

Clostridium difficile Contamination in the Medical and Surgical Wards of a Community Hospital



M.C. Faires¹, D.L. Pearl¹, J.S. Weese²

¹ Department of Population Medicine, ² Department of Pathobiology, University of Guelph, Guelph, Ontario, Canada



Introduction

- Research has indicated that the environment may play a significant role in the transmission of *Clostridium difficile* in the hospital¹.
- Several studies have been published surveying the environment in patient rooms^{2,3}; however, information pertaining to *C. difficile* contamination in the general hospital environment is limited.
- No studies have investigated an association between *C. difficile* on specific hospital surfaces, longitudinally, during non-outbreak scenarios in community hospitals.
- Environmental factors that may be associated with *C. difficile* contamination have not been fully explored.
- Identifying these risk factors can be used by hospital personnel for surveillance purposes to improve infection control measures for reducing the contamination of the hospital environment with *C. difficile*.

Objectives

- To determine the prevalence of *C. difficile* contamination in patient rooms and the general environment of a community hospital;
- Compare *C. difficile* strains between patients with *C. difficile* infection (CDI) and the environment using PCR ribotyping;
- To determine what environmental surfaces are most likely contaminated with *C. difficile*;
- Identify factors associated with *C. difficile* contamination in patient rooms and the general hospital environment.

Methods

- The participating healthcare facility is a 300-bed community hospital in southern Ontario, Canada that serves a mixed urban and rural population. No *C. difficile* outbreaks occurred during the study period.
- Environmental sampling of patient rooms and the general hospital environment of one surgical ward and two medicine wards was conducted during six visits over a 15 week period. Sampling was conducted once a week for three consecutive weeks during weeks 1-3 (visit 1-3) and weeks 13-15 (visits 4-6).
- For patient rooms, sampling was conducted in exposed rooms (rooms housing a patient under isolation precautions) and unexposed rooms (rooms housing a patient not under isolation precautions).
- For the general environment, surfaces sampled were distributed over the ward and located in nursing and physician work areas, hallways, and visiting rooms.
- A dry sterile electrostatic cloth was wiped over the surface to be sampled up to a maximum area of 20cm x 20cm. Cloths were placed in individual sterilized bags. Information collected for each sample included: date, ward, location within the ward, surface material, and the type of surface.
- Stool samples for *C. difficile* isolation were obtained from patients diagnosed with CDI via EIA that were hospitalized in the medicine and surgical wards during the study period.
- Selective culture for *C. difficile* was performed⁴. All isolates were investigated for the presence of toxin A (*tcdA*)⁵, toxin B (*tcdB*)⁶, and the binary toxin (*cdtA*)⁷ genes using PCR.
- PCR ribotyping was performed⁸. When a ribotype pattern was identified as an international ribotype based on comparison to reference strains, the appropriate numerical designation (e.g., 078) was assigned. Alternatively, an internal laboratory designation was assigned.
- Toxinotyping was conducted on a representative of each toxigenic ribotype⁹.
- Data were analyzed using exact logistic regression due to the small number of contaminated sites. The dependent variable was the presence or absence of *C. difficile*. Independent variables investigated included: visit number (general environment), ward, type of patient room, surface material, surface location (general environment), and type of surface sampled. Only univariable models were constructed.
- All tests were two-sided and statistical significance was based on a $\alpha \leq 0.05$. Odds ratios (OR) and 95% confidence intervals (CI) were reported.

Results

PATIENT ROOMS

- A total of 218 surfaces located in 26 unexposed rooms and 13 exposed rooms were sampled.
- Overall, 6.4% (n=14) of surfaces were contaminated with *C. difficile*.
- Results from the univariable exact logistic regression models are presented in Table 1. Cork surfaces were at an increased risk for *C. difficile* contamination compared to plastic surfaces.
- Four different ribotypes were identified among the 14 isolates recovered with ribotype 078 the most prevalent (Table 2).

Table 1: Univariable exact logistic regression models of variables associated with *C. difficile* contamination in patient rooms.

