

## CONCISE REPORT

# Comparison of bacterial loads of two types of hospital pillows: Perspectives of improving hospital hygiene standards

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## ABSTRACT

There is increasing evidence that hospital pillows may spread pathogens. This study measured microbial loads inside disinfectable antimicrobial filter-equipped SleepAngel pillows (N=32) and pillows equipped with plastic covers (n=32). The bacteria were counted and identified. Filter pillows were more often sterile inside and contained fewer colonies than regular pillows (p=0.0001). Regular and SleepAngel pillows harbored equal amounts of microorganisms on surface but interior of SleepAngel pillows were more often culture negative, and hence, SleepAngel pillows transformed volumetric reservoirs to surfaces. SleepAngel pillows could contribute to a growing assortment of tools used in infection prevention and control.

## KEY WORDS

microbiology, infection control, pillow, bedding, hospital hygiene

## INTRODUCTION

Microorganisms can remain viable on common hospital surfaces up to several weeks. In contrast to evidence regarding hard surfaces, relatively few studies have focused on textiles (1, 2, 3, 5). Bedding constitutes a known reservoir for pathogens (8). Pillow seams and care labels that are attached by stitching to the pillow form the most significant vector for pathogens (7).

As microbes can enter regular bedding, bedding is not just a surface, but a volumetric pathogen reservoir. Usually plastic pillow protectors are used to prevent the entry. Legislation concerning microorganisms in pillows is vague – for example, EU council directive (2007/47/EC) states that a medical device must reduce risk for hospital-acquired infection. European Pharmacopoeia (Ph Eur) provides volumetric criteria for non-sterile pharmaceutical products: lack of *Staphylococcus aureus* and *Pseudomonas aeruginosa*, and the colony counts should not exceed the specific limits of each product category (4). However, these criteria appear relevant for assessment of volumetric hospital textile objects. The food industry has a standard of less than 5 cfu/cm<sup>2</sup> aerobic growth and lack of indicator microorganisms. Adaption thereof has been suggested (3) previously for surfaces of medical devices. Previously, no standards have been suggested for volumetric medical devices.

The aim of this study was to investigate and compare the microbial loads inside two types of hospital pillows after three months of use in the Turku University Hospital (Finland), maternity ward.

## METHODS

Manufactured by Gabriel Scientific Ltd, the filter pillow (SleepAngel Pneumapure) is a European Conformity class I medical device designed for infection prevention. It has waterproof and zipperless structure combined with PneumaPure™ filter technology, which enables airflow into the pillow but blocks bacteria, viruses and allergens as well as ingress of liquid. Its pore size, 0.2 µm, is routinely used for guaranteeing cell culture purity (6). The filter pillows are manufactured in regular factory conditions that are not required to be sterile. The surface of the pillow requires disinfection before each patient. The regular pillows (cotton surface, synthetic filling) are equipped with open-ended plastic protectors, because sealing a pillow in the plastic would make it feel like a balloon under the head.

The pillows were used in hospital for three months. Before each patient admission, hospital personnel prepared the pillows. They disinfected the filter pillows' surfaces with an

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all-purpose cleaner (Erisan Oxy+ 2%). They removed the regular pillows' plastic protectors and evaluated whether the pillows required laundry or merely changing the plastic pillow protector. The filter pillows (n=32) and regular hospital pillows (n=32) were collected from underneath a patient's head or from bed of a patient just discharged. Before collection, the pillows were subjected to the described hygiene routines (disinfection or cover change). None of the studied regular pillows were subjected to laundry immediately prior to collection. All pillows were collected on the same day.

### MICROBIOLOGICAL ANALYSES

The pillows were packed into sterile bags, transported, treated equally, and sampled within 24 hours. The surface of the pillows was analyzed by contact plate method with blood agar (BA). The samples were taken by contacting the plate to four sites of a pillow.

