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Concise Communication

Carbapenem-resistant *Acinetobacter baumannii* load in patients and their environment: the importance of detecting carriers

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Abstract

The environment surrounding 30 of 31 carriers of carbapenem-resistant *Acinetobacter baumannii* (CRAB) was contaminated by CRAB. The environmental CRAB loads were similar whether carriers were identified only by surveillance cultures (nonclinical carriers) or also had positive clinical cultures. Screening to detect and isolate nonclinical CRAB carriers may be important to prevent CRAB transmission.

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Carbapenem-resistant *Acinetobacter baumannii* (CRAB) can survive on dry surfaces for months and is often resistant to common disinfectants.[1] Horizontal transmission of CRAB occurs via the hands of healthcare personnel, who move between patients or from contaminated objects or surfaces to patients, or via patients' direct contact with contaminated objects or surfaces. Therefore, contact precautions are recommended for CRAB carriers.[2] Carriers can be identified by clinical cultures (ie, clinical carriers) or by surveillance cultures (ie, nonclinical carriers). Screening for CRAB carriage is recommended in special situations (eg, outbreaks), but its value in nonoutbreak settings remains controversial.[2] Assessing the CRAB load in nonclinical carriers and determining whether they contaminate their environment is important for deciding whether routine CRAB screening and carrier isolation should be implemented. We investigated CRAB load among CRAB carriers and their environment, and we compared nonclinical carriers to clinical carriers.

Methods

Study setting and patient sample

This research was conducted at Tel Aviv Sourasky Medical Center, Israel, between November 2015 and December 2016. As part of an infection control intervention to combat CRAB hyperendemicity, we screened randomly selected patients and their environment in medical wards and intensive care units for CRAB on several occasions.[3] Occasions on which patients had positive surveillance cultures for CRAB were included in this study. We reviewed the microbiological results for these CRAB carriers in the previous and following month from the date of the positive screening test. Patients with a positive clinical sample for CRAB were categorized as clinical carriers. Otherwise, they were categorized as nonclinical carriers. The study was approved by the hospital's institutional review board.

Data collection

The following data were retrieved from medical records and microbiological databases: age, sex, date and anatomic site of CRAB-positive clinical samples.

Surveillance cultures

Patients and their environment were screened as previously described.[3,4] In brief, patients were screened from the following sites; skin (4 limbs), buccal mucosa, and rectum (not all patients). Environmental samples were collected from 23 high-touch objects and surfaces using sponges, and a median of 10 sites (range, 4–15) were sampled per occasion.

Laboratory methods

Samples were processed as previously described using both direct plating and enrichment.[4] We used CHROMagar MDR *Acinetobacter* plates (Hylabs, Israel). From each positive plate, 1 suspicious colony was isolated and identified using MALDI-TOF (bioMérieux, France).

Evaluation of patient and environmental CRAB load

We evaluated CRAB load at each body site and environmental site using a semiquantitative scale, based on the colony counts: no growth (0); growth only after enrichment (1); direct growth of up to 10 CFU (2); direct growth of 10–100 CFU (3); and direct growth of >100 CFU (4). Each patient's CRAB load was calculated as the sum of the body sites' scores divided by the maximum score possible (4 multiplied by 2 or 3 body sites). Environmental CRAB load was calculated as the sum of the environmental site scores divided by the maximum score possible (4 multiplied by the number of sites screened).[4] The range of these

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Table 1. Semiquantitative CRAB Load in Patients and Their Environment

	Patient Load, No./Total (%)			Environmental Load, No./Total (%)		
Carrier Type	Low	Medium	High	Low	Medium	High
Nonclinical carriers	12/18 (66.7)	3/18 (16.6)	3/18 (16.7)	4/18 (22.2)	11/18 (61.1)	3/18 (16.7)
Clinical carriers	1/13 (7.7)	5/13 (38.4)	7/13 (53.8)	1/13 (7.7)	7/13 (53.8)	5/13 (38.4)

