenser. All components were rinsed with tap water and dried. The dispenser, including all components, was then thoroughly disinfected inside and outside with a wipe soaked with Bacillol AF. The aim was to keep all surfaces wetted with the disinfectant for at least 30 s before the next refill. Five experiments were performed in the 'old contamination' group, and three in the 'new contamination' group.

Manual procedure 2: Procedure 2 was similar to procedure 1, except that hygienic hand disinfection was performed for 30 s after all cleaning and disinfection work, immediately before the next refill. Three experiments were performed in the 'new contamination' group.

Manual procedure 3: The dispenser, including all components, was left in a 30-L disinfection bin filled with a cleaning solution for 10 min (1% Bodedex forte; Bode Chemie GmbH, Hamburg, Germany). Particular attention was paid to ensure that all inner and outer surfaces were covered. The dispenser was then taken out and wiped mechanically with the cleaning solution, inside and outside, with particular attention to the inner dispenser edge. All components, including the inner dispenser edge, were rinsed thoroughly with tap water, dried thoroughly with a clean tissue, and then wiped inside and outside with an alcohol-based surface disinfectant (Bacillol AF). The aim was to keep all surfaces wetted with the disinfectant for at least 30 s before the next refill. Six experiments were performed in the 'old contamination' group.

Manual procedure 4: The dispenser and the lid were rinsed thoroughly with hot tap water. One sachet of the

oxygen-releasing disinfectant Dismozon plus (Bode Chemie GmbH, Hamburg, Germany) was dissolved in 2 L of cold water (0.8%) in the dispenser, and mixed thoroughly. All surfaces of the dispenser, including the lid, were wiped thoroughly with the solution. The dispenser was closed, turned around in a washing basin or bin (liquid may come out) and left for 1 h. The dispenser was emptied and rinsed with hot tap water before the next refill. Three experiments were performed in the 'old contamination' group.

Manual procedure 5: The dispenser and lid were rinsed thoroughly with hot tap water, followed by thorough cleaning of all surfaces with a single-use tissue and a tenside-based household cleaner, followed by a second rinse with hot water. All components were wiped thoroughly inside and outside with an alcohol-based surface disinfectant (Bacillol AF) and allowed to dry. Three experiments were performed in the 'old contamination' group.

Manual procedure 6: The dispenser and lid were rinsed thoroughly with hot tap water and dried. All components were wiped thoroughly inside and outside with an alcohol-based surface disinfectant (Bacillol AF) and allowed to dry. Three experiments were performed with three different types of 'old contamination' (*Achromobacter species 3* [clone 1], *Achromobacter species 3* [clone 6], and a combination of *Achromobacter species 3* [clone 4] and *S. marcescens*).

Automatic processing procedures

Experiments were performed in a washer-disinfector for laboratory glassware (G 7736 CD, Miele, Germany), similar to a common dishwasher (Figure 1). Three processes were evaluated:



Figure 1: Inside of the washer disinfector used for processing of the contaminated dispensers for surface disinfection tissues

Automatic procedure 1: Rinse for 1 min with warm water (approximately 45 °C), cleaning for 5 min at 70 °C using an alkaline cleaner (Dismoclean 28 alka med at 0.3%, Bode Chemie GmbH, Hamburg, Germany); disinfection at 70 °C for 5 min (Dismoclean 28 alka med at 0.5%), fi-

nal rinse at 70 °C for 1 min, drying for 10 min at 90 °C (total duration: approximately 50 min). Two experiments were performed in the 'old contamination' group and two in the 'new contamination' group.

Automatic procedure 2: Rinse for 1 min with warm water (approximately 45 °C), cleaning for 5 min at 60 °C using a mild alkaline cleaner (Dismoclean 21 clean at 0.5%, Bode Chemie GmbH, Hamburg, Germany), rinse with warm water (35–40 °C) for 1 min, followed by rinse with hot water (70 °C) for 3 min, drying for 5 min at 45–52 °C (total duration: approximately 50 min). Four experiments were performed in the 'old contamination' group.

