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

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Introduction

- Research has indicated that the environment may play a significant role in the transmission of *Clostridium difficile* in the hospital[1].
- 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

1) To determine the prevalence of *C. difficile* contamination in patient rooms and the general environment of a community hospital;
2) Compare *C. difficile* strains between patients with *C. difficile* infection (CDI) and the environment using PCR ribotyping;
3) To determine what environmental surfaces are most likely contaminated with *C. difficile*;
4) 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 performed[4]. 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 performed[8]. 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 ribotype[9].
- 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 an $\alpha \leq 0.05$. 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[2]	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	Toxinotype	Toxin Genes
Patient Rooms:	(n=14)		
078	64.3% (9)	V	*tcdA, tcdB, cdtA*
MOH-AI	21.4% (3)	0	*tcdA, tcdB*
027	7.1% (1)	III	*tcdA, tcdB, cdtA*
MOH-V	7.1% (1)	0	*tcdA, tcdB*
General Environment:	(n=16)		
078	37.5% (6)	V	*tcdA, tcdB, cdtA*
027	12.5% (2)	III	*tcdA, tcdB, cdtA*
MOH-V	12.5% (2)	0	*tcdA, tcdB*
001	6.3% (1)	0	*tcdA, tcdB*
HA-1	6.3% (1)	XII	*tcdA, tcdB*
MOH-AG	6.3% (1)	0	*tcdA, tcdB*
MOH-T	6.3% (1)	0	*tcdA, tcdB*
MOH-U	6.3% (1)	0	*tcdA, tcdB*
HA-2	6.3% (1)	Not tested	None
Patients:	(n=21)		
027	33.3% (7)	III	*tcdA, tcdB, cdtA*
MOH-C	14.3% (3)	IX	*tcdA, tcdB, cdtA*
CHP-A	9.5% (2)	XXIV	*tcdA, tcdB, cdtA*
MOH-AD	9.5% (2)	III	*tcdA, tcdB, cdtA*
078	4.8% (1)	V	*tcdA, tcdB, cdtA*
CHP-C	4.8% (1)	XXIV	*tcdA, tcdB, cdtA*
CHP-D	4.8% (1)	0	*tcdA, tcdB*
MOH-M	4.8% (1)	0	*tcdA, tcdB*
MOH-Q	4.8% (1)	XII	*tcdA, tcdB*
MOH-V	4.8% (1)	0	*tcdA, tcdB*
MOH-Y	4.8% (1)	III	*tcdA, tcdB, cdtA*

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 Canada[10]. 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.

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