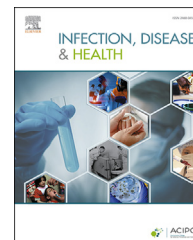


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Research paper

Nurses' knowledge, practices and perceptions regarding *Clostridioides difficile*: Survey results

Kara Finnimore ^{a,b,*}, Wendy Smyth ^{c,d}, Janine Carrucan ^a, Cate Nagle ^{c,d}

^a Infection Prevention and Control, Townsville Hospital and Health Service, Townsville University Hospital, 100 Angus Smith Drive, Douglas, Queensland 4814, Australia

^b Safety, Quality and Innovation Unit, Sunshine Coast Hospital and Health Service, Sunshine Coast University Hospital, 6 Doherty Street, Birtinya, Queensland 4575, Australia

^c Townsville Institute of Health Research and Innovation, Townsville University Hospital, 100 Angus Smith Drive, Douglas, Queensland 4814, Australia

^d Centre for Nursing and Midwifery Research, James Cook University, Townsville, Queensland 4811, Australia

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KEYWORDS

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Healthcare associated;
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Abstract *Background:* *Clostridioides difficile* infection (CDI) can cause patients debilitating symptoms, places additional demands on nurses' and midwives' and is increasingly prevalent. Understanding the knowledge base of nurses caring for patients with CDI may contribute to improving care practices.

Methods: A cross-sectional anonymous survey across our Hospital and Health Services was conducted. Descriptive statistics and thematic analysis techniques were used to analyse, summarise, and report data.

Results: A total of 198 completed surveys by nurses were included in the analysis. Most respondents (73.2%) could not recall having any recent CDI education. Nearly all agreed that CDI is an important infection control issue (80.8%), and that CDI education was important (94.9%). Knowledge of the potentially fatal outcome of CDI was not well known with only 53% responding correctly to this question. Respondents were confident in fundamental infection control precautions of patient placement (93.4%) and environmental cleaning (86.4%). Knowledge of the microbiological aspects of CDI were less well known. The impact to workload and the additional burden of caring for patients with CDI was evident in the overwhelming response (83%) to the two open-ended questions about what makes it "easy" and what make it "hard" to implement infection control strategies for CDI patients.

Conclusion: Respondents identified many factors that could contribute to less-than optimal care and management of inpatients with CDI, and identified some solutions that would facilitate the provision of best practice. An educational intervention, with emphasis on the areas of greatest knowledge deficits, has been developed.

* Corresponding author.

E-mail address: Kara.finnimore@health.qld.gov.au (K. Finnimore).

Highlights

- Nurses identified a lack of recent education about *C.difficile*.
 - Nurses recognised the importance of *C.difficile* infection.
 - A major barrier to controlling *C.difficile* infections was facility limitations.
 - Nurses readily identified enablers of good infection control strategies.
 - Addressing knowledge deficits would enable good infection control strategies.
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Introduction

The gram-positive spore-forming anaerobic bacterium *Clostridioides difficile*, also known as *Clostridium difficile* or *C. difficile*, is widespread in natural and built environments such as healthcare settings [1]. *C. difficile* infection (CDI) is associated with disruption of the gastrointestinal tract flora such as that caused by antibiotic use and can result in asymptomatic colonisation to severe disease such as colitis or peritonitis, and death [1]. *C. difficile* infection is considered largely preventable, and it is the subsequent impact on patients, requirements for complex treatments, and recurrent infections that contribute to this organism being recognised as a significant infection control issue [1]. Colonisation and infection caused by this bacterium are nearly always limited to the gastrointestinal tract [2]. Patients with CDI are affected by symptoms of diarrhoea and fever, haemodynamic instability, rigors, and changes to blood pathology [2]. Managing patients with CDI can be challenging as patients should be isolated in a single room and staff need to wear appropriate personal protective equipment such as gloves and gowns.

C. difficile infection is recognised as an infection risk within Australia where there have been increasing rates since 2016 [1], and internationally [3]. The implications of CDI in Australia include an almost threefold increase in length of hospital stay, significant additional costs to health care systems, morbidity and mortality [1]. Although most patients with a CDI diagnosis comprise pre-existing cases [4], approximately one-third (32.5%) of people discharged from hospital with a CDI diagnosis developed the symptoms while an inpatient [1].