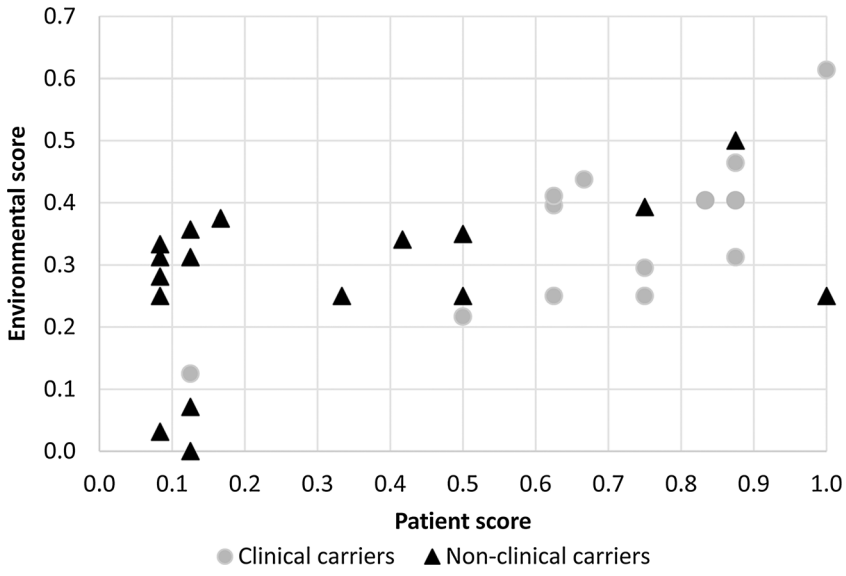

Fig. 1. Correlation between patient CRAB load score and environmental CRAB load score. Spearman rank correlation coefficient, $\rho = 0.67$ ($P = .01$) for clinical carriers; $\rho = 0.495$ ($P = .04$) for nonclinical carriers.

values was divided into 3 equal categories of low, medium, and high CRAB load.

Statistical analysis

Groups were compared using the Fisher exact test, and correlation was assessed using the Spearman rank correlation coefficient ρ. Statistical analyses were performed using SAS version 9.4 software (SAS Institute, Cary, NC).

Results

Of 79 patients screened, 27 tested positive for CRAB and comprised our sample. Mean age was 73 years (±15.5 SD) and 15 (55.6%) were female. One patient was identified as a CRAB carrier on 3 separate occasions (screened on different wards), and 2 patients were identified as carriers on 2 occasions (screened in the same ward, 1 month apart), for a total of 31 occasions of positive patient screenings and their associated environmental samples.

Among the 31 positive patient screenings, 13 were from clinical carriers and 18 were from nonclinical carriers. Clinical sites were sputum (n = 10), blood (n = 3), and drainage (n = 2); 2 patients were positive in 2 sites. Of 308 environmental sites sampled, 238 (77%) were CRAB positive (Supplementary Table S1 online).

CRAB load in patients and their environment

Table 1 shows the CRAB load in patients and their environment. Although nonclinical carriers had lower CRAB loads than clinical carriers ($P = .003$), the environmental CRAB load was similar between the groups ($P = .31$). The scatter plot in Figure 1 shows the correlation between patient load and environmental load in clinical and nonclinical carriers. The environment was CRAB positive on 30 of 31 occasions. The environmental load on 26 of 31 occasions ranged from 20% to 50% of the maximum score, regardless of patient CRAB load or clinical (or nonclinical) status.

Discussion

Current guidelines call for contact precautions when providing care for patients known to be colonized or infected by CRAB, but active screening of patients for CRAB is recommended only in special circumstances (eg, outbreaks).[2] The immediate vicinity of nearly all CRAB carriers was contaminated by CRAB and CRAB load in the environment was similar between clinical and nonclinical carriers. These findings suggest that CRAB screening to detect carriers might have a role in curtailing environmental contamination and preventing transmission.

Carriers and infected patients shed pathogens into their environment. Dissemination into the surroundings may differ between patients and between pathogens. We previously showed that carbapenem-resistant *Enterobacterales* (CRE) dissemination to the environment follows the 20:80 rule: 20% of carriers act as superspreaders and are responsible for 80% of shedding.[5] In contrast, in the current study, the CRAB loads in the environment were similar in the surroundings of >80% of carriers. One possible explanation may be the different anatomic site of colonization between CRE and CRAB. In a study looking only at CRAB, Rosa et al[6] showed that environmental contamination differed by colonization site.

