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Identifying Patients at High Risk for Carbapenem-Resistant *Enterobacteriaceae* at Admission: Nurse-Led or Doctor-Led?

To the Editor—Carbapenem-resistant *Enterobacteriaceae* (CRE), especially carbapenemase-producing (CP) CRE, has become a major public health concern, mostly due to its high level of transmission potential. Additionally, mortality associated with CRE infections is reported to be between 40% and 50%.[1] At Tan Tock Seng Hospital (TTSH), a 1,500-bed teaching hospital in Singapore, we have been practicing a mixture of proactive infection control strategies (eg, screening patients with travel history to CRE endemic countries) and reactive infection control strategies (eg, contact tracing once CRE is identified from clinical cultures) since 2010.[2] However, these activities have not stemmed the rising trend of CP-CREs, particularly the New Delhi metallo-β-lactamase (NDM-1)–producing *Enterobacteriaceae*. The situation became more pressing in 2013 when a large tertiary care hospital in Singapore witnessed a significant increase in *Klebsiella pneumoniae* carbapenemase (KPC)–producing *Enterobacteriaceae*.[3] In July 2013, we started screening high-risk patients for CREs (patients with hospitalization in healthcare facilities other than TTSH during the preceding 1 year) within 24 hours of admission, with the objectives of identifying endemic CP-CREs early and preventing an influx of other CP-CREs. This report details the implementation of this high-risk screening program and compares the compliance to screening of high-risk patients between doctors and nurses.

We divided the implementation period into 2 phases: phase 1 (July 2013–March 2014) and phase 2 (April 2014–December 2014). During phase 1, high-risk patients were identified by the clinicians. Doctors ordered surveillance cultures for CRE, which were collected by the nurses. This doctor-led screening strategy was presented at the hospital clinical directors meeting, with heads of departments being encouraged to regularly reiterate to their teams the importance of screening for high-risk patients. E-mail reminders were also sent to all doctors at regular intervals. In phase 2, high-risk patients were identified by nurses as part of routine admission assessment. The nurse-led screening strategy was presented at a nurse managers' meeting and was communicated to all nurses via e-mail. With the support from hospital administration, nurses were given "rights to order" for CRE surveillance cultures for high-risk patients so as not to delay collection of surveillance cultures. Identification criteria of high-risk patients were printed on an inpatient nursing assessment checklist. Both phases of implementation were fully supported by the hospital administration. On a weekly basis, the infection control unit collected both the total number of high-risk patients screened as well as the number of positive results identified. Regular feedback regarding missed high-risk patients was provided to the medical and nursing teams during phase 1 and phase 2, respectively.

For CRE surveillance, patients were screened for fecal carriage of CRE using a single rectal swab specimen or stool sample, which were plated onto chromogenic agar (chromID CARBA, bioMérieux SA, Marcy l'Etaile, France). After overnight incubation, colonies with color appearance according to the manufacturer's instruction, were considered presumptive CRE colonies. The presence of different

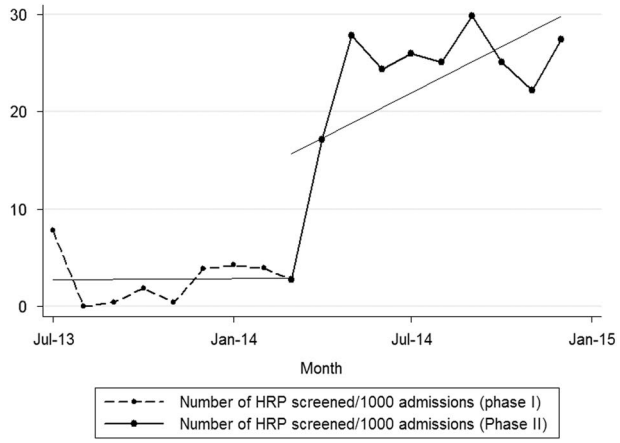

FIGURE 1. Screening of high-risk patients (HRPs) for carbapenemase-resistant Enterobacteriaceae (CRE) by rectal swab or stool specimen within 24 hours of admission.
During phase 1 (July 2013–March 2014), surveillance cultures were obtained following physician orders. During phase 2 (April 2014–December 2014), surveillance culture orders were ordered at the discretion of the nursing staff. Significantly more HRPs were screened following the intervention in phase 2 than following the intervention in phase 1. The number of CREs identified also increased during phase 2 compared with phase 1, but these numbers were not significantly different.

carbapenemase genes was determined using a multiplex real-time polymerase chain reaction (PCR) assay targeting three carbapenemases with potential for rapid spread locally, namely, $bla_{\text{NDM-1}}$, bla_{KPC}, and $bla_{\text{OXA-48-like}}$. Samples positive for these genotypes as well as all other carbapenem non-susceptible isolates were subsequently sent to the National Public Health Laboratory (NPHL), Singapore for further phenotypic work-up and PCR screening for Class A (KPC, IMI, GES, SME), Class B (NDM, IMP, VIM) and Class D (OXA$_{\text{-48-like}}$) carbapenemases.

During the study period (from July 2013 to December 2014) a total of 1204 high-risk patients were identified and screened for CREs. As shown in Figure 1, after the introduction of nurse-led screening, there was a significant increase in the number of patients screened, from 2.8 per 1,000 admissions to 25.0 per 1,000 admissions [incidence rate ratio (IRR), 1.01; 95% CI, 1.00 – 1.01; $P < .001$]. The total number of CREs identified increased from 0.02 per 1,000 admissions in phase 1 (9 months) to 0.32 per 1,000 admissions in phase 2 (9 months); however, this increase in trend was not statistically significant (IRR, 1.00; 95% CI, 0.99 – 1.01; $P = .24$). Of the 15 CREs identified, there were 4 $bla_{\text{NDM-1}}$, 2 bla_{KPC}, and 1 $bla_{\text{OXA-48}}$, and 8 nonCP-CREs. Incidence of CP-CRE increased from 0.3 of 10,000 patient days in 2010 to 0.9 of 10,000 patient days in 2014 [incidence rate ratio (IRR), 1.34; 95% CI, 0.55–3.23; $P = .52$].

We observed that nurse-led multidisciplinary implementation was more effective than doctor-led implementation in identifying and screening patients at high risk for CRE on admission. The reason for this difference is unclear; however, we believe 2 factors may have been instrumental. First, the inclusion of criteria for high-risk screening as part of nursing assessment checklist functioned as a constant reminder for the nurses. Second, process simplification by allowing the nurses to order the test for the patients may have promoted compliance from the nurses. On the other hand, because past hospitalization history is routinely gathered by doctors, there was no supplementary trigger or reminder for them to order surveillance cultures for CRE. Similar success with nurse-led interventions have been observed in reducing the unnecessary use of urinary catheterization[4] and in antimicrobial stewardship programs.[5] Surveillance, especially targeted screening of high-risk patients, remains an integral part of CRE control strategy. We found that a nurse-led multidisciplinary approach was associated with an increase in the number of high-risk patients screened and the number of CREs identified at admission.

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