American Journal of Infection Control ■■ (2015) ■■–■■

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major articles

Asymptomatic rectal colonization with carbapenem-resistant *Enterobacteriaceae* and *Clostridium difficile* among residents of a long-term care facility in New York City

Nishant Prasad MD [a,b,c], Georges Labaze MD [a,d], Joanna Kopacz MD [a,b,c], Sophie Chwa MD [a,d], Dimitris Platis MD [a,d], Cynthia X. Pan MD [a,d], Daniel Russo MD [c], Vincent J. LaBombardi PhD [e], Giuliana Osorio [e], Simcha Pollack PhD [f], Barry N. Kreiswirth PhD [g], Liang Chen [g], Carl Urban PhD [a,b], Sorana Segal-Maurer MD [a,b,*]

[a] *Department of Medicine, NewYork-Presbyterian/Queens, Flushing, NY*
[b] *The Dr. James J. Rahal Jr. Division of Infectious Diseases, NewYork-Presbyterian/Queens, Flushing, NY*
[c] *Silvercrest Center for Nursing and Rehabilitation, Flushing, NY*
[d] *Division of Geriatrics and Palliative Medicine, NewYork-Presbyterian/Queens, Flushing, NY*
[e] *Department of Pathology, NewYork-Presbyterian/Queens, Flushing, NY*
[f] *Computer Information Systems and Decision Sciences, St. John's University, Queens, NY*
[g] *Public Health Research Institute, New Jersey Medical School, Rutgers University, Newark, NJ*

Key Words:
Clostridium difficile
carbapenem-resistant *Enterobacteriaceae*
rectal colonization
long-term care facility

Background: Residents of long-term care facilities (LTCFs) are at increased risk for colonization and development of infections with multidrug-resistant organisms. This study was undertaken to determine prevalence of asymptomatic rectal colonization with *Clostridium difficile* (and proportion of 027/NAP1/BI ribotype) or carbapenem-resistant *Enterobacteriaceae* (CRE) in an LTCF population.

Methods: Active surveillance was performed for *C difficile* and CRE rectal colonization of 301 residents in a 320-bed (80-bed ventilator unit), hospital-affiliated LTCF with retrospective chart review for patient demographics and potential risk factors.

Results: Over 40% of patients had airway ventilation and received enteral feeding. One-third of these patients had prior *C difficile*–associated infection (CDI). Asymptomatic rectal colonization with *C difficile* occurred in 58 patients (19.3%, one-half with NAP1+), CRE occurred in 57 patients (18.9%), and both occurred in 17 patients (5.7%). Recent CDI was significantly associated with increased risk of *C difficile* ± CRE colonization. Multivariate logistic regression analysis revealed presence of tracheostomy collar to be significant for *C difficile* colonization, mechanical ventilation to be significant for CRE colonization, and prior CDI to be significant for both *C difficile* and CRE colonization.

Conclusions: The strong association of *C difficile* or CRE colonization with disruption of normal flora by mechanical ventilation, enteral feeds, and prior CDI carries important implications for infection control intervention in this population.

The Centers for Disease Control and Prevention have labeled carbapenem-resistant *Enterobacteriaceae* (CRE) and *Clostridium difficile* urgent threats requiring mandatory reporting.[1] Residents of long-term care facilities (LTCFs) are at increased risk for colonization with these pathogens and increased risk for development of subsequent infections.[2-5] However, insufficient data exist as to the burden of asymptomatic colonization and concurrent colonization with both *C difficile* and CRE.

* Address correspondence to Sorana Segal-Maurer, MD, The Dr. James J. Rahal Jr Division of Infectious Diseases, NewYork-Presbyterian/Queens, 56-45 Main St, Flushing, New York 11355.
E-mail address: sxsegalm@nyp.org (S. Segal-Maurer).

Funding/Support: Supported by The Eugene & Theresa M. Lang Center for Research and Education (processing of microbiologic specimens and statistical analysis).
Previous Presentation: Presented at the American Geriatrics Society 2014 meeting, May 15-18, 2014, Orlando, FL (Abstract C-77).
Conflicts of Interest: None to report.

0196-6553/
http://dx.doi.org/10.1016/j.ajic.2015.11.021

We present a study to assess the rates of rectal colonization with *C difficile* and CRE among patients in an affiliated LTCF using rectal swabs. We include an analysis of risk factors and molecular analysis of CRE and presence of *C difficile* 027/NAP1/BI ribotype.

METHODS

Setting

The study took place at a 320-bed medical center–affiliated LTCF housing adult patients (including a dedicated 80-bed ventilator unit and a short-term rehabilitation floor). All patients with mechanical ventilation or use of tracheostomy collar are housed on 1 of 3 wards (2 ventilator units and 1 step-down unit), designated here as respiratory units. Patients located on the short-term rehabilitation floor were excluded from the study because of their transient nature. We did not change infection control isolation policies for asymptomatic colonized patients because we did not have an outbreak situation.

