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Analysis of Intra-Hospital Transfers and Hospital Onset *Clostridium Difficile* Infection

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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 [1,2], suggesting hospital environments may play an important role in the spread of HO-CDI. 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. While there is a significant body of research examining the role inter-hospital transfers play in the spread of infectious diseases [3,4], there are no hospital-level studies that examine the role of *intra*-hospital transfers on transmission dynamics of HO-CDI that we are aware of. 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 1, 2013 through January 1, 2016. The Department of Clinical Epidemiology identified cases of HO-CDI using standardized National Health Safety Network/CDC (NHSN) 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 neighbor 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: 1) 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), 2) 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 based on 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 (OR) and 95% confidence intervals (CI) were calculated for covariates retained in the final model. Variance inflation factors (VIFs) were calculated for the variables to ensure no multicollinearity.

386 cases of HO-CDI were identified during the study period. The matched case and control groups were well balanced with standardized mean differences below 10% for each variable used within the matching algorithm. In univariate analyses, patients with a 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, shown in 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 approximately 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 which may harbor the *C. difficile* spores, putting patients that experience more intra-hospital transfers at greater risk of CDI. 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 UV 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.

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Table I:

Multivariate analysis of risk factors for CDI

Variable	OR	95% CI	p-value
Transfer Days	1.07	1.02 - 1.13	0.003
CCI	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