Variables	Unexposed Rooms (n=26) (%)	Exposed Rooms (n=13) (%)	OR (95% CI)	P-Value
Ward:				
Medicine A	3/54 (5.6)	3/25 (12)	Referent	
Medicine B	3/35 (8.6)	0/16 (0)	0.76 (0.12 – 3.77)	0.744
Surgery	3/60 (5)	2/28 (7.1)	0.73 (0.17 – 3.02)	0.758
Room Type:				
Unexposed	9/149 (6)	Not applicable	Referent	
Exposed	Not applicable	5/69 (7.2)	1.21 (0.31 – 4.23)	0.769
Material Type:				
Plastic	5/74 (6.8)	1/37 (2.7)	Referent	
Cork	3/23 (13)	3/10 (30.0)	3.84 (0.95 – 15.65)	0.030
Fabric ¹	0/26 (0)	0/10 (0)	0.36 (0 – 2.61)	0.336
Laminate	1/26 (3.9)	1/12 (8.3)	0.97 (0.09 – 5.76)	<0.999
Surface Sampled:				
End of bed	1/26 (3.8)	1/13 (7.7)	Referent	
Bulletin board ²	3/23 (13)	3/10 (30.0)	4.03 (0.66 – 43.85)	0.131
Chair back ³	2/25 (8)	0/13 (0)	1.03 (0.07 – 14.88)	<0.999
Overbed table ²	1/26 (3.9)	1/12 (8.3)	1.03 (0.07 – 14.88)	<0.999
Privacy curtain ^{1,2}	0/26 (0)	0/10 (0)	0.44 (0 – 5.75)	0.494
Television ²	2/23 (8.7)	0/11 (0)	1.15 (0.08 – 16.76)	<0.999

¹ Median unbiased estimates for OR

² Surfaces were not present in all patient rooms at the time of sampling

Table 2: Typing data for *C. difficile* isolated from surfaces located in patient rooms, the general environment, and patient specimens.

Ribotype	Number (n=14)	Toxinotype	Toxin Genes
Patient Rooms:			
078	64.3% (9)	V	<i>tcdA</i> , <i>tcdB</i> , <i>cdtA</i>
MOH-AI	21.4% (3)	0	<i>tcdA</i> , <i>tcdB</i>
027	7.1% (1)	III	<i>tcdA</i> , <i>tcdB</i> , <i>cdtA</i>
MOH-V	7.1% (1)	0	<i>tcdA</i> , <i>tcdB</i>
General Environment:			
078	37.5% (6)	V	<i>tcdA</i> , <i>tcdB</i> , <i>cdtA</i>
027	12.5% (2)	III	<i>tcdA</i> , <i>tcdB</i> , <i>cdtA</i>
MOH-V	12.5% (2)	0	<i>tcdA</i> , <i>tcdB</i>
001	6.3% (1)	0	<i>tcdA</i> , <i>tcdB</i>
HA-1	6.3% (1)	XII	<i>tcdA</i> , <i>tcdB</i>
MOH-AG	6.3% (1)	0	<i>tcdA</i> , <i>tcdB</i>
MOH-T	6.3% (1)	0	<i>tcdA</i> , <i>tcdB</i>
MOH-U	6.3% (1)	0	<i>tcdA</i> , <i>tcdB</i>
HA-2	6.3% (1)	Not tested	None
Patients:			
027	33.3% (7)	III	<i>tcdA</i> , <i>tcdB</i> , <i>cdtA</i>
MOH-C	14.3% (3)	IX	<i>tcdA</i> , <i>tcdB</i> , <i>cdtA</i>
CHP-A	9.5% (2)	XXIV	<i>tcdA</i> , <i>tcdB</i> , <i>cdtA</i>
MOH-AD	9.5% (2)	III	<i>tcdA</i> , <i>tcdB</i> , <i>cdtA</i>
078	4.8% (1)	V	<i>tcdA</i> , <i>tcdB</i> , <i>cdtA</i>
CHP-C	4.8% (1)	XXIV	<i>tcdA</i> , <i>tcdB</i> , <i>cdtA</i>
CHP-D	4.8% (1)	0	<i>tcdA</i> , <i>tcdB</i>
MOH-M	4.8% (1)	0	<i>tcdA</i> , <i>tcdB</i>
MOH-Q	4.8% (1)	XII	<i>tcdA</i> , <i>tcdB</i>
MOH-V	4.8% (1)	0	<i>tcdA</i> , <i>tcdB</i>
MOH-Y	4.8% (1)	III	<i>tcdA</i> , <i>tcdB</i> , <i>cdtA</i>

GENERAL ENVIRONMENT

- Over the study period, 53 different surfaces, for a total of 263 samples, were tested. Overall, 6.1% (n=16) of surfaces were contaminated with *C. difficile*.
- Results of the univariable exact logistic regression models for *C. difficile* contamination are presented in Table 3. There were no significant differences between environmental surfaces.
- The distribution of *C. difficile* contamination, per visit, fluctuated over the study period with the highest prevalence identified on Visit 4.
- The highest prevalence of *C. difficile* contamination occurred on surfaces located in visiting rooms.
- Heating oven handles and chairs were identified as having the highest prevalence of *C. difficile* contamination.
- Nine different ribotypes were identified among the 16 isolates recovered with ribotype 078 the most prevalent (Table 2).

