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Review Article

How long can nosocomial pathogens survive on textiles? A systematic review

Wie lange können nosokomiale Infektionserreger auf Textilien überleben? Eine systematische Übersichtsarbeit

Abstract

Aims: Healthcare-associated infections linked to contaminated textiles are rare but underline their potential role as a source for transmission. The aim of the review was to summarize the experimental evidence on the survival and persistence of the different types of nosocomial pathogens on textiles.
Methods: A literature search was performed on MedLine. Original data on the survival of bacteria, mycobacteria, and fungi and persistence of viruses on textiles were evaluated.
Results: The survival of bacteria at room temperature was the longest on polyester (up to 206 days), whereas it was up to 90 days for some species on cotton and mixed fibers. Only low inocula of 100 CFU were found on all types of textiles with a short survival time of ≤3 days. Most bacterial species survived better at elevated air humidity. The infectivity of viruses on textiles is lost much faster at room temperature, typically within 2–4 weeks.
Conclusions: Contaminated textiles or fabrics may be a source of transmission for weeks. The presence of pathogens on the coats of healthcare workers is associated with the presence of pathogens on their hands, demonstrating the relevance of textile contamination in patient care.

Keywords: survival, pathogens, textiles, fabrics

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Zusammenfassung

Zielsetzung: Nosokomiale Infektionen, die von kontaminierten Textilien ausgehen, sind selten, zeigen aber dennoch ihr Potenzial als Quelle einer Übertragung. Ziel der Übersichtsarbeit war es, experimentell gewonnene Daten zum Überleben bzw. zur Persistenz verschiedener nosokomialer Pathogene auf Textilien zusammenfassend darzustellen.
Methode: Eine Literaturrecherche wurde auf MedLine durchgeführt. Originaldaten zum Überleben von Bakterien, Mykobakterien und Pilzen sowie zur Persistenz von Viren auf Textilien wurden ausgewertet.
Ergebnisse: Das Überleben von Bakterien bei Raumtemperatur war am längsten auf Polyester (bis zu 206 Tage), wohingegen es auf Baumwollen bzw. gemischten Fasern bis zu 90 Tage betrug. Nur kleine Inokula von 100 KBE konnten auf allen Textilien über maximal 3 Tage überleben. Die Mehrzahl der Bakterienspezies überlebte bei höherer Luftfeuchtigkeit besser. Die Infektiosität der Viren ging auf Textilien bei Raumtemperatur schneller verloren, meist innerhalb von 2–4 Wochen.
Fazit: Kontaminierte Textilien können über Wochen eine Quelle für Übertragungen darstellen. Der Nachweis von Pathogenen auf den Kitteln der Mitarbeiter war mit dem Nachweis der Pathogene auf ihren Händen assoziiert. Auch darin zeigt sich die Bedeutung der Kontamination von Textilien in der Patientenversorgung.

Schlüsselwörter: Überleben, Pathogene, Textilien, Stoffe

Introduction

Healthcare-associated infections linked to contaminated textiles are rare, but play a role as a potential source of transmission. One example is the spread of group A streptococcus infections. An outbreak on a geriatric medical ward was explained by the presence of one healthcare worker (HCW) on the ward who was perineal carrier. Contamination of a fabric-upholstered chair used by the HCW in an office adjacent to the ward was also detected and was suspected to have enhanced the transmission to other HCWs [1]. Another example is an outbreak of meropenem-resistent *A. baumannii* on an intensive care unit. The major source appeared to be the curtains surrounding the patient' beds [2]. Feather pillows have been described as an unexpected source of *Acinetobacter* spp., potentially causing outbreaks [3]. Outbreaks caused by bacterial spores on linen have also been reported, e.g., resulting in bacteraemia [4], [5]. Work garments have also been described to be contaminated with various types of microorganisms. The cuffs of long-sleeved coats frequently contact patients or environmental surfaces [6]. Soiled linen was also described as the source of tinea corporis infections in two HCWs who had only indirect contact to a patient infected with *T. tonsurans* [7]. The survival of nosocomial pathogens on inanimate surfaces has been well described [8]. But the persistence of pathogens on different types of textiles has not been reviewed. The purpose of this review was therefore to summarize the experimental evidence on the survival and persistence of the different types of nosocomial pathogens on textiles.

