



병상 커튼 미생물 오염률: 전향 배양 연구

이찬미^{1*} · 고혜연^{2*} · 이효연² · 오영록² · 최평균^{1,2} · 박완범^{1,2} · 김남중^{1,2}

서울대학교 의과대학 내과학교실¹, 서울대학교병원 감염관리센터²

Microbial Contamination Rates of Hospital Privacy Curtains: A Prospective Culture Study

Chan Mi Lee^{1*}, Hye Yeon Goh^{2*}, Hyo Yeon Lee², Young Rok Oh², Pyoeng Gyun Choe^{1,2},
Wan Beom Park^{1,2}, Nam Joong Kim^{1,2}

Department of Internal Medicine, Seoul National University College of Medicine¹, Center for Infection Control and Prevention, Seoul National University Hospital², Seoul, Korea

Received April 27, 2021

Revised May 28, 2021

Accepted May 31, 2021

Corresponding author:

Nam Joong Kim

E-mail: molder@unitel.co.kr

ORCID:

<https://orcid.org/0000-0001-6793-9467>

*CM Lee and HY Goh contributed

equally to this work.

Contaminated curtains are a reservoir of microorganisms that can be a source of infection outbreak. In order to investigate the contamination rates of hospital curtains over time, we obtained cultures from 34 hospital privacy curtains and 2 control curtains over 8 weeks. If the cultures revealed over 2.5 colony-forming units (CFU)/cm² of microorganisms, the curtains were considered contaminated. The burden of microorganisms in the control curtains remained under 0.2 CFU/cm² during the study period. The cumulative contamination rate of the hospital privacy curtains increased over time (week 2: 15.6%, week 4: 37.0%, and week 8: 55%). The contamination rates of the curtains from the 2-, 4-, 5-, 6-, and 7-bed rooms were 0% (0/1), 0% (0/4), 20% (1/5), 43.8% (7/16), and 100% (3/3), respectively. Methicillin-resistant *Staphylococcus aureus* was not isolated from either the control or the hospital curtains during the study period. Vancomycin-resistant enterococci was not isolated from the control curtains but was isolated from 11.8% (4/34) of the hospital curtains (week 2: 2, week 4: 1, and week 6: 1). The contamination rate of the hospital curtains increased over time and showed a tendency to rise with an increase in the number of beds in a room.

Key Words: Hospital, Contamination, Environment

Hospital privacy curtains are easily contaminated by microorganisms [1,2]. Contaminated curtains are a potential source of infection and a reservoir for dissemination [3,4]. Considering curtains as potential sources of infection outbreak, it would be reasonable to recommend a protocol for regular changing frequencies. Guidelines for environmental infection control suggest that privacy curtains should be disinfected or changed more frequently than the surfaces having minimal hand contact [5]. The objective of this study was to estimate the contamination

rates of hospital curtains over time and suggest the factors to be considered when deciding the regular changing frequencies of hospital curtains.

We collected 34 hospital privacy curtains from one intensive care unit (ICU) (n=5) and six general wards (n=29). Initially, we did not include the curtains if vancomycin-resistant enterococci (VRE) or methicillin-resistant *Staphylococcus aureus* (MRSA) was isolated from the admitted patients. Of the 29 curtains from the general wards, 1 was from a 2-bed room, 4 from 4-bed



rooms, 5 from 5-bed rooms, 16 from 6-bed rooms, and 3 from 7-bed rooms. Additionally, we collected two control curtains from meeting rooms where no patients had any direct contact. New laundered curtains were placed at the start of the study. All hospital and control curtains were made from the same fabric (100% polyester) and had the same design and size.

They were sampled at baseline and at weeks 1, 2, 3, 4, 6, and 8. During the study period, the curtains were changed, as determined by the healthcare workers who were caring for patients. It is recommended to change curtains at least every 8 weeks or if they become visibly contaminated or have been used by VRE- or MRSA-isolated patients. We also recommend changing curtains if the curtain cultures reveal VRE or MRSA.

The patient's side and leading edge of the curtains were cultured using Rodac plates (Synergy Innovation, Seongnam, South Korea) by pressing against the curtain for 30 seconds. Curtain cultures tested in the subsequent weeks were obtained from the same height but lateral to the previous sampling site. Contact plates were incubated at 36.5°C for 48 hours, and swab samples were streaked on blood agar plates (Synergy Innovation), C-VRE plates (Synergy Innovation) for VRE selection, and MRSA6 plates (Synergy Innovation) for MRSA selection. The plates were incubated for 48 hours at 36.5°C, and the colony-forming units (CFU) were counted. Contamination levels were determined by calculating the CFU/cm² per plate. If the cultures revealed microorganism contamination levels above 2.5 CFU/cm², the curtain was considered contaminated. The study was approved by the Institutional Review Board of the Seoul National University Hospital (No. 2009-073-1157).

In this study, 34 hospital curtains and 2 control curtains were placed and cultured as described previously. Fourteen hospital curtains were removed prior to week 8: seven following various changing schedules of each ward,

three due to VRE isolation from the curtain cultures, two due to MRSA isolation from the admitted patients, and two due to VRE isolation from the admitted patients. The three curtains showing VRE isolation and two curtains used by patients with VRE were not the same.

