ORIGINAL RESEARCH

Clostridioides difficile infection and household hygiene: the patient experience

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ABSTRACT

Background: *Clostridiodes difficile* infection (CDI) is a prevalent healthcare-associated infection that also occurs in community settings. Household hygiene may be an underutilized strategy for controlling environmental spore contamination. Currently, no standardized protocol exists for cleaning the homes of individuals with CDI, and patients often lack guidance on effective hygiene practices.

Objective: This study aimed to explore the household hygiene experiences and practices of patients discharged from hospital following a CDI diagnosis.

Methods: Semi-structured interviews were conducted with individuals diagnosed with CDI within one year of hospital discharge. Seven interviews were completed – four in person and three by telephone. An inductive content analysis approach was used to code and analyze the transcripts.

Results: Participants generally lacked awareness of CDI transmission pathways. Cleaning routines were based on habit (e.g., weekly schedules) or visible dust accumulation, rather than the potential for contamination or transmission risk. Most cleaning products used were not effective against spores.

Conclusion: The hygiene practices reported by participants were unlikely to adequately decontaminate their home environments. Developing and providing a targeted hygiene protocol at discharge may help reduce the risk of reinfection or transmission to household members.

INTRODUCTION

Clostridioides difficile infection (CDI) is the leading cause of healthcare-associated diarrhea in industrialized countries (Normington *et al.*, 2021). *Clostridioides difficile (C. difficile)* produces spores that are shed in the faeces of infected individuals during and after illness, contaminating the healthcare environment – particularly patient rooms (Otter *et al.*, 2011; Weber *et al.*, 2013). These spores are highly resilient, capable of surviving in the environment for five months or more (Jinno *et al.*, 2012; Kim *et al.*, 1981; Porter *et al.*, 2024) and are resistant to many commonly used disinfectants, including quaternary ammonium compounds (Davies *et al.*, 2020).

While the transmission of *Clostridioides difficile* infection (CDI) in healthcare settings has been extensively studied – leading to well-established environmental decontamination protocols – evidence on the role of the household environment in CDI transmission remains limited. A scoping review conducted by our team confirmed this gap in the literature (Egan *et al.*, 2023). Only two studies were identified, both with very small sample sizes. These studies concluded that household transmission may contribute to cases of community-associated CDI (CA-CDI) and recurrent CDI, respectively (Loo *et al.*, 2016; Shaughnessy *et al.*, 2016).

CA-CDI, defined as CDI occurring without prior exposure to healthcare interventions, has remained relatively stable in Canada, with rates of 1.40 per 1,000 patient admissions in 2018 and 1.38 per 1,000 in 2022 – equating to approximately 1,400 cases annually (CNISP, 2024). Recurrent CDI (RCDI), characterized by the return of symptoms within eight weeks following successful treatment, affects approximately 20% of individuals with CDI (Larrainzar-Coghen *et al.*, 2016).

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RCDI may be caused by reinfection with the same strain present in the environment (Oka *et al.*, 2012).

Patients may be discharged from hospital while still shedding *C. difficile* spores. These spores can persist on household surfaces, where they may be transferred to hands and subsequently ingested, potentially leading to intestinal colonization or infection (Otter *et al.*, 2011; Rusin *et al.*, 2002). The infectious dose for *C. difficile* is very low (Otter *et al.*, 2011); even minimal exposure to spores poses a risk of colonization or infection for household members (Miller *et al.*, 2022). However, ingestion of spores alone is typically insufficient to cause CDI; disruption of the gut microbiota – most often due to antibiotic use – is usually a prerequisite for the development of symptoms (Bagdasarian, *et al.,* 2015).