Methods

A MedLine search was performed on the 29th and 31st of May, 2019. The following terms were used: cotton bacteria survival (361 hits), cotton virus survival (155 hits), cotton virus persistence (39 hits), cotton yeast survival (16 hits), cotton fungus survival (267 hits), cotton mycobacterium survival (19 hits), polyester bacteria survival (327 hits), polyester virus survival (57 hits), polyester virus persistence (8 hits), polyester yeast survival (13 hits), polyester fungus survival (174 hits), polyester mycobacterium survival (13 hits), wool bacteria survival (46 hits), wool virus survival (26 hits), wool virus persistence (8 hits), wool yeast survival (5 hits), wool fungus survival (31 hits), wool mycobacterium survival (5 hits), silk bacteria survival (51 hits), silk virus survival (14 hits), silk virus persistence (0 hits), silk yeast survival (6 hits), silk fungus survival (32 hits), and silk mycobacterium survival (0 hits). Publications were included and results were extracted from them when they provided original data on the survival or duration of persistence of bacteria, mycobacteria, fungi or viruses on textiles. Articles were excluded when they did not provide any original data on survival or persistence. Reviews were also excluded, but screened for any information within the scope of the review.

Results

Bacteria

Cotton

On cotton, many bacterial species are able to survive at room temperature for long periods of time, such as *Enterococcus* spp. (up to 90 d), *P. aeruginosa* (up to 8 w), *S. aureus* (up to 8 w), *K. pneumoniae* (up to 8 w), *S. pyogenes* (up to 46 d), *E. coli* (up to 45 d), *Enterobacter* spp. (up to 35 d), *S. sonnei* (up to 27 d), coagulase-negative *Staphylococcus* spp. (up to 27 d), *Acinetobacter* spp. (up to 25 d), *P. mirabilis* (up to 9 d) and *S. maltophilia* (up to 7 d). Other species at a high initial cell count, however, survive only for short periods of time at room temperature, e.g., *N. gonorrhoeae* and *S. marcescens* (both up to 3 d), *B. fragilis*, *B. cepacia* and C. *diphtheriae* (all up to 2 d), *P. vulgaris* (up to 1 d), *V. cholerae* (up to 8 h), *Salmonella* spp. (up to 5 h), *C. jejuni* (up to 3 h) and *F. nucleatum* (up to 2 h). At lower temperatures, the survival may be longer, as shown for *S. sonnei* and *S. equi*. A low inoculum of approximately 100 CFU was found for many species with only a short survival period of 2 h *(Acinetobacter* spp.) or ≤1 h (*E. coli*, *P. mirabilis*, *P. aeruginosa* and *S. marcescens*). Only *Enterobacter* spp. was able to survive much longer (up to 3 d) when inoculated with only 100 CFU. *M. bovis* survived on cotton for 2 m. Higher air humidity was associated with longer survival of *E. coli*, whereas lower air humidity enhanced the survival of *S. aureus* and *S. pyogenes* (Table 1).

Synthetic fibers

On synthetic fibers such as polyester, the survival times of high inocula at room temperature ranged from up to 206 d (*E. coli*, *S. aureus*, *S. pyogenes*), 90 d *(Enterococcus* spp.), 56 d (*K. pneumoniae*, *P. aeruginosa*), 26 d (*Enterobacter* spp.), 14 d *(Acinetobacter* spp.) to 7 d (*S. marcescens*). A low inoculum of approximately 100 CFU was found for many species with only a short survival period of 2 d (*K. pneumoniae*), 1 d *(Enterobacter* spp.), 8 h (*Acinetobacter* spp.), 2 h (*P. mirabilis*) or ≤1 h (*E. coli*, *P. aeruginosa*, *S. marcescens*). Higher air humidity favored longer survival of *E. coli*, *S. aureus* and *S. pyogenes* (Table 2).

Mixed and other fibers

High inocula applied to mixed and other fibers were able to survive at room temperature for up to 90 d *(Enterococcus* spp.), 49 d *(Enterobacter* spp.), 45 d (*E. coli*), 41 d (*S. aureus*), 33 d (*P. aeruginosa*), 28 d (coagulase-negative *Staphylococcus* spp.), 19 d *(Acinetobacter* spp.), 14 d (*K. pneumoniae*, *M. morganii*, *P. mirabilis*), and 7 d

