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Major article

Differential environmental contamination with *Acinetobacter baumannii* based on the anatomic source of colonization

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Intensive care unit

Background: *Acinetobacter baumannii* is a pathogen of importance worldwide.
Methods: From January 2011 until January 2012, environmental and surveillance cultures were collected from patients admitted to our intensive care units (ICUs). Surveillance cultures were obtained on admission to the ICU and weekly thereafter. Environmental cultures of high-touch surfaces were performed on an alternating basis every week. A room was designated as contaminated if at least 1 object was positive for carbapenem-resistant *A baumannii*. We only evaluated the rooms belonging to patients who tested positive for *Acinetobacter* infection.
Results: Five hundred eighty-six rooms were cultured across the 5 ICUs surveyed, of which 134 (22.9%) had patients who tested positive for infection with *Acinetobacter*. Among patients colonized in the rectum, the odds of having bed rails contaminated with *A baumannii* were 2.55 times the odds of those with only respiratory colonization ($P = .03$). The odds of having intravenous pumps contaminated with *A baumannii* among patients with only respiratory colonization were 2.72 times the odds of contamination among patients colonized in the rectum ($P = .03$).
Conclusions: There was a significant difference in the degree of contamination of bedrails and intravenous pumps based on the occupant's anatomic source of *A baumannii* infection.

Acinetobacter baumannii is a gram-negative cocobacillus of increasing importance given that it is one of the most common organisms linked to health care-associated infections, especially within intensive care units (ICUs).[1-3] *A baumannii* has a tendency to develop resistance to various antibiotics, being frequently susceptible only to colistin.[4] Therefore, measures to prevent and control the dissemination of this pathogen are necessary.

The hospital environment is known to serve as a reservoir for *A baumannii*; this organism can survive in desiccated surfaces for prolonged periods of time.[5,6] Surfaces that are most frequently touched by the health care workers (eg, bedside rails and bedside tables) are usually the most contaminated objects.[7,8] Additionally, exposure to a contaminated environment has been associated with the acquisition of multidrug-resistant organisms.[9,10] In a previous study, we showed that the presence of a patient colonized with *A baumannii* in a hospital room increased the likelihood of finding *A baumannii* in the room's environment.[8] However, the differential effect of the anatomic source of colonization on the degree of environmental contamination is currently unknown. Therefore, we aimed to determine the proportion of objects contaminated in patient hospital rooms and the proportion of individual surfaces (eg, bed rails and intravenous [IV] pumps) testing positive based on the patient's *A baumannii* anatomic source of colonization.

METHODS

This infection control project was performed from January 1, 2011 to January 31, 2012, at a 1,500-bed public teaching hospital. During this period, the facility was experiencing an endemic situation with carbapenem-resistant *A baumannii* for which a series of interventions were implemented. These interventions included

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Table 1
Proportion of contaminated surfaces based on patient's anatomic source of colonization with *Acinetobacter baumannii*

Anatomic source	No. of contaminated surfaces in the room				Any positive site
	Bed rails	Bedside tables	IV pumps	Ventilator panel	
Only respiratory (n = 54)	9 (16.7)	1 (1.8)	11 (20.4)	2 (3.7)	18 (33.3)
Rectal* (n = 80)	27 (33.8)	2 (2.5)	6 (7.5)	5 (6.2)	35 (43.8)
P value	.03	1	.03	.7	.34

NOTE. Values are given as n (%).
IV, intravenous.
*Includes patients co-colonized in both the rectum and the respiratory tract.

both active surveillance cultures and environmental cultures of inpatient rooms across the ICUs. The protocol for this study was reviewed and approved by the University of Miami's Institutional Review Board.

Active surveillance cultures

Since 2009 active surveillance cultures have been performed on patients upon admission to adult ICUs and weekly thereafter. These cultures include rectal swabs, and if the patient is mechanically ventilated, respiratory cultures. The collection and processing of the samples have been previously described.[8] We only evaluated the rooms belonging to *Acinetobacter*-positive patients; this term was used for a patient with at least 1 positive surveillance culture for carbapenem-resistant *A baumannii* up to the day environmental cultures were performed.