Effective cleaning and disinfection in healthcare settings require appropriate selection, proper dilution, correct application, and sufficient contact time – the duration a chemical agent must remain wet on a surface to be effective (Otter *et al.*, 2013). Similar evidence-based guidance is needed for household decontamination to reduce the risk of *C. difficile* transmission, colonization, or reinfection (Bloomfield *et al.*, 2017) to prevent the risk of transmission that can result in colonization or re-infection. Previous research by our group found that Ontario hospitals did provide household hygiene advice to patients with CDI based on provincial guidelines; however, this information often downplayed the risk of transmission and lacked specific instructions on how to effectively reduce *C. difficile* spores in the home environment (Egan *et al.*, 2019).

The purpose of the current study is to describe the lived experiences of individuals discharged from hospital with CDI, with a focus on their knowledge, perceptions, and household hygiene practices. The insights gained from this research may inform the development of evidence-based household hygiene guidelines to help reduce the risk of CDI transmission and reinfection.

METHODS

Research ethics approval was obtained from the University of Guelph Research Ethics Board (REB# 23-04-007) and the Waterloo-Wellington Research Ethics Board (WWREB# 2023-0758). This study forms part of the primary author's PhD research project.

Participants

Table 1 summarizes the characteristics of the participants by age, gender, details of CDI, type of interview, and information received about household hygiene.

Table 1: Characteristics of participants

	Age	Gender	Diarrhea at home	CA or HA*	Recurrence of CDI symptoms at any point in illness	In-person or phone	Spouse joined interview	Recalled receiving Info about Household hygiene	Comments
Case 1	70-79	Man	Before hospitalization only	CA	Yes	Phone	Yes	Don't remember	Antibiotics prior to CDI symptoms
Case 2	80-89	Man	Before hospitalization only	CA	Yes	Phone	Yes	Not a lot	
Case 3	70-79	Man	After hospitalization only	HA	No	In-person	Yes	No. Zero.	
Case 4	50-59	Woman	Before and after hospitalization	CA	No	In-person (not at home)	No	Physician told me that recent studies say to use own washroom	Chemotherapy
Case 5	70-79	Man	After hospitalization only	HA	No	In-person	Yes	No	Interview cut short due to participant reporting a fever soon after interview started
Case 6	70-79	Woman	Before and after hospitalization	CA	Yes	Phone	No	No	Appendicitis
Case 7	70-79	Woman	Before and after hospitalization	CA	No	In-person	N/A	No	Pneumonia, stress

***CA and HA indicate Community-associated and Hospital-associated with respect to the onset of diarrheal symptoms. All participants classified as CA in this study had onset of symptoms at home and had not been hospitalized prior to onset.**

Participant recruitment was conducted with the support of the infection prevention and control (IPAC) team at the participating hospital. In September 2023, the IPAC team identified 49 patients who had laboratory-confirmed CDI and had been discharged to their homes (excluding long-term care and retirement homes) since September 2022. Letters of invitation were sent to these individuals, but the response rate was low, with only three agreeing to participate. In October 2024, ethical approval was obtained to extend recruitment by sending letters to an additional 55 individuals who had been diagnosed with laboratory-confirmed CDI and discharged since the initial round. This second round of recruitment resulted in four additional participants agreeing to take part in the study. The overall response rate was 7/104 (6.7%).

Interviews and data analysis

Semi-structured interviews were conducted by the primary author, either by telephone or in person, according to participant preference, using a pilot-tested interview guide. Verbatim transcripts were created from the audio recordings and served as the basis for content analysis following the methodology outlined by Erlingsson and Brysiewicz (2017). Transcription, inductive coding, and analysis were carried out manually by the primary author through an iterative process, resulting in the identification of four themes. All data were stored securely on a password-protected computer and OneDrive account accessible only to the primary author.

Text presented in quotations reflects the direct words of participants.