Table 2: Survival of bacteria on synthetic fibers

Species	Strains/isolates	Inoculum	Material	Temperature	Survival	Reference
A. baumannii	15 multi-resistant strains	10^5–10^6	Polyester	25°C	≥7 d	[24]
Acinetobacter spp.	2 isolates from a hospital	10^2 10^4–10^5	Polyester	22°–26°C	8 h 4–14 d	[27]
Enterobacter spp.	2 isolates from a hospital	10^2 10^4–10^5	Polyester	22°–26°C	1 d 5–26 d	[27]
E. casseliflavus	1 isolate from a hospital (vanC VRE)	10^7	Polyester	23°–24°C	>90 d	[33]
E. faecalis	ATCC 29212	10^7	Synthetic fibers	RT	2 w	[34]
E. faecalis	4 isolates from a hospital (1 vanA VRE, 1 vanB VRE)	10^7	Polyester	23°–24°C	73–90 d	[33]
E. faecium	15 multi-resistant strains	10^5–10^6	Polyester	25°C	≥7 d	[24]
E. faecium	4 isolates from a hospital (1 vanA VRE, 1 vanB VRE)	10^7	Polyester	23°–24°C	43–90 d	[33]
E. gallinarum	1 isolate from a hospital (vanC VRE)	10^7	Polyester	23°–24°C	>90 d	[33]
E. coli	2 isolates from a hospital	10^2 10^4–10^5	Polyester	22°–26°C	1 h 3–9 d	[27]
E. coli	NCTC 8003	10^8	Polyester	23°C	<10 d	[36]
E. coli	ATCC 35218	10^7	Synthetic fibers	RT	3 w	[34]
E. coli	NCTC 8545	10^5–10^6	Polyester	RT	46–206 d*	[35]
K. pneumoniae	2 isolates from a hospital	10^2 10^4–10^5	Polyester	22°–26°C	2 d 4–11 d	[27]
K. pneumoniae	15 multi-resistant strains	10^5–10^6	Polyester	25°C	<3 d	[24]
K. pneumoniae	ATCC 700603	10^7	Synthetic fibers	RT	>8 w	[34]
P. mirabilis	2 isolates from a hospital	10^2 10^4–10^5	Polyester	22°–26°C	2 h 2–4 d	[27]
P. aeruginosa	2 isolates from a hospital	10^2 10^4–10^5	Polyester	22°–26°C	<1 h 1–2 d	[27]
P. aeruginosa	ATCC 27583	10^7	Synthetic fibers	RT	>8 w	[34]
S. marcescens	2 isolates from a hospital	10^2 10^4–10^5	Polyester	22°–26°C	1 h 4–7 d	[27]
S. aureus	ATCC 25923	10^5–10^6	Polyester	27°C	1–3 d	[45]
S. aureus	15 multi-resistant strains	10^5–10^6	Polyester	25°C	≥7 d	[24]
S. aureus	6 isolates from a hospital (3 MRSA)	10^7	Polyester	23°–24°C	10–56 d	[33]
S. aureus	NCTC 6538	10^8	Polyester	23°C	<21 d	[36]
S. aureus	NCTC 7447	10^5–10^6	Polyester	RT	46–206 d*	[35]
S. aureus	ATCC 25923	10^7	Synthetic fibers	RT	>8 w	[34]
Staphylococcus spp.	6 coagulase-negative isolates from a hospital (3 methicillin-resistent)	10^7	Polyester	23°–24°C	7–22 d	[33]
S. pyogenes	DMU 724	10^5–10^6	Polyester	RT	46–206 d*	[35]

RT = room temperature; *longer survival at higher air humidity

(*S. maltophilia*). Short survival times were found with *S. typhimurium* (≥1 d), *N. gonorrhoeae* (up to 1 d), and *S. dysenteriae* (4 h). Low inocula of 100 CFU were often associated with shorter survival times, e.g., in *K. pneumoniae* (1–3 d), *Acinetobacter* spp. (7 h), *E. coli* (≤6 h) or *P. mirabilis*, *P. aeruginosa* and *S. marcescens* (≤1 h). Longer survival was associated with higher air humidity in *K. pneumoniae*, *M. morganii*, *P. mirabilis*, *S. aureus* and *S. epidermidis* (Table 3).

Fungi

Most fungal species applied as high inocula were able to survive at room temperature on various types of fibers for 30 d or more (*A. fumigatus*, *C. glabrata*, *C. krusei*, *C. parapsilosis*, *C. tropicalis*, *C. neoformans*), 21 d (*G. candidum*), or 14 d (*C. albicans*). The differences between the fiber materials were variable. Four fungal species survived better on cotton or wool, three species on the blended fiber, and two on silk (Table 4).