Methods of interior sampling are based on Weernink et al. (8) and Ph Eur (4). Two cuts were made with a sterilized paper knife to diagonally opposed corners of the pillows in laminar flow cabinet. The contents (20 to 25 ml) were pulled out with sterile forceps and inserted into 20 ml sterile saline in 50 ml sterile falcon tube. The samples were shaken and then vortexed for two minutes. 100 µl samples were plated on horse blood agar (BA), CLED agar and Saboraud Emmons (SE). BA and CLED were incubated for 32 hours at 37°C; SE was incubated for 80 hours at 37°C.

The number of colonies and types of colonies was recorded and pure cultures were isolated onto Mueller-Hinton agar for further analysis. The pure cultures from pillows were identified by means of MALDI-TOF (database: MBT Compass Library DB-5989) according to manufacturers' instructions. In case of unclear identification, the analyses were repeated.

### RESULTS

Interiors of regular pillows were more often culture positive than filter pillows (Fisher's exact test  $p=0.0002$ ) (Table 1), the total counts of microorganisms from inside of regular pillows were higher, as well (T-test  $p=0.035$ ). One regular pillow interior yielded more than 100 CFU per milliliter of interior

material. The surfaces of regular pillows yielded greater counts of bacteria but the difference was not statistically significant. The diversity of microorganisms on regular pillows appeared higher than that of filter pillows. The microorganisms detected from insides and surfaces of the pillows appeared mostly commensal, no serious healthcare-associated pathogens were detected. Any pillow with any bacteria would have exceeded the Ph Eur standard for mass  $10^1$  CFU/g, and is identical to analysis of sterile vs nonsterile. Some of the microbes could not be identified by means of MALDI-TOF. No mechanical failure was observed in any pillow.

### DISCUSSION AND CONCLUSIONS

This study highlights the role of regular hospital pillows as bacterial reservoirs. We did not detect any known healthcare-associated pathogens; typical bacterial isolates were coagulase-negative staphylococci. Moreover, we considered the counts of microorganisms as low even in the regular pillows. It is possible that this was influenced by clinical setting, which in our study was maternity ward. Perhaps a different picture would have emerged in an infectious diseases, urology or intensive care ward. On the other hand, reducing transmission of coagulase-negative staphylococci has been highly relevant to immunocompromised patients for decades (9).

Filter pillows mitigated the reservoir function from volumetric to that of surface. The bacteria inside the filter pillows were probably sealed into the pillows during production, while majority of microorganisms isolated from the regular hospital pillows probably originated from the patients (the bacteria bypassed the plastic pillow protectors into the interior). This would provide rationale for the higher inside counts in the regular pillows. The disinfection of the filter pillow surfaces reduced microbial counts more effectively than passive protection provided by the pillow covers. This would provide rationale for the trend towards higher surface microbial counts on the regular pillows.

A larger study with in a more challenging hospital setting is necessary to investigate whether filter pillows' mitigation of reservoir function from volumetric to that that of the surface translates to actual reduction of hospital-acquired infections.

**TABLE 1: Distribution of bacterial colonies from pillows**

#### Number of contaminated pillows by identified microorganisms

Sample	N of samples	N of colonies	MSSA <sup>§</sup>	CoNS <sup>€</sup>	<i>M. luteus</i>	<i>Bacillus</i> spp. <sup>#</sup>	<i>Caulobacter</i> sp.
Interior							
Filter pillow	32	3	0	0	0	0	1
Regular pillow	32	65	0	6	1	0	0
Surface							
Filter pillow	32	82	0	1	0	3	0
Regular pillow	32	264	1	16	5	0	0

<sup>€</sup> Coagulase-Negative staphylococci: *S. epidermidis*, *S. warneri*, *S. hominis*, *S. capitis*, *S. pettenkoferi*.

<sup>#</sup> *Bacillus mycoides*, *Bacillus* spp.

<sup>§</sup> methicillin-susceptible *Staphylococcus aureus*

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