The contamination level of the control curtains remained under 0.2 CFU/cm² during the study period. Eleven hospital curtains exceeded the contamination threshold of 2.5 CFU/cm² before week 8. The cumulative rate of the contaminated curtains increased during the study period (week 2: 15.6%, week 4: 37.0%, and week 8: 55%; Table 1). MRSA was not isolated from either the control or the hospital curtains during the study period. VRE was not isolated from the control curtains but was isolated from 11.8% (4/34) of the hospital curtains (week 2: 2, week 4: 1, and week 6: 1).

Among the five curtains in the ICU, none were contaminated above a threshold of 2.5 CFU/cm². In contrast, out of the 29 curtains from the general wards, the contamination rates of the curtains from 2-, 4-, 5-, 6-, and 7-bed rooms were 0% (0/1), 0% (0/4), 20% (1/5), 43.8% (7/16), and 100% (3/3), respectively.

Our study revealed that the cumulative contamination rate of the hospital privacy curtains increased over time as compared to the control curtains. Contamination rates tended to increase with an increase in the number of beds in a room. Considering that contamination is likely to occur due to direct contact with patients, caregivers, and healthcare workers, the increased number of beds might have contributed to increased chances of contact and contamination. In this study hospital, all ICU patients were placed in a 1-bed room, and the curtains in the ICU were not frequently touched because most of the patients were sedated. As a result, none of the curtains in the ICU were contaminated during the study period.

Although there is no definite cutoff value for the contamination levels in a hospital environment, previous

Table 1 Cumulative contamination rates of hospital privacy curtains

	Baseline	Week 1	Week 2	Week 3	Week 4	Week 6	Week 8
No. of curtains evaluated	34	34	32	31	27	22	20
Cumulative No. of contaminated curtains	0	3	5	9	10	11	11
Cumulative contamination rate (%)	0	8.8	15.6	29.0	37.0	50.0	55.0

studies have used 2.5 CFU/cm² as the threshold for defining a surface in a hospital environment as clean [6,7]. Because previous research used values below 2.5 CFU/cm² as the hygiene criteria [8,9], we used it as the contamination threshold. The contamination level threshold for hospital privacy curtains is not well established.

Currently, there are no standardizations for the changing or cleaning frequencies of the hospital curtains [5]. Frequent changing of the hospital curtains might have a favorable effect on reducing healthcare-associated infection, but it could increase the cost and prevalence of musculoskeletal disorders among the healthcare workers responsible for changing them [10]. Considering the contamination rate and contamination by multi-drug resistant organisms such as VRE and MRSA, changing curtains only when visibly contaminated is not a sound practice. We suggest that the frequency of changing hospital curtains based on the time elapsed from laundering and the number of beds in a room would be reasonable. We recommend that the regular changing frequencies of hospital curtains do not exceed 4 weeks.

This study has some limitations. First, we did not investigate the correlation between the contamination of curtains and the transmission of microorganisms to the patients. Second, we could not determine whether the contamination was directly from a colonized patient, because we did not perform molecular analysis of the contaminating microorganisms.

We found that the contamination rate of the hospital curtains increased over time and showed a tendency to rise with an increase in the number of beds in a room. The regular changing frequencies of hospital curtains should be based on the time elapsed from laundering and the number of beds in a room.

References

1. Trillis F 3rd, Eckstein EC, Budavich R, Pultz MJ, Donskey CJ. Contamination of hospital curtains with health-care-associated pathogens. *Infect Control Hosp Epidemiol* 2008;29:1074-6.
2. Woodard DR, Buttner M, Cruz P, Roeder J. Microbial contamination of privacy curtains in the emergency department of a metropolitan hospital. *J Hosp Infect* 2018; 100:e153-4.
3. Mahida N, Beal A, Trigg D, Vaughan N, Boswell T. Outbreak of invasive group A streptococcus infection: contaminated patient curtains and cross-infection on an ear, nose and throat ward. *J Hosp Infect* 2014;87:141-4.
4. Das I, Lambert P, Hill D, Noy M, Bion J, Elliott T. Carbapenem-resistant *Acinetobacter* and role of curtains in an outbreak in intensive care units. *J Hosp Infect* 2002; 50:110-4.
5. Sehulster L, Chinn RY. Guidelines for environmental infection control in health-care facilities. Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). *MMWR Recomm Rep* 2003;52(RR-10):1-42.
6. Ho YH, Wang LS, Jiang HL, Chang CH, Hsieh CJ, Chang DC, et al. Use of a sampling area-adjusted adenosine triphosphate bioluminescence assay based on digital image quantification to assess the cleanliness of hospital surfaces. *Int J Environ Res Public Health* 2016;13:576.
7. Furlan MCR, Ferreira AM, da Silva Barcelos L, Rigotti MA, de Sousa AFL, Dos Santos Junior AG, et al. Evaluation of disinfection of surfaces at an outpatient unit before and after an intervention program. *BMC Infect Dis* 2019;19:355.
8. Mulvey D, Redding P, Robertson C, Woodall C, Kingsmore P, Bedwell D, et al. Finding a benchmark for monitoring hospital cleanliness. *J Hosp Infect* 2011;77:25-30.
9. Malik RE, Cooper RA, Griffith CJ. Use of audit tools to evaluate the efficacy of cleaning systems in hospitals. *Am J Infect Control* 2003;31:181-7.
10. Davis KG, Kotowski SE. Prevalence of musculoskeletal disorders for nurses in hospitals, long-term care facilities, and home health care: a comprehensive review. *Hum Factors* 2015;57:754-92.