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Analysis of Bed Bug (*Cimex lectularius*) Introductions Into an Academic Medical Center

Bed bugs (*Cimex lectularius*) are an important human ectoparasite, but little is known about their impact on the healthcare system.^{1–3} When a bed bug is captured at our institution a hired pest management professional (PMP) confirms and decontaminates the area where it was identified. The study objective was to investigate when and where bed bugs were found in the medical center and to determine the associated financial impact.

METHODS

Pest management costs for bed bug events were reviewed for a single tertiary-care academic medical center located in Cleveland, Ohio, between August 1, 2014, and August 31, 2015. The medical center had 973 inpatient adult, pediatric, and obstetrics and gynecology (OB/Gyn) beds; 80 of these were intensive care unit (ICU) beds. During the study period, the medical center had 30,478 adult medical/surgical admissions, 9,996 OB/Gyn admissions, and 10,761 pediatric admissions. The adult emergency department (ED) had 31 full-time (plus 16 part-time) beds and 67,525 patient visits. The adult ED discharged 43,580

patients and admitted 16,119 (24%). Of adult inpatients, 53% were admitted through the ED.

A generalized linear autoregressive moving average model (GLARMA) was applied to estimate the relationship between the number of bed bug events and various predictors while accounting for serial dependence over time. We assumed a 1-day lag model with a log link because the main outcome follows Poisson distribution.

RESULTS

During the study period, there were 180 bed bug events (or 1 event every 2.2 days); 72 of these events occurred in the adult ED; 40 of these events occurred on the adult inpatient floors; and 20 of these events occurred in the outpatient clinics or dialysis center (plus 5 instances in which it was unclear whether the bed bug originated from an inpatient or outpatient). Another 14 events occurred on the pediatric inpatient floor; 11 in OB/Gyn; 5 in the pediatric ED; 3 in the pediatric ICU; 2 in the adult medical ICU; 1 in radiology; and 7 in other parts of the hospital (ie, sickle cell center, preoperative area, endoscopy clinic, walk-in clinic, and laboratory). Moreover, 96 bed bug events (54%) occurred in the adult and pediatric inpatient and outpatient units; 77 bed bug events (42%) occurred in the adult and pediatric EDs, and 7 bed bug events (4%) occurred in other areas of the hospital. Furthermore, 138 bed bug events (77%) were associated with adult patients; 12% were associated with pediatric patients; 7% were associated with the OB/Gyn unit; and 4% were associated with other areas of the hospital. There was 1 bed bug event for every 938 patients in the ED, every 726 admitted adult inpatients, and every 633 admitted pediatric inpatients.

We investigated days of the week on which bed bug events occurred. In the medical center, 16 bed bug events occurred on Sundays, 23 on Mondays, 33 on Tuesdays, 34 on Wednesdays, 22 on Thursdays, 28 on Fridays, and 24 on Saturdays. In the adult ED, 7 bed bug events occurred on Sundays, 11 on Mondays, 14 on Tuesdays, 11 on Wednesdays, 6 on Thursdays, 12 on Fridays, and 11 on Saturdays. Using a GLARMA model with adult ED events as the outcome and adjusting for ED patient volume, no day of the week was statistically more likely to have bed bug events either in the hospital or the adult ED.

According to our GLARMA analysis, in the medical center, the mean number of bed bug events in the months of November–April was 12.5 (standard deviation [SD], 3.45) compared with 15.3 (SD, 4.43) for May–October ($P = .45$). In the adult ED, the mean number of monthly bed bug events in November–April was 4.5 compared with 6.38 in May–October. In the adult ED, there were 23 bed bug events in the first 10 days of the month, 24 in the middle of the month, and 25 in the last 10 days of the month. A bed bug event was associated with 0.11% of adult ED patients, or 1 bed bug event every 5.5 days.

We did not find an association between bed bug events in the adult ED and the rest of the medical center using a GLARMA model with adult ED events as the outcome and adjusting for ED volume ($P = .98$). Furthermore, we found no association

between the number of bed bug events in the adult ED and the adult ED rate of patients who left without being seen (LWBS) ($P = .094$) using a GLARMA model adjusting for ED patient volume, the number of daily admitted patients who presented to the ED, the ED LWBS from the previous day, and the number of ED closure minutes (which was due mainly to an excess ED volume and a lack of available inpatient beds).

Bed bug eradication bills for the adult ED and medical center ranged between \$125 and \$1,050, with a mean of \$344 for the ED and \$337 for the medical center. The annual costs of treating bed bugs were \$22,844 for the adult ED and \$55,915 for the medical center.

DISCUSSION

The bed bugs found in the ED were likely the result of new introductions originating from infested patients.⁴ Verifi Bed Bug Traps (FMC, Philadelphia, PA) placed in the ED did not capture any insects, and no bed bugs were found after a bed-bug-detecting canine unit was hired to inspect the ED.⁴ The ED previously reported a patient suspected or confirmed of having a bed bug every 3.8 days, requiring a treatment room to be taken out of service for an average of ~ 18 hours per bed bug event, with direct costs to the ED of \$29,575 per year.⁴ The discrepancy may be related to the time of year in the previous study, changes in the local insect epidemiology, or changes in patient demographics. We have shown that bed bugs are a significant and costly problem, and efforts should be directed to the ED to prevent bed bug introductions into the medical center.

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