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Letters to the Editor

Analysis of intra-hospital transfers and hospital-onset *Clostridium difficile* infection

Sir,

Hospital-onset *Clostridium difficile* infection (HO-CDI) is associated with both antibiotics and prolonged hospital stays and represents the third most common healthcare-associated infection based on a point-prevalence survey [1]. Studies show that the spores of CDI can survive on surfaces for up to five months, suggesting that hospital environments may play an important role in the spread of HO-CDI [1,2]. By extension, one might expect that the greater the number of hospital environments a patient is exposed to, the greater the likelihood of acquiring CDI. Whereas there is a significant body of research examining the role played by inter-hospital transfers in the spread of infectious diseases, there appear to be no hospital-level studies that examine the role of intra-hospital transfers on transmission dynamics of HO-CDI [3,4]. This study assesses whether a higher number of intra-hospital patient transfers increases the risk of HO-CDI infection.

A retrospective case–control study was performed using data from the electronic medical records (EMR) of adult patients admitted to The Ohio State University Wexner Medical Center from December 1st, 2013 through January 1st, 2016. The Department of Clinical Epidemiology identified cases of HO-CDI using standardized National Health Safety Network/Centers for Disease Control and Prevention surveillance definitions. A control group of patients without CDI was selected by performing a 1:3 match using exact matching techniques based on two characteristics with known correlations for HO-CDI: antibiotic use during hospitalization and age [5]. Nearest-neighbour matching on the admitting department was also used to ensure a similar distribution of patient health conditions. Transfer data were extracted from the EMR to provide the following variables: (i) days to onset of HO-CDI (total number of days in the hospital until diagnosis with HO-CDI for cases or exit from hospital for controls); (ii) number of intra-hospital transfers (total number of transfers until diagnosis with HO-CDI for cases or exit from hospital for controls). Intra-hospital transfers were identified in the EHR by coding for each time a patient was removed from a room. A Charlson Comorbidity Index (CCI) was also created for the patients, calculated according to the billed discharge diagnoses that fell within a year of their current hospital admission.

Descriptive summary statistics were calculated, and a multivariable logistic regression model was used to model the risk of HO-CDI infection as a function of the days to onset, number of inter-hospital transfers, patient age, patient antibiotic usage, and CCI. Covariates were removed if they were not significantly associated with CDI infection, leaving the most parsimonious model. Goodness of fit was calculated for each model, and the model with the lowest Akaike Information Criterion was considered to have the best fit. Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for covariates retained in the final model. Variance inflation factors were calculated for the variables to ensure no multicollinearity.

This study was reviewed and approved by The Ohio State University Institutional Review Board.

In all, 386 cases of HO-CDI were identified during the study period. The matched case and control groups were well balanced with standardized mean differences $<10\%$ for each variable used within the matching algorithm. In univariate analyses, patients with an HO-CDI case had a greater number of days until onset of CDI (10 vs 9.3; $P = 0.17$) and a significantly higher number of intra-hospital transfers (3.2 vs 2.8; $P = 0.01$). Results from the multivariate logistic regression model (Table I) suggest a significant relationship between CDI risk and the number of transfers. For each additional transfer the odds of HO-CDI infection increase by ~7% (OR: 1.07; 95% CI: 1.02–1.13).

In light of these results, we suggest that intra-hospital transfers expose patients to more environments that may harbour the *C. difficile* spores, putting patients who experience more intra-hospital transfers at greater risk of CDI.

Table I
Multivariate analysis of risk factors for *Clostridium difficile* infection

Variable	OR	95% CI	*P*-value
Transfer days	1.07	1.02–1.13	0.003
Charlson comorbidity index	1.00	0.96–1.05	0.83
Age	1.00	0.99–1.01	0.72
Antibiotics	0.98	0.59–1.61	0.92

OR, odds ratio; CI, confidence interval.

Our findings are unique and relevant to healthcare systems and to decision-makers seeking to reduce infection spread. Despite the intensive infection prevention interventions (enteric isolation, discharge terminal cleaning with sporicidal, and ultraviolet disinfection), our findings show that more patient transfers are associated with increased risk of HO-CDI. This raises the likelihood that with less intensive environmental disinfection, there might be an even larger effect of transfer. This research supports investigating the utility of bringing equipment for testing/care to patients, to reduce unnecessary patient movement within hospitals. This would mandate meticulous attention to disinfection of mobile equipment after each patient use or ideally single-patient use. By providing more insight into the mechanisms that propagate HO-CDI, this research provides a new avenue of study regarding the reduction of HO-CDI outbreaks.

Conflict of interest statement
None declared.

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Increased hospital-specific nosocomial rates of *Clostridium difficile* infection in Finnish hospitals with high prevalence of imported cases at admission, 2008–2015☆

Sir,

Surveillance of *Clostridium difficile* infections (CDI) has been conducted since 2008 as part of the Finnish Hospital Infection Program. Hospital-specific CDI rates are ranked in feedback to participating hospitals to improve control measures. During 2008–2010 the overall nosocomial rate of CDI decreased by 26%; however, the rates and trends differed between hospitals [1]. Besides gaps in infection control, several other factors may influence the hospital-specific CDI rates, such as awareness of CDI, diagnostic methods and activity, prevalence of colonization and infection at admission, antimicrobial usage, and emergence of certain *C. difficile* ribotypes. We aimed to determine whether hospital-specific nosocomial CDI rates are associated with testing frequency, use of polymerase chain reaction (PCR) in CDI diagnosis and/or rate of imported CDI cases.

Data were reported by 19 hospitals participating in the hospital-based CDI surveillance between 2008 and 2015, representing four out of five tertiary, nine out of 15 secondary and three out of ~20 other acute care facilities in Finland. Case-finding was laboratory-based, and the European Centre for Disease Prevention and Control definition for CDI was used [1]. A hospital-specific nosocomial case was defined as a patient with CDI onset 72 h after admission or in the community within four weeks from the last discharge to the same hospital. CDI cases with disease onset before that time were defined as linked to community, to another healthcare facility, or of unknown origin.

We obtained data on stool specimens tested for CDI per 1000 patient-days between 2014 and 2015 from two hospital surveys. Use of PCR on stool specimens in laboratories serving the participating hospitals was obtained from surveys conducted by the national reference laboratory [2]. We used patient-days as

☆ Data presented in part at the European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE), Stockholm, Sweden, November 6th to 8th, 2017, as a poster.