Table 2: Selected quotes for each theme

Theme	Select participant quotations
Limited understanding of cause, risk and transmission of CDI	"It would be nice to get a little cheat sheet of hygiene. Just a little cheat sheet. One pager. Plain language. Not too complicated and so people could put it on their fridge and people could say "OK" just so it doesn't re-infect him or spread it to someone else."
Belief that visibly clean is hygienically clean	"My wife is a very thorough cleaner, so I guess I probably just took it for granted that it would all be cleaned thoroughly."
Household hygiene and faeces are emotionally charged topics	"My mom's philosophy was more like 'germs are good for you, and it will build your immune system.'"
Household hygiene processes are ineffective against *C. difficile*	"I give the bathrooms a deep clean once a week. Or I try to. Um and then I give it a... what do you call it... this is a very old-fashioned term... you give it a lick and a promise in between."

RESULTS

Four themes emerged during the content analysis: 1) knowledge gaps regarding the cause, risk, and transmission of CDI; 2) the perception that visibly clean is hygienically clean; 3) the emotional charge associated with household hygiene and faeces; and, 4) ineffective household hygiene practices to reduce *C. difficile*. Selected participant quotations are provided by theme in Table 2.

Theme one: knowledge gap related to cause, risk and transmission of CDI

Participants demonstrated a knowledge gap regarding how they acquired CDI and the mechanisms by which it could be transmitted to others. One participant mentioned using masks as a preventive measure, though this is not an effective method for preventing CDI transmission. After the interviewer explained the transmission pathway, the participant responded, "Well, I'll tell you, probably about 95% of the population has no idea what you just said."

Participants' knowledge of household hygiene varied based on their life experiences. Two participants perceived themselves as having a higher level of understanding regarding infection transmission, which they attributed to their work experience: one was a former chef, and the other was a former dental hygienist with a degree in science. Two additional participants reported that their hygiene practices were based on their family's approach, which may have been insufficient.

Two participants reported independently seeking information online. One referred to the Mayo Clinic website, while the other consulted the "Governments of Canada and Ontario" websites. They searched for general information about CDI as well as specific prevention measures, such as how to clean their homes.

Most participants (6/7; 85.7%) reported not recalling receiving formal information from the discharging hospital. One participant mentioned, "The doctor who discharged me at the hospital did say something about recent studies saying you should use your own washroom... you don't want your family to get this." Another participant shared that she received informal information from the cleaner who cleaned her isolation room twice daily. The cleaner told her that Clorox was the only disinfectant capable of killing *C. difficile*. The participant relayed this information to her sister, who then purchased a pre-mixed Clorox spray product to clean the house. However, during the in-person interview,

the primary author noted that the product was not sporicidal, as it contained quaternary ammonium rather than chlorine.

Theme two: perception that visibly clean is hygienically clean

Participants were asked to identify the most contaminated areas in their homes as an indication of where they would focus their cleaning efforts. The kitchen, floors, and toilets were the most frequently mentioned, with four out of seven participants citing these areas. Definitions of "clean" provided by participants primarily centered around visual cues, such as dusting and tidiness. However, there were also comments about the importance of keeping bathrooms (especially toilets) clean. One participant, unprompted by the interviewer, mentioned cleaning in relation to "food and bowel movements" and emphasized the need for "disinfection" where possible in the home, while also acknowledging that many surfaces in the living room could not be disinfected.

Less than half (3/7; 42.8%) of the participants reported implementing specific practices to prevent transmission once the person with CDI was discharged home. One participant mentioned using a separate bathroom and changing bed sheets more frequently, another reported wiping down surfaces more often, and the third participant said they placed sheets on the couch to prevent contamination.

Theme three: perception of household hygiene and faeces as emotionally charged

Participants spoke about the emotional toll the illness took on them and their spouses: fear of accidents if they couldn't reach the toilet in time, the "depression" associated with being "infected", and fear that hospital staff lacked knowledge about *C. difficile*. Words such as "paranoid", "fanatic", "guilt", and "shame" were used to describe their feelings.