After institutional review board approval for collection of patient data, active surveillance for presence of CRE and *C difficile* was performed on all residents using rectal swabs. Because this was part of facility-wide infection control initiative, patient informed consent was not obtained. Residents were excluded if they exhibited signs and symptoms of diarrhea, had documented *C difficile*–associated infection (CDI), were receiving a course of treatment for CDI, or resided on the short-term rehabilitation floor.

Rectal swabs were performed once for each individual resident over a 17-week period (because of sporadic staffing). In accordance with current guidelines, no specific interventions were implemented for asymptomatic colonized patients.[6] Rectal (rather than perianal) swabs were chosen as per recent data supporting optimal detection of CRE.[7,8]

Microbiology

Rectal swab specimens were collected using a double-swab transport system containing Stuart media. On receipt in the laboratory, 1 swab was removed and tested for *C difficile* toxin B gene and NAP-1 North American pulsed-field type I 027 ribotype using the Xpert *C. difficile* assay (Cepheid, Sunnyvale, CA). The second swab was used to inoculate a 5-mL trypticase soy broth tube to which one 10-μg ertapenem susceptibility disk had been added. These tubes were incubated for 18 hours at 35°C in ambient air. After incubation the tubes were vortexed, and 100 μL of the broth culture was inoculated onto a MacConkey agar plate streaked for isolation. These plates were incubated for 18 hours at 35°C in ambient air. After this, all colonies growing on the plate were identified, and susceptibility testing was performed in the VITEK 2 (bioMérieux, Durham, NC) according to standard protocol.[9] Although all colony types were identified, we only include data on lactose fermenters in this article. Isolates that demonstrated resistance to ertapenem were confirmed to be CRE by utilization of the Hodge test.[10] We considered any *Enterobacteriaceae* that grew on the plates and tested resistant to a carbapenem in the VITEK 2 as CRE.[11] Further molecular testing for CRE and extended-spectrum β-lactamase (ESBL) genes, including bla_{KPC}, bla_{NDM}, bla_{IMP}, bla_{VIM}, bla_{OXA-48}, bla_{CTX-M}, bla_{SHV}, and bla_{TEM}, was performed by molecular beacon real-time polymerase chain reaction (PCR) assay.[12,13]

Patient data

Retrospective chart review included patient demographics, comorbid conditions, proton pump inhibitor (PPI) use in prior 60 days, prior history CDI (including number of days since last infection), use of mechanical ventilation or tracheostomy collar, use of enteral feeding, use of quinolone class antimicrobials in prior 30 days, days since prior hospital transfer, and geographic location in the LTCF (specifically, location on respiratory units compared with general units). Data regarding other antibiotic use was not complete and therefore not tabulated.

Statistical methods

Comparisons of continuous variables between the groups was done using the independent *t* test and summarized as mean ± SD. Fisher exact test was used for categorical variables. The association of the binary variables *C difficile* colonization and CRE colonization with independent predictors was performed using univariate and multivariate logistic regression. The area under the curve (AUC) and sensitivity and specificity were used to quantify the clinical implications of the findings. Means and SDs are presented as mean ± SD, and 95% confidence intervals (CIs) were used as a measure of precision of the odds ratios (OR) and other important parameters. *P* values <.05 were deemed statistically significant; no multiple test adjustment to the *P* value was done. All analyses were conducted using SAS 9.4 (SAS Institute, Cary, NC).

RESULTS

Of 320 patients, 301 were included in the analysis. Of the 301 patients, 5 were receiving either enteral flagyl (n = 3) or intravenous vancomycin (n = 2) with no documented symptoms or laboratory confirmation of CDI (either active or prior) and were therefore included in the data analysis. The median age of the participants was 75 years (range, 23-102 years). Of the participants, 63% were women, 41% were white, and most had comorbid conditions (Table 1). Over 40% of patients had airway ventilation (mechanical or tracheostomy collar) and enteral tube feeds (all percutaneous) (Table 2).

Patients located on the respiratory units represented 41% of the cohort. Over 90% of these patients were receiving enteral feeding compared with only 12% on general units (111 of 133 patients, $P < .0001$) (Table 2). Over one-third of these patients had prior CDI (compared with 7% on other units, $P < .0001$). Use of PPIs within the

Table 1
Sample characteristics (N = 301)

Characteristic	Value
Age, range (median)	23-102 (75)
Female	190 (63.1)
Ethnicity	
White	122 (40.5)
Black	108 (35.9)
Asian	34 (10.3)
Hispanic	37 (12.3)
Comorbid conditions	
HTN	254 (84.4)
DM	148 (49.2)
HLD	168 (55.8)
CAD	110 (36.5)
CHF	103 (34.2)
Dementia	130 (43.2)
COPD	78 (25.9)
Located on respiratory floors	122 (40.5)

NOTE. Values are n (%) or as otherwise indicated.
CAD, coronary artery disease; *CHF*, congestive heart failure; *COPD*, chronic obstructive pulmonary disease; *DM*, diabetes mellitus; *HLD*, hyperlipidemia; *HTN*, hypertension.