

all containers must bear international symbols with appropriate wording.

In conclusion, regulated medical waste volumes could be reduced by 40% and violations of segregation could be reduced by 90% if best environmental practices such as this new classification of hospital waste were adopted, and in turn it could reduce the cost of waste disposal, given that every hospital produces about 80% of recyclable waste. Because of improper classification of waste, they are considered to be hazardous and more money is spent on their disposal every year. By following this proper classification system and its disposal method, we can economically spend money on hospital waste disposal.

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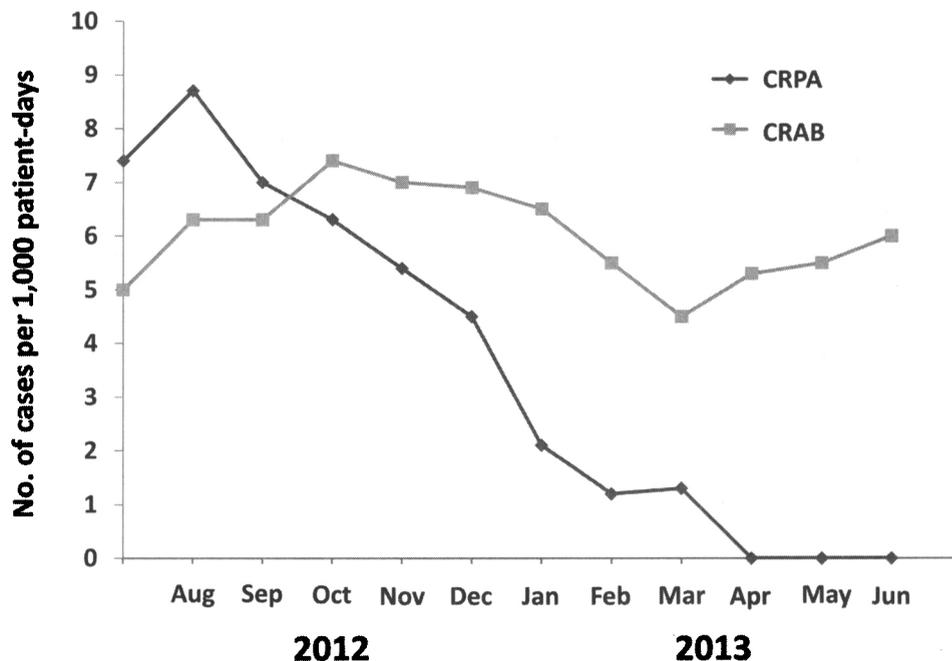
Associations between Carbapenem Use, Carbapenem-Resistant *Pseudomonas aeruginosa*, and Carbapenem-Resistant *Acinetobacter baumannii*

To the Editor—Appropriate antimicrobial therapy is associated with reduction in mortality.^{1,2} Empiric antimicrobial

therapy has led to the increased use of carbapenems for initial broad-spectrum treatment of nosocomial infections worldwide.^{1,2} A few studies have suggested that carbapenems have a differential impact on gut ecology, defined as the emergence of carbapenem-resistant *Acinetobacter baumannii* (CRAB) and carbapenem-resistant *Pseudomonas aeruginosa* (CRPA).^{3,4} In 2 studies, doripenem was less likely to select for CRPA yet was similar in gut-selection capacity to imipenem-cilastatin and meropenem for CRAB.^{3,4} Limited data are available to inform on the relationship between carbapenem use and the prevalence of CRAB and CRPA. We therefore conducted a study to assess the association between carbapenem consumption and the change in prevalence of CRAB and CRPA in a single hospital over an 11-month period.