Environmental cultures

As previously described,[8] environmental cultures from inpatient rooms were obtained on a weekly basis. Four standard objects were cultured from the rooms: bed rails, bedside tables, IV pumps, and ventilator control panels.[8] The designation of *Acinetobacter*-positive room was used if any of the 4 objects had carbapenem-resistant *A baumannii* evident on environmental cultures. For the purposes of this project we only included consecutive and unique *Acinetobacter*-positive patients who had environmental cultures performed on at least 1 occasion during the study period. Only the first set of environmental cultures per unique patient was included.

Statistics

We first analyzed the effect of the anatomic source of *A baumannii* (rectal colonization vs only respiratory colonization), treated as a categorical variable, on the proportion of culture-positive objects within a patient's room. For the purposes of our study, patients who had both rectal and respiratory positive cultures were categorized as rectally colonized. Patients solely colonized in the respiratory tract were assigned to the only respiratory colonization group. Similar analyses were performed using contamination of each individual object based on the occupant's anatomic source of colonization. Proportions were analyzed using χ^2 or Fisher's exact test, as required. All analyses were done using SAS version 9.2 (SAS Institute Inc, Cary, NC).

RESULTS

A total of 586 rooms were cultured across 5 ICUs surveyed during the study period. Of these, 452 (77.1%) housed *Acinetobacter*-negative patients, and 134 (22.9%) housed *Acinetobacter*-positive patients. We found 54 patients with only respiratory colonization, 10 patients with only rectal colonization, and 70 patients who were co-colonized (rectum and respiratory tract).

The proportion of contaminated surfaces on the room based on the patient's source of colonization with *A baumannii* can be seen in Table 1. Patients with only respiratory colonization had negative environmental cultures of their rooms in 66% of instances (36 of 54), and among the remaining 18 patients who had positive environmental cultures, 15 (28%) had only 1 object positive for contamination with *A baumannii* and 3 patients (5%) had 2 or more objects contaminated. Among the 80 patients with rectal colonization, 45 (56%) had negative environmental cultures, 30 (37.5%) had only 1 object that tested positive, and 5 (6%) had 2 or more sites that tested positive for *A baumannii*. These differences in proportions of contaminated objects based on anatomic source of colonization failed to reach significance ($P = .34$). A post-hoc analysis performed excluding the 70 patients with co-colonization, found that among patients with only rectal colonization, 70% (7 of 10) had at least 1 object contaminated, compared with 33% (18 of 54) in those patients with only respiratory colonization. These differences almost reached statistical significance ($P = .058$).

The odds of having bed rails contaminated with *A baumannii* among patients with rectal colonization was 2.55 times the odds of contamination found in only respiratory colonized patients (95% confidence interval, 1.08–5.98; $P = .03$) (Fig 1). To the contrary, among the only respiratory colonized patients, the odds of having IV pumps contaminated with *A baumannii* was 2.72 times the odds of contamination found in patients with rectal colonization (95% confidence interval, 1.07–6.9; $P = .03$) (Fig 1). No association was found between a specific anatomic source of colonization and contamination of either the bedside tables or mechanical ventilators.

DISCUSSION

We were able to show that bedrails belonging to patients colonized in the rectum had higher contamination with *A baumannii* than patients colonized only in the respiratory tract, and that IV pumps were more contaminated among patients with respiratory colonization than among patients colonized in the rectum. These results seem logical based on the proximity between colonization sources and preferentially contaminated objects. This is in accordance with previous studies in which the surrounding environment of patients with *A baumannii* infection has been found to be frequently contaminated,[7,8] even more so than with other pathogens.[11] To the best of our knowledge, ours is the first study that shows a differential risk of environmental contamination with *A baumannii* based on the anatomic source of patient colonization.

The objects cultured in our project (ie, bedrails, bedside tables, IV pumps, and ventilator control panels) have been previously described as high-touch surfaces.[12] Prior studies showed that bedrails are the most frequently contaminated objects among patients colonized with *A baumannii*.[7,8] Therefore, our findings add to the current body of literature by suggesting that this contamination might differ based on the anatomic source of colonization. The findings in our study support the performance of various infection control interventions. Because most hospitals do not routinely perform active surveillance cultures upon admission to their ICUs, opportunities for prompt identification of colonized individuals can be lost, especially in regions where *A baumannii* infection is endemic at moderate to high levels. Furthermore, knowledge of the source of colonization and the differential burden of contamination in distinct surfaces could be used to direct cleaning efforts in a targeted way.

The limitations of our project include being a single-center study during a situation of endemic *A baumannii* infection. It is also a