Table 4: Survival of fungi on different types of fibers

Species	Strains/isolates	Inoculum	Material	Temperature	Survival	Reference
A. fumigatus	Clinical isolate	10^7	Silk	21°–24°C	27 d	[25]
A. fumigatus	Clinical isolate	10^7	Cotton	21°–24°C	>30 d	[25]
A. fumigatus	Clinical isolate	10^7	Blend of 60% cotton and 40% polyester	21°–24°C	>30 d	[25]
A. fumigatus	Clinical isolate	10^7	Wool	21°–24°C	>30 d	[25]
C. albicans	Clinical isolate	10^7	Cotton	21°–24°C	6 d	[25]
C. albicans	Clinical isolate	10^7	Blend of 60% cotton and 40% polyester	21°–24°C	6 d	[25]
C. albicans	Clinical isolate	10^7	Wool	21°–24°C	12 d	[25]
C. albicans	Clinical isolate	10^7	Silk	21°–24°C	12 d	[25]
C. albicans	Clinical isolate	10^7	Cotton	22°C	14 d	[53]
C. albicans	Clinical isolate	10^7	Blend of 50% cotton and 50% polyester	22°C	14 d	[53]
C. glabrata	Clinical isolate	10^7	Cotton	21°–24°C	>30 d	[25]
C. glabrata	Clinical isolate	10^7	Blend of 60% cotton and 40% polyester	21°–24°C	>30 d	[25]
C. glabrata	Clinical isolate	10^7	Wool	21°–24°C	>30 d	[25]
C. glabrata	Clinical isolate	10^7	Silk	21°–24°C	>30 d	[25]
C. krusei	Clinical isolate	10^7	Cotton	21°–24°C	3 d	[25]
C. krusei	Clinical isolate	10^7	Blend of 60% cotton and 40% polyester	21°–24°C	6 d	[25]
C. krusei	Clinical isolate	10^7	Silk	21°–24°C	21 d	[25]
C. krusei	Clinical isolate	10^7	Wool	21°–24°C	>30 d	[25]
C. parapsilosis	Clinical isolate	10^7	Cotton	22°C	14 d	[53]
C. parapsilosis	Clinical isolate	10^7	Blend of 50% cotton and 50% polyester	22°C	14 d	[53]
C. parapsilosis	Clinical isolate	10^7	Cotton	21°–24°C	>30 d	[25]
C. parapsilosis	Clinical isolate	10^7	Blend of 60% cotton and 40% polyester	21°–24°C	>30 d	[25]
C. parapsilosis	Clinical isolate	10^7	Wool	21°–24°C	>30 d	[25]
C. parapsilosis	Clinical isolate	10^7	Silk	21°–24°C	>30 d	[25]
C. tropicalis	Clinical isolate	10^7	Cotton	21°–24°C	3 d	[25]
C. tropicalis	Clinical isolate	10^7	Blend of 60% cotton and 40% polyester	21°–24°C	6 d	[25]
C. tropicalis	Clinical isolate	10^7	Silk	21°–24°C	24 d	[25]
C. tropicalis	Clinical isolate	10^7	Wool	21°–24°C	>30 d	[25]
C. neoformans	Clinical isolate	10^7	Cotton	21°–24°C	>30 d	[25]
C. neoformans	Clinical isolate	10^7	Blend of 60% cotton and 40% polyester	21°–24°C	>30 d	[25]
C. neoformans	Clinical isolate	10^7	Wool	21°–24°C	>30 d	[25]
C. neoformans	Clinical isolate	10^7	Silk	21°–24°C	>30 d	[25]
G. candidum	Clinical isolate	10^7	Blend of 60% cotton and 40% polyester	21°–24°C	6 d	[25]
G. candidum	Clinical isolate	10^7	Silk	21°–24°C	6 d	[25]
G. candidum	Clinical isolate	10^7	Wool	21°–24°C	12 d	[25]
G. candidum	Clinical isolate	10^7	Cotton	21°–24°C	21 d	[25]