From July 1 to September 30, 2012 (period 1), the increase in the incidence of CRPA in both surgical and medical units was defined as an outbreak at Thammasat University Hospital and associated with increased empiric doripenem and fosfomycin use; CRAB estimates remained stable during this interval (Figure 1). The incidence of CRAB and CRPA were continuously monitored via the hospital laboratory database and infection control surveillance records. Infection control measures to prevent transmission of CRAB and CRPA were implemented in the 2 units inclusive of an education program on infection control, a hand hygiene program, contact isolation, patient cohorting, environmental cleaning, and antimicrobial stewardship. Compliance with infection control processes, as well as antibiotic consumption, was continuously monitored, as described elsewhere.⁵ There was no routine hospital policy for active surveillance for CRAB and CRPA. For the outbreak investigation, a case patient was defined as a patient colonized or infected with CRAB and CRPA via clinical cultures procured more than 48 hours after admission to 1 of the 2 units. Hand hygiene compliance rate was defined as the number of observations that demonstrated compliance to hand hygiene before and after patient contact divided by the total number of observations. Compliance to contact isolation was defined as the number of observations confirming adherence to contact isolation precautions divided by the total number of observations. During environmental cleaning observations, the housekeeper was observed for cleaning of bed rails, overbed tables, infusion pumps, clean countertops, and soiled countertops, and results were recorded as “cleaned during observation,” “not cleaned during observation,” “not applicable,” or “not observed.” Weekly calculation of the fraction of items scored as “cleaned” versus “not cleaned” was recorded. Correlations between carbapenem consumption and CRAB or CRPA were performed using Pearson correlation analysis.

From October 1, 2012, to May 30, 2013 (periods 2-4), the incidence of CRPA steadily declined, while there was no significant change in the incidence of CRAB; compliance to infection control measures varied over time (Figure 1). The consumption of doripenem declined over the 11-month period, yet overall carbapenem consumption increased. There



Variables	2012 (7/12-9/12)	2012 (10/12-12/12)	2013 (1/13-3/13)	2013 (4/13-6/13)
Antibiotic consumptions^a				
Imipenem	3.8	4.9	7.9	8.4
Meropenem	5.2	6.1	9.2	9.9
Doripenem	6.1	5.4	2.9	2.1
Quinolones	2.1	1.9	2.4	2.2
3 rd gen ceph	12.4	13.6	12.5	13.1
Adherence to IC measures^b				
Hand hygiene	40	44	66	70
Contact isolation	45	45	58	62
Environmental cleaning	34	40	60	64

FIGURE 1. Incidence of carbapenem-resistant *Pseudomonas aeruginosa* (CRPA), carbapenem-resistant *Acenitobacter baumannii* (CRAB), carbapenem consumption, and compliance to infection control (IC) measures. ^aDefined daily dose per 1,000 patient-days; ^b100 observations per period.

was a significant correlation between increased doripenem consumption and decline in CRPA incidence ($r = 0.59$; $P = .01$) and increased overall carbapenem consumption and CRAB incidence ($r = 0.69$; $P = .001$). Improvement in infection control compliance from January 1, 2013, to June 30, 2013 (periods 3–4), versus July 1, 2012, to December 30, 2012 (periods 1–2), was associated with a 14% decline in CRAB incidence (6.5 vs 5.6 cases 1,000 patient-days; $P = .42$).

In the report of these observations, we acknowledge that active surveillance was not routinely performed, and we did not aim to evaluate the impact of carbapenem use for patient-level changes in gut microbiota. Furthermore, given the nature of the study, it is possible that there were some unmeasured

confounders and biases that were associated with the reduction in CRPA. Nevertheless, during the outbreak investigation we prospectively measured infection control practices and consumption of carbapenems, flouroquinolones, and third-generation cephalosporins. Given that the rate of CRPA declined before CRAB and that CRAB declined after improvement in infection control measures while consumption of key antibiotics remained constant, our findings suggest that increased doripenem consumption versus imipenem or meropenem may be less likely to select for CRPA. However, the overall increased carbapenem consumption was associated with increased incidence in CRAB. Given the complexity of CRAB and CRPA epidemiology, control of a hospital outbreak due to these organisms may require a combination of

strategies.^{6,7} Furthermore, the overall concept of antimicrobial stewardship includes judicious carbapenem consumption, carbapenem deescalation, and efforts to optimize short courses of antimicrobial therapy, as appropriate. Together, these strategies remain important to limiting the local and global emergence of carbapenem-resistant non-Enterobacteriaceae.⁷

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