Automatic procedure 3: Rinse for 1 min with warm water (approximately 45 °C), cleaning for 5 min at 60 °C without the addition of a chemical cleaner, rinse with warm water (35–40 °C) for 1 min, followed by rinse with hot water (70 °C) for 3 min; drying for 5 min at 45–52 °C (total duration: approximately 50 min). Four experiments were performed in the 'old contamination' group.

Determination of efficacies of different dispenser-cleaning-disinfection processes

The efficacies of the processes were determined by filling the reprocessed dispensers with 2.5 L Mikrobac forte (0.5%) and a tissue role (X-wipes; Bode Chemie GmbH, Hamburg, Germany) and leaving at room temperature. Six tissues were taken from each dispenser three times a week, to simulate clinical conditions. Samples of the disinfectant solution were taken on days 7, 14, 21 and 28. Serial dilution was performed in casein peptone soymeal peptone broth containing neutralizing agents (0.1% histidin, 0.1% cysteine, 0.3% lecithin, 3% Tween 80). The combination of neutralizers was validated and was effective for the tested product. Aliquots of 1 mL were spread on casein peptone soymeal peptone agar and incubated for 72 h. Colonies were counted and the number of colony-forming units (CFU) per mL was determined.

Results

Among the manual processes, use of an alcohol-based surface disinfectant was effective when a hot-water rinse (procedures 5 and 6) or a specific cleaning step (procedure 3) was performed before the alcohol-disinfection step (Table 1). A hot-water rinse followed by the use of an oxygen-releaser for manual cleaning and disinfection was also effective (procedure 4). However, cleaning and disinfection using an alcohol-based surface disinfectant alone did not prevent recontamination of the disinfectant solution over 28 days.

All the automatic procedures effectively prevented recontamination over 28 days (Table 2).

Table 1: Number of colony-forming units per mL detected in Mikrobac forte (0.5%) left for 28 days at room temperature in contaminated tissue dispensers ('old contamination' or 'new contamination'), processed using different types of manual procedures

Type of procedure	Type of dispenser contamination	Dispenser	CFU/mL			
			Day 7	Day 14	Day 21	Day 28
Manual procedure 1	'old contamination' (<i>Achromobacter spp.</i> 3)	1	7	10 ⁷	10 ⁷	n.a.
		2	10 ³ -10 ⁴	10 ⁷	10 ⁷	n.a.
		3	0	0	0	0
		4	0	0	0	0
		5	0	0	0	0
	'new contamination' (<i>Achromobacter spp.</i> 3)	1	0	0	0	0
		2	0	0	10 ⁷	10 ⁷
		3	0	0	0	0
	Manual procedure 2	'new contamination' (<i>Achromobacter spp.</i> 3)	1	0	0	0
2			0	10 ²	10 ⁷	10 ⁷
3			0	0	10 ²	10 ³
Manual procedure 3	'old contamination' (<i>Achromobacter spp.</i> 3)	1	0	0	0	0
		2	0	0	0	10 ²
		3	0	0	0	0
		4	n.a.	0	0	0
		5	n.a.	0	0	0
		6	n.a.	0	0	0
Manual procedure 4	'old contamination' (<i>Achromobacter spp.</i> 3)	1	n.a.	0	0	0
		2	n.a.	0	0	0
		3	n.a.	0	0	0
Manual procedure 5	'old contamination' (<i>Achromobacter spp.</i> 3)	1	0	0	0	0
		2	0	0	0	0
		3	0	0	0	0
Manual procedure 6	'old contamination' (<i>Achromobacter spp.</i> 3, clone 1)	1	0	0	0	0
		2	0	0	0	0
		3	0	0	0	0
	'old contamination' <i>Serratia marcescens</i> and <i>Achromobacter spp.</i> 3, clone 4)	1	0	0	0	0
		2	0	0	0	0
		3	0	0	0	0
	'old contamination' (<i>Achromobacter spp.</i> 3, clone 6)	1	0	0	0	0
		2	0	0	0	0
		3	0	0	0	0

n.a. = not available

Table 2: Number of colony-forming units per mL detected in Mikrobac forte (0.5%) left for 28 days at room temperature in contaminated tissue dispensers ('new contamination' or 'old contamination') processed with different types of automatic procedures