PATIENT ISOLATES

- A total of 21 patient isolates were collected during the study period. Overall, 11 ribotypes were identified, with 027 the most prevalent in the patient population (Table 2).

Table 3: Univariable exact logistic regression models of variables associated with *C. difficile* contamination in the general hospital environment.

Variables	C. difficile (%)	OR (95% CI)	P-Value
Visit:			
1	4/50 (8)	Referent	
2	1/37 (2.7)	0.32 (0.01 – 3.45)	0.389
3	2/43 (4.7)	0.56 (0.05 – 4.17)	0.683
4	6/52 (11.5)	1.49 (0.33 – 7.69)	0.742
5	1/48 (2.1)	0.25 (0.004 – 2.63)	0.363
6	2/33 (6.1)	0.74 (0.06 – 5.56)	0.999
Ward:			
Medicine A	8/83 (9.6)	Referent	
Medicine B	3/70 (4.3)	0.42 (0.07 – 1.85)	0.229
Surgery	5/110 (4.6)	0.45 (0.11 – 1.63)	0.245
Surface Location:			
Hallway	6/126 (4.8)	Referent	
Nurses' and physician work areas	6/99 (6.1)	1.29 (0.33 – 4.99)	0.768
Visiting room	4/38 (10.5)	2.34 (0.46 – 10.52)	0.243
Surface material:			
Plastic	7/115 (6.1)	Referent	
Fabric	7/91 (7.7)	1.28 (0.37 – 4.47)	0.782
Laminate ¹	0/17 (0)	0.68 (0 – 4.85)	0.594
Rubber	1/17 (5.9)	0.96 (0.02 – 8.37)	0.999
Wood	1/23 (4.4)	0.70 (0.01 – 5.94)	0.999
Surface sampled:			
Computer keyboard	3/55 (5.5)	Referent	
Chair	6/64 (9.4)	1.78 (0.36 – 11.58)	0.503
Counter top ¹	0/18 (0)	0.78 (0 – 7.52)	0.570
Glove box holder	1/13 (7.7)	1.44 (0.03 – 19.78)	0.999
Other ²	6/113 (5.3)	0.97 (0.19 – 6.24)	0.999

¹ Median unbiased estimates for OR

² Surfaces in this category included the following: drug cart (1/17; 5.9%), hand rail (1/17; 5.9%), heating oven handles (3/17; 17.6%), isolation room supplies holder (0/11; 0%), lamp shade (0/4; 0%), linen (1/15; 6.7%), patient charts (0/16; 0%), towels (0/16; 0%)

Conclusion

- In exposed and unexposed patient rooms, cork surfaces, which were attributed to bulletin boards, were at an increased risk for *C. difficile* contamination. Tourniquets used for phlebotomies were secured to bulletin boards. It is theorized that tourniquets became contaminated with *C. difficile* from patient's skin which subsequently contaminated the cork surfaces of bulletin boards.
- Heating oven handles and chairs had the highest prevalence of *C. difficile* contamination in the general environment. These surfaces are frequently touched by staff, patients and/or visitors.
- In patient rooms and the general environment, surface materials such as cork, fabric, and plastic were repeatedly contaminated with *C. difficile*. These materials can vary in their porosity and texture which can make them difficult to clean and disinfect. Therefore, they can act as potential sources of *C. difficile* transmission and dissemination.
- Ribotype 078 accounted for 50% of isolates from patient rooms and the general environment but only 4.8% of patients. The reason for the high prevalence of 078 in the hospital environment and the discordance between environmental and patient prevalence is not known. However, this particular ribotype is prevalent among *C. difficile* strains isolated from food animals in Canada¹⁰. The participating hospital serves a rural community, which may increase the likelihood for exposure to 078 in the community with subsequent transmission into the hospital.
- The prevalence of toxinotype variants (toxinotypes other than toxinotype 0) in patients was striking, with only 14% of isolates belonging to toxinotype 0. These high prevalence and diversity of toxinotype variants has not been previously reported in a community hospital patient population.
- Further studies regarding contact rates among hospital surfaces, type of surface material, and the populations using these surfaces are warranted.

Acknowledgements

The authors wish to thank the hospital that participated in this study, the Infection Prevention and Control Department personnel for research assistance, the Microbiology Laboratory personnel for collecting patient specimens, and Joelle Rousseau for laboratory assistance.

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