In addition to the fear and uncertainty surrounding CDI, participants also discussed the discomfort associated with talking about household hygiene and faeces. One participant remarked, "I've thought about this quite a bit and this is a very, very difficult subject for people to address because the way they clean their house is sacrosanct. And people don't like talking about faeces." Another echoed this sentiment, saying, "It's a taboo discussion. Whether it's culture or your beliefs, you don't talk about it, about poo."

Theme four: Ineffective household hygiene practices against C. difficile

Participants who lived with others reported sharing cleaning duties where physically able. Cleaning floors and dusting were the most frequently mentioned tasks. Several participants expressed a desire to clean "everything", with particular attention to "anything that people touch a lot" such as "taps, you know, your counters, the knobs".

Most participants (6/7; 85.7%) reported conducting weekly cleaning of the home. One participant described cleaning the bathrooms and kitchen once a day, while the spouse of another participant reported cleaning the bathroom after each use by the person with CDI.

Participants described their processes for cleaning in general terms. "Top-down", "wipe and go" and "spray and let sit" were common descriptions. When asked about contact time between the cleaning product and the surface, no participant considered how long the product should stay wet on the surface to be effective.

Six participants reported using wipes (e.g., Lysol wipes) on the high touch surfaces in their homes such as door handles, light fixtures, and using them until "it gets dirty", or after doing "several rooms". One participant reported using surface wipes on themselves which is not recommended as the active ingredients are not meant for skin contact. Three participants described using non-commercial cleaning cloths. One described using a cloth once on a contaminated item (toilet seat) and then changing it, and two described using cloths multiple times before laundering.

Participants were asked if they thought their household hygiene practices were effective against *C. difficile*. Three participants thought that they were "diligent" and "thorough", and one said since their spouse didn't catch it, they believed they were effective in preventing the transmission.

Several barriers to cleaning in general emerged from the interviews. Age, arthritis, chemotherapy and time required to clean were barriers identified by participants. These barriers impacted when and how cleaning could be conducted. CDI symptoms and consequences such as fatigue and weight loss were reported as barriers to performing household cleaning. Two participants described the need to spread the cleaning over several days while they were recovering.

Participants described selection of products based on brand name recognition, ease of use, perceived effectiveness as a cleaner, or lack of strong smell. Some non-commercial substances were also identified such as soap, hot water and vinegar. None of the reported cleaners were sporicidal with the potential exception of one respondent who reported using "Javex" (a sodium hypochlorite product) and water but without a specific concentration it was not possible to determine if the concentration was sufficient to be sporicidal.

DISCUSSION

Knowledge gaps

Participants in the current study expressed concern about transmission of CDI to and from others, and the desire to avoid "getting it again", but there was a lack of understanding of the mode of transmission of *C. difficile*. Serious gaps in knowledge were also noted in terms of what to clean and most placed emphasis on dusting and cleaning floors and a secondary focus on high-touch surfaces. Surfaces in a home that are likely to pose a low risk of transmission of infection are floors and furniture and higher risk surfaces are hand contact surfaces and the equipment (cloths, etc.) used to conduct cleaning, and hands (Maillard *et al*., 2020). A European survey conducted in February 2020 demonstrated poor understanding of the household situations that posed a risk of transmission and that required hygiene practices to be conducted (International Association for Soaps & Hygiene, 2021). In fact, participants

demonstrated a lack of clarity about what "hygiene" actually means (International Association for Soaps & Hygiene, 2021).

Household hygiene advice may be provided to a person with CDI while hospitalized or upon discharge as noted in a previous study by the authors (Egan *et al.*, 2019). However, the participants in this study did not seem to recall receiving this information. This indicates a need for additional mechanisms such as a central web-based resource or support from public health agencies for people with CDI in the community.

Perceptions

Participants described having a "clean home" to mean the absence of visible dirt, which is in line with previous studies (Bloomfield *et al.*, 2017; Maillard *et al.*, 2020). This is problematic in that pathogens like *C. difficile* can survive on surfaces that appear to be clean (Porter *et al.*, 2024).