Viruses

Cotton

At room temperature, some viruses persisted for long periods of time, such as the variola virus (18 m), vaccinia virus (up to 2 w), rabbit haemorrhagic disease virus (up to 10 d) or poliovirus (up to 7 d). The majority of viruses lose their infectivity at room temperature on cotton within 1 d (coronavirus, cytomegalievirus, ebolavirus, influenza A virus, influenza B virus, metapneumovirus). Low inocula have a substantially shorter persistence, as

Table 5: Persistence of viruses on cotton

Species	Strains/isolates	Inoculum	Material	Temperature	Persistence	Reference
Coronavirus	Strains 229E and OC43	$5x10^3$	Cotton	21°C	≤8 h	[54]
Coronavirus	Clinical isolate of SARS coronavirus	10^6 10^5 10^4	Cotton gown	RT	24 h 1 h 5 min	[55]
Cytomegalievirus	Clinical isolate from urine	Unknown	Cotton	25°–27°C	≤2 h	[56]
Cytomegalievirus	Strain AD169	200	Cotton	RT	≤6 h	[57]
Ebolavirus	Clinical isolate	10^7	Cotton gown	21.5°C	<24 h	[58]
Influenza A Virus	Strain NIBRG-121sw (H1N1)	10^5	Cotton pillowcases	RT	8 h	[59]
Influenza-A-Virus	Strain 11/78 (H1N1)	10^3	Cotton handkerchief	28°C	12 h	[60]
Influenza A Virus	Strain Delaware 471/86 (H13N7)	$6x10^4$	Cotton	RT	1 d	[61]
Influenza-B-Virus	Strain 1/79	10^3	Cotton handkerchief	28°C	10 h	[60]
Metapneumovirus	Strain APV/MN-2a	$3x10^4$	Cotton	RT	1 d	[61]
Poliovirus	Type 2	10^9–10^{10}	Cotton (sheeting, terry cloth, knit jersey)	25°C	4–7 d	[62]
Poliovirus	Type 1	Unknown	Cotton	18°–20°C	143 h*	[63]
Rabbit haemorrhagic disease virus	Strain CAPM V-351	10^6–10^7	Cotton	15°C	10 d	[64]
Reovirus	Strain R2, strain S1133	10^3–10^4	Cotton	23°–26°C	1–4 d	[65]
Vacciniavirus	Strain Lederle	10^8–10^9	Cotton (sheeting, terry cloth, knit jersey)	25°C	1–2 w	[66]
Variola virus	Clinical isolate	$5x10^5$	Cotton	4°C 20°–24°C 30°C	≥10 y 18 m 60–70 d	[67]

RT=room temperature; *2 $\log_{10}$ reduction

demonstrated with the coronavirus. The variola virus remained infectious for more than 10 years at 4°C (Table 5).

Synthetic fibers

On synthetic fibers, some viruses kept their infectivity at room temperature for 12 d (ebolavirus), up to 7 d (influenza A virus, norovirus), or up to 3 d (calicivirus). The metapneumovirus could only persist for less than 1 d (Table 6).

Mixed and other fibers

On the different types of fibers, viruses kept their infectivity at room temperature for up to 28 d (vacciniavirus), 14 d (calicivirus, norovirus), 12 d (foot-and-mouth disease virus) and 10 d (poliovirus). The influenza A virus, however, persisted only for up to 1 h. A low temperature enabled the vacciniavirus to persist longer, whereas the foot-and-mouth disease virus lost its infectivity sooner (Table 7).

Discussion

The compilation of data shows that the survival of bacteria at room temperature was the longest on polyester (up to 206 d), whereas it was 90 d for some species on cotton and mixed fibers. Only low inocula of 100 CFU were found on all types of textiles with a short survival time of ≤3 d. Most bacterial species survived better at elevated air humidity. The infectivity of viruses on textiles is lost much faster at room temperature, typically within 2–4 w. These data show that contaminated textiles may well serve as a source of transmission, provided the inoculum is high enough. Elevated air humidity is an advantage for survival of bacteria.

