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The Effect of Terminal Cleaning on Environmental Contamination Rates of Multidrug-Resistant *Acinetobacter baumannii*

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Abstract

We evaluated the prevalence of multidrug-resistant *Acinetobacter baumannii* environmental contamination before and after discharge cleaning in rooms of infected/colonized patients. 46.9% of rooms and 15.3% of sites were found contaminated at baseline. 25% of rooms, 5.5% of sites, were found contaminated post cleaning. Cleaning significantly decreased environmental contamination of *A. baumannii*, however, persistent contamination represents a significant risk factor for transmission. Further studies on this and more effective cleaning methods are needed.

Introduction

Acinetobacter baumannii has emerged as a significant pathogen associated with hospital-acquired infections (HAIs).¹ *A. baumannii* colonizes and infects hospitalized patients; leading to increased morbidity and mortality, particularly in high-risk intensive care (ICU), trauma and burn unit patients.¹ Environmental contamination has been linked to outbreaks involving multidrug-resistant (MDR) *A. baumannii*.^{1,2} The role of routine environmental cleaning (in non-outbreak settings) to prevent transmission of pathogens and thus deter HAIs is less clear but is a potential cost-effective intervention for *A. baumannii* and other MDR pathogens.²⁻⁶

We evaluated the prevalence of environmental contamination with MDR *A. baumannii* before and after terminal cleaning among ICU patients colonized or infected with the organism.

Methods

Patients in the medical, surgical and cardiac surgery ICUs at the University of Maryland Medical Center (UMMC) with a known history of colonization or infection with MDR *A.*

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baumannii were included. MDR was defined as susceptible to ≥ 2 classes of antibiotics.⁶ When a potential participant was to be discharged from their room, environmental samples were collected. After terminal cleaning by environmental services, and prior to new patient admission, samples were collected again from the same locations. Environmental services personnel were unaware of the study.

UMMC terminal cleaning implements a “top-down” (high to low surfaces) cleaning method. Curtains, infusion pumps and respiratory equipment are removed from the room. Wipes saturated with Virex II 256 (Diversey), a quaternary ammonium compound based hospital-grade disinfectant, are used for cleaning all surfaces. A new wipe is used on each surface to avoid cross-contamination. The floor is mopped from back to front with the same disinfectant solution with an 8-10 minute dwell time.

Environmental samples were obtained from up to 10 sites: sink drain and edge of basin, buttons of bed rails, bedside table handle, vital sign monitor buttons, call button/remote, supply cart drawer handles, interior and exterior door handles, infusion pump buttons, ventilator machine buttons, and the floor on either side of the bed (approximately 25cm² area). The whole surface of buttons and handles (bedside table, supply cart drawers and door) were sampled. Not all sites were present in every room. Samples were collected using a pre-moistened BactiSwab dual-tip swab (Remel™) for each site; swabs were rotated and swiped 3 times across each surface.

Swabs were vortexed in Brain Heart Infusion broth with 6 µg/ml imipenem and incubated overnight at 35°C. After incubation, cloudy broths were plated onto MacConkey and MacConkey with 6 µg/ml imipenem agar. Isolates were identified as *A. baumannii* using API20E or Vitek II (bioMérieux). Susceptibility was performed using CLSI guidelines and MDR-status confirmed. Statistical analysis was performed using a McNemar's test.

Results

Between March 2009 and April 2011, 487 cultures were collected from 32 rooms. Fifteen rooms (46.9%) and 41 sites (n=268, 15.3%), were found positive for MDR *A. baumannii* pre-terminal cleaning. The highest rates of contamination prior to cleaning were: floor (12/32, 37.5%), supply cart (7/30, 23.3%), bed rails (5/24, 20.8%) and ventilator (3/15, 20.0%). Each site was positive at least once. Patients with environmental contamination pre-cleaning had their most recent MDR *A. baumannii* culture (clinical or surveillance) collected 53.3 (95% CI 40-66.7, median 16) days prior to environmental sampling; compared to 261.7 (95% CI 203.1-320.3, median 311) days for patients without environmental contamination. Eight rooms (25.0%) were found positive post-terminal cleaning. Overall, a significant reduction in the number of contaminated rooms ($p=0.01$) and sites ($p>0.01$) was observed. Twelve sites (n=219, 5.5%) were found positive post-cleaning. All rooms positive post-cleaning were positive pre-cleaning. Sites with persistent contamination were: floor (4/32, 12.5%), bedside table (2/27, 7.4%), call button (2/20, 10%), door handles (3/32, 9.4%) and supply cart (1/26, 3.8%). See Figure 1 for comparison of contamination rates by site.

Discussion

Almost half of the rooms occupied with patients colonized or infected with *A. baumannii* were contaminated with the pathogen. Moreover, environmental contamination was present even among patients not known to have a recent culture positive for *A. baumannii*, suggesting a potential longevity of contamination on surfaces in patient rooms. A significant reduction in contamination was seen after terminal cleaning occurred amongst the 32 rooms sampled, however, over half the rooms positive prior to cleaning remained contaminated.

Manian *et al.* looked at persistent contamination rates of MDR *A. baumannii* after multiple cleaning treatments using a 1:10 dilution of household bleach to disinfect. Manian found a significant reduction in positive sites after one round of cleaning, but not positive rooms.³

Persistent room contamination serves as a potential reservoir for transmission and colonization of future room occupants. Nseir *et al.* found that admission into an ICU room whose previous occupant was positive for MDR *A. baumannii* increased the risk of acquisition.⁴ Nseir goes on to suggest environmental contamination may play a role in its spread.

Current cleaning techniques in terms of products used or thoroughness of cleaning may not be adequate in the decontamination of this pathogen. Novel methods, such as hydrogen peroxide vapor and ultra-violet light, have been shown to be significantly more effective; however, turnaround time may limit regular use and hinder implementation in hospitals.^{3,4,7}

This study has a few potential limitations. Since cleaning methods and staff were not observed, potential poor cleaning technique or practice may have occurred, and post-cleaning contamination rates may be improved with education and feedback to environmental services. Molecular typing was not completed; it cannot be proven that the strain of *A. baumannii* is identical between patient and environmental isolates. Finally, because the same area was sampled on each surface, this may lead to an overestimation of the effect of cleaning; however, enrichment broths were used to reduce this effect.

In conclusion, environmental sites in rooms of patients colonized or infected with *A. baumannii* are frequently contaminated with this organism. Even after cleaning, over 25% of rooms remain contaminated, representing a potential source of transmission. Additional studies are needed to assess more optimal methods of room cleaning and disinfection to prevent HAIs and their spread.

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Figure 1.
Contamination rates at pre and post terminal cleaning, broken down by culture site.