Type of procedure	Type of dispenser contamination	Dispenser	CFU/mL			
			Day 7	Day 14	Day 21	Day 28
Automatic procedure 1	'new contamination' (<i>Achromobacter spp.</i> 3)	1	0	0	0	0
		2	0	0	0	0
	'old contamination' (<i>Achromobacter spp.</i> 3)	1	0	0	0	0
		2	0	0	0	0
Automatic procedure 2	'old contamination' (<i>Achromobacter spp.</i> 3)	1	0	0	0	0
		2	0	0	0	0
		3	0	0	0	0
		4	0	0	0	0
Automatic procedure 3	'old contamination' (<i>Achromobacter spp.</i> 3)	1	0	0	0	0
		2	0	0	0	0
		3	0	0	0	0
		4	0	0	0	0

Discussion

Surface disinfectant solutions in reusable tissue dispensers are usually recommended to be used for up to 28 days, based on the efficacy and stability data provided by the manufacturer. They may be based on surface-active ingredients, such as quaternary ammonium compounds, glucoprotamin or amines, they may also contain an aldehyde, or they may be based on alcohols, such as ethanol, propan-2-ol (iso-propanol) or propan-1-ol (n-propanol). Reusable dispensers should be cleaned and disinfected before refilling, according to the manufacturer's recommendations.

The results of the current study showed that automatic cleaning-disinfection procedures were effective in preventing recontamination of new disinfectant solution. This can probably be explained by relatively strong mechanical cleaning, supported by a temperature of 60–70 °C. Mechanical cleaning is known to be the best option for removing biofilms in water-containing systems [2].

Four of the six tested manual procedures were also effective, though some of these processes took between 30 and 90 min to complete, which may represent a major limitation to their clinical acceptance. Processes that involved rinsing with hot water were effective, indicating that thermal cleaning is effective, and is probably also a good choice for biofilm removal [3].

The use of alcohol-based surface disinfectants is recommended by many manufacturers, but was shown to be on its own insufficient; it was only effective when a real cleaning step was performed before the alcohol-disinfection step. The value of thorough cleaning for overall processing results has been emphasized in different types of processing [4], [5] and this study suggests that pro-

cessing reusable surface disinfectant tissue dispensers can be regarded in a similar way.

One limitation of this study was that only one surface disinfectant was used to refill the tissue dispensers, and we were therefore unable to see if the same procedures yielded the same results with other surface disinfectants. However, we expect that the results would be similar, because isolates from contaminated dispensers were previously shown to multiply at room temperature in three different disinfectants based on different types of surface-active ingredients [1].

Not all healthcare facilities, such as nursing homes and doctors' practices, will have access to automatic cleaning-disinfection procedures, and effective manual procedures are thus essential. However, effective manual processes are lengthy, which may make them difficult to implement. Shorter procedures, such as procedures 5 and 6, will be welcome if recontamination of the disinfectant solution due to insufficient processing can be prevented.

Further studies are needed to preserve the benefit of locally-available surface disinfectant tissue dispensers for targeted surface disinfection e.g., in high-risk areas. Cases of bacteremia caused by contaminated quaternary ammonium compounds were reported as early as 1958 [6]. In 1976, Dixon et al. wrote: "More than 15 years ago, editorials in *Lancet* and the *British Medical Journal* warned of potential problems associated with the misuse of dilute aqueous QACs, for by that time, human disease resulting from inactivation or contamination of these agents had been reported. Nonetheless, aqueous QACs continued to be used, and associated problems continued to be reported." [7]. In that respect, the current results and proposals regarding dispenser processing will contribute to the safe use of surface disinfectants.

Conclusions

This study demonstrated that some cleaning processes for reusable dispensers are ineffective, and that use of a high temperature during the cleaning step, or use of a biofilm-active cleaning agent is essential to ensure the effective processing of reusable dispensers for surface disinfectant tissues.

Notes

Competing interests

All authors are employed by Bode Chemie GmbH, Hamburg, Germany.

Poster presentation

The results of this study were presented as a poster at the 2nd ICPIC, Geneva, Switzerland in June 2013 [8].

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Corresponding author:

Prof. Dr. Günter Kampf
Bode Science Center, Bode Chemie GmbH,
Melanchthonstr. 27, 22525 Hamburg, Germany
guenter.kampf@bode-chemie.de

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