These data may have implications for the washing intervals of clothes worn at work. The duration of wear has an

Table 6: Persistence of viruses on synthetic fibers

Species	Strains/isolates	Inoculum	Material	Temperature	Persistence	Reference
Calicivirus	Feline calicivirus strain F9	10^6	Nylon carpet fibers	RT	1–3 d	[68]
Ebolavirus	Clinical isolate	10^7	Tyvek	21°C 27°C	12 d 3 d	[69]
Influenza A Virus	Strain Delaware 471/86 (H13N7)	$6x10^4$	Polyester	RT	<1 d	[61]
Influenza A Virus	5 strains (H1N1)	Unknown	Microfibre	RT	1 w	[70]
Metapneumovirus	Strain APV/MN-2a	$3x10^4$	Polyester	RT	<1 d	[61]
Norovirus	Murine norovirus strain CW3	10^6	Nylon carpet fibers	RT	7 d	[68]

RT=room temperature

Table 7: Persistence of viruses on mixed and other fibers

Species	Strains/isolates	Inoculum	Material	Temperature	Persistence	Reference
Calicivirus	Feline calicivirus strain F9	10^6	Wool	RT	7–14 d	[68]
Influenza A Virus	Clinical isolate (H1N1)	30 $3x10^3$ $3x10^5$	Facial tissue	RT	<15 min <15 min ≤15 min	[71]
Influenza A Virus	Clinical isolate (H1N1)	30 $3x10^3$ $3x10^5$	Pillow case	RT	<15 min ≤15 min ≤60 min	[71]
Foot-and-mouth disease virus	3 strains	Unknown	Wool	4°C 18°C 37°C	2–3 d 11–12 d 33–68 h	[72]
Norovirus	Murine norovirus strain CW3	10^6	Wool	RT	7–14 d	[68]
Parainfluenzavirus	3 strains	10^3	Lab coat	22°C	0.5–4 h*	[73]
Parainfluenzavirus	3 strains	10^3	Facial tissue	22°C	2 h	[73]
Poliovirus	Type 2	10^9–10^{10}	Wool (blanket, gabardine)	25°C	10 d	[62]
Respiratory syncytial virus	Clinical isolate	10^5	Paper facial tissue	22°–25°C	1 h	[74]
Respiratory syncytial virus	Clinical isolate	10^5	Cloth gowns (cotton and polyester)	22°–25°C	1–2 h	[74]
Vacciniavirus	Strain VR119	10^7	Carpet	21°–23°C 6°–7°C	<1–14 d** 21–56 d**	[75]
Vacciniavirus	Strain Lederle	10^8–10^9	Wool (blanket, gabardine)	25°C	2–4 w	[66]

RT=room temperature; *depending on the type of coat; **longer persistence at lower air humidity

impact on the overall microbial load. It has been shown that the bacterial contamination of nurses' coats is significantly higher after the second shift than after the first [9]. The change intervals in clinical practice may not reflect the real risk of contaminated clothes. In France, doctors changed their coats on average every 20 days [10]. Contaminated clothes may also have an impact on the contamination of the HCWs' hands and vice versa. The presence of pathogens on coats is associated with the presence of pathogens on the hands of HCWs, whence they were probably originally transferred to the coats. Nevertheless, this still suggests that a contaminated coat can serve as a reservoir for contamination of the HCWs' hands [11]. It has therefore been proposed that doctors leave their arms bare below the elbows, hang up their coat before patient contact, and launder their coat daily [12].

The impregnation of textiles with antimicrobial agents such as silver compounds, triclosan or copper has also been discussed to reduce their contamination in healthcare [13]. Copper-impregnated textiles can reduce multiresistant bacterial species within 1 h [14]. Among chronic ventilator-dependent patients, a significant reduction of healthcare infections indicators, such as antibiotic treatment initiation events, fever days and antibiotic usage, was described when the HCWs wore copper-oxide impregnated textiles instead of regular hospital textiles [15]. Copper-impregnated linens were even described to

reduce healthcare-associated *C. difficile* infections [16]. Despite all the encouraging results, the permanent exposure of nosocomial pathogens to a biocidal agent is likely to enhance tolerance to this agent [17]. *A. baumannii*, for example, has been described to become resistant to copper, also by exposure to subinhibitory concentrations of copper [18]. The increased tolerance may well be explained by copper efflux systems [19]. Certain *P. aeruginosa* isolates have also been found to possess copper tolerance [20]. Items with permanent biocidal impregnation should therefore be regarded with great caution, because it seems to be a matter of time before nosocomial pathogens develop a tolerance to them, possibly even a cross-tolerance to other biocidal agents or antibiotics [21], [22], [23].

Conclusions

Contaminated textiles or fabrics may be a source of transmission for weeks. The presence of pathogens on the coats of healthcare workers is associated with the presence of pathogens on their hands, demonstrating the relevance of textile contamination in patient care.

Notes

Competing interests

The author declares that he has no competing interests.

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