We did not detect a significant difference in the environmental load between clinical and nonclinical carriers. In one study, 48% of rooms of multidrug-resistant *A. baumannii* (MDR-AB) carriers

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were contaminated, even among patients in whom MDR-AB was detected >2 months earlier.[7] High environmental contamination has also been observed in carriers of gram-positive, drug-resistant organisms (ie, VRE and MRSA).[8]

The WHO determined that there is insufficient evidence to recommend routine CRAB screening because the value of screening and the optimal screening method are uncertain.[2] Regarding the optimal screening method, a growing body of evidence indicates that culturing the skin using a premoistened sponge with overnight enrichment is the best method to detect CRAB carriage.[4,9,10] Regarding the benefit of screening, identifying and isolating CRAB carriers and intensifying terminal cleaning of their surroundings should reduce transmission. However, more studies are needed to determine whether the "search and isolate" strategy in endemic settings could prevent in-hospital transmission and to outline screening criteria (ie, who and when to screen).

A strength of this study is that we reported CRAB load semiquantitatively, not just as present or absent. A limitation is that we did not perform molecular studies to test similarity between patient and environmental isolates (ie, environmental contamination could be unrelated to the current patient).

In summary, the environment surrounding CRAB carriers, including those identified solely by surveillance cultures, is contaminated with CRAB. Screening to detect and isolate nonclinical CRAB carriers may be important to prevent CRAB transmission. Studies that evaluate whether implementation of CRAB screening in endemic settings reduces CRAB incidence are needed.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2023.39

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References

1. Piperaki E-T, Tzouvelekis LS, Miriagou V, Daikos GL. Carbapenem-resistant *Acinetobacter baumannii*: in pursuit of an effective treatment. *Clin Microbiol Infect* 2019;25:951–957.
2. World Health Organization. Guidelines for the prevention and control of carbapenem-resistant Enterobacteriaceae, *Acinetobacter baumannii* and *Pseudomonas aeruginosa* in health care facilities. https://www.who.int/publications/i/item/9789241550178
3. Lerner AO, Abu-Hanna J, Carmeli Y, Schechner V. Environmental contamination by carbapenem-resistant *Acinetobacter baumannii*: the effects of room type and cleaning methods. *Infect Control Hosp Epidemiol* 2020;41:166–171.
4. Nutman A, Lerner A, Schwartz D, Carmeli Y. Evaluation of carriage and environmental contamination by carbapenem-resistant *Acinetobacter baumannii*. *Clin Microbiol Infect* 2016;22:949.e5–949.e7.
5. Lerner A, Adler A, Abu-Hanna J, Cohen Percia S, Kazma Matalon M, Carmeli Y. Spread of KPC-producing carbapenem-resistant Enterobacteriaceae: the importance of super-spreaders and rectal KPC concentration. *Clin Microbiol Infect* 2015;21:470.e1–e7.
6. Rosa R, Depascale D, Cleary T, Fajardo-Aquino Y, Kett DH, Munoz-Price LS. Differential environmental contamination with *Acinetobacter baumannii* based on the anatomic source of colonization. *Am J Infect Control* 2014;42:755–757.
7. Thom KA, Johnson JK, Lee MS, Harris AD. Environmental contamination because of multidrug-resistant *Acinetobacter baumannii* surrounding colonized or infected patients. *Am J Infect Control* 2011;39:711–715.
8. Knelson LP, Williams DA, Gergen MF, *et al.* A comparison of environmental contamination by patients infected or colonized with methicillin-resistant *Staphylococcus aureus* or vancomycin-resistant enterococci: a multicenter study. *Infect Control Hosp Epidemiol* 2014;35:872–875.
9. Doi Y, Onuoha EO, Adams-Haduch JM, *et al.* Screening for *Acinetobacter baumannii* colonization by use of sponges. *J Clin Microbiol* 2011;49:154–158.
10. Nutman A, Temkin E, Lellouche J, Ben David D, Schwartz D, Carmeli Y. Detecting carbapenem-resistant *Acinetobacter baumannii* (CRAB) carriage: which body site should be cultured? *Infect Control Hosp Epidemiol* 2020;41:965–967.