The emotions and embarrassment that participants reported may have prevented them from discussing the mechanisms of transmission with healthcare providers which may have contributed to their lack of knowledge. This finding supports earlier findings where participants reported embarrassment and humiliation (Guillemin *et al.*, 2014).

Household hygiene practices

Participants' description of when they cleaned were aligned with results from a multi-country study on household hygiene behaviour that showed that cleaning tends to be done on a daily or weekly schedule rather than as contamination occurs (e.g., immediately after a person with CDI defecates) (Aunger *et al.*, 2016).

Household hygiene practices of the participants in this study did not consider important elements such as the essential moments to clean, contact time, management of cleaning equipment, and use of sporicidal agents. This is likely because they did not recall receiving this information.

Products available in ready-to-use formulation at retail in Canada are not sporicidal. Chlorine bleach mixed with water to achieve a hypochlorite concentration of at least 1,000 ppm with an appropriate contact time is the only feasible sporicidal option for household use. Recognition that a bleach product should be used is not sufficient – the effective concentration and contact time must also be understood. However, even with knowledge of effective concentration levels, application of a chlorine solution is not practical for all surfaces that may be contaminated in a home (e.g., soft furnishings).

Overall, the cleaning procedures described by participants in this study were insufficient to mitigate risk of *C. difficile* transmission, from knowing when to clean, cleaning frequency and choice of cleaning products. There is a demonstrated need for healthcare providers to provide information on appropriate household hygiene measures that can prevent colonization or re-infection of CDI (Weaver *et al.*, 2017).

Strengths and limitations

The main limitation of this research is the small sample size and the resulting lack of diversity in the participants. However, there was a small source population to begin with and the difficulty of discussing this topic may have deterred people from responding. Despite the small sample size, the comments made by participants were consistent and, therefore, we think that data saturation (when no new themes emerge from responses) was attained, a key measure of adequacy in qualitative research (Hennink & Kaiser, 2022). The study was not intended to provide representation of all CDI patients but rather to gain perspective of some patients to inform future educational efforts. Multiple attempts were made to recruit participants and all participants who agreed to participate were included in the analysis. Further study to obtain a more diverse sample, to ask about hand hygiene, personal protective equipment and laundry practices and a review of specific hospital discharge procedures would be helpful.

In-person interviews allowed for deep discussion and the ability to see the household environment and the cleaning products. As might be expected, more detailed information came from in-person interviews than the telephone interviews as the participants seemed more motivated to provide information. This could be because people who are more likely to enjoy talking selected the in-person option, or that face-to-face communication helped to build trust and open dialogue.

Participant recall about receiving information from the hospital may also be poor given that the time between discharge and the interview could be up to one year. However, the time from discharge to interview was not measured, so the impact of recall bias is unknown.

CONCLUSION

This study explored participants' lived experience with household hygiene post-CDI and, similar to existing research, highlights knowledge gaps in the understanding of CDI and the cleaning procedures required to mitigate transmission. All household hygiene practices and products described by participants would be ineffective to reduce the risk of household transmission. Household hygiene and faeces were considered emotionally charged, embarrassing and difficult to discuss.

Hence, there is a need for patient education specific to measures to take to reduce the risk of transmission and reinfection (Donskey, 2023). A targeted hygiene approach is important in all households but is even more pressing in households where one of the members is excreting a pathogen that can survive in the environment and cause colonization and infection in others, such as *C. difficile*. A protocol for household cleaning/decontamination for people with *C. difficile* should be developed that would give guidance on what, when, where, and how to clean surfaces in the home based on the potential reservoirs, the probability of contamination of surfaces, the potential for exposure, etc. The guidance should also include advice on how and when to conduct a "terminal" cleaning based on the estimated length of time that the shedding of spores will occur (Bloomfield *et al.*, 2016).

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