C. difficile differs from other antimicrobial resistant organisms in that it can exist in a vegetative state or as spores that are resistant to the bactericidal effects of alcohol-based hand rubs and commonly used hospital disinfectants [5]. Another unique characteristic of this bacterium is that patients under two years of age are commonly asymptomatic carriers and appear to remain resistant to the disease with suggestions that this is because “infants lack appropriate toxin receptors on the bowel mucous membrane(s)” [6], p.59.

It is recommended that patients with suspected or diagnosed CDI are placed on transmission-based precautions [7]. The impact to the patient includes not only the physiological symptoms associated with CDI, but also the effects of being placed in single room isolation. Healthcare workers are

required to don additional personal protective equipment when caring for patients with CDI and use enhanced environmental cleaning practices related to the ability of the spore form of the *C. difficile* to remain on environmental surfaces for an extended period. Since these spores are also resistant to many commonly used disinfectants, any surfaces or fomites that could be contaminated should be cleaned and disinfected with a suitable product [3].

There are several published studies assessing healthcare workers’ knowledge, perceptions, and practices regarding CDI. Most studies include a combination of multi-disciplinary healthcare workers (nurses, physicians, health technicians, environmental services) and no studies including midwives were found. Of four studies that solely investigated nurses [8–11], two focused on nurses in dedicated infection control roles [8,11]. Only one Australian study (involving doctors and nurses) was found [12] with other studies being undertaken in the United States of America [8–10,13,14], France [8], South Africa [15], and the United Kingdom [11,16–18]. Due to the paucity of research that investigates healthcare workers’ knowledge and experience of CDI and particularly the gap in research that focuses on nurses in clinical settings in Australia, it was considered important to investigate nurses’ knowledge of CDI.

Aim

The aim of this study was to understand nurses’ knowledge, practices, and perceptions regarding inpatients with CDI to inform an educational intervention.

Methods

Study design

A cross-sectional anonymous survey was designed to elicit nurses’ knowledge, practices, and perceptions regarding CDI.

Survey development

Questionnaire items were primarily informed by the Australasian Society for Infectious Diseases (ASID)/the Australasian College of Infection Prevention and Control’s (ACIPC) position statement on *C. difficile* [3]. The questionnaire was pre-tested by six clinical nurses working in

the Infection Control Nursing Team and by an Infectious Diseases Consultant. Electronic and hard copy versions of the questionnaire were developed. The electronic version was hosted on the Qualtrics platform.

There were four sections to the questionnaire. It began with 25 statements that assessed knowledge (Section 1), practice (Section 2) and perceptions (Section 3) about CDI, to which the respondents could answer 'Agree', 'Disagree' or 'Unsure'. Section 3 also asked respondents to nominate three barriers and three enablers to the implementation of infection control strategies for patients with CDI using free text. Section 4 comprised four questions about the respondent's role, designation, years in the profession, and facility where they usually worked.

Setting, participants, recruitment and data collection

The setting was a <blinded for review> Hospital and Health Service that included a tertiary hospital and seven rural health facilities. All nurses practising clinically on inpatient wards (excluding mental health units) at the time of survey distribution in January 2021 were invited to participate. Recruitment was by way of an invitation email; participants could access the survey via a Quick Response (QR) code or link in the invitation email, or they could complete the paper version and return it to a collection folder in the wards. The survey was open for nine weeks.

Data analysis

Data from Qualtrics was downloaded into Microsoft Excel and merged with paper-based questionnaire responses that were entered manually on the spreadsheet. Data analysis was undertaken in SPSS Version 25.0 (IBM Corp. 2017). Descriptive statistics were used to summarise the data including frequencies and proportions. Chi-square test for independence was used to analyse association between variables (level of significance was set at $p < 0.05$). Open-text responses were grouped into themes and sub-themes, following an established methodology for thematic analysis [19]. One researcher led the development of initial themes. A second researcher verified the sub-themes and themes, which were then reviewed and agreed upon by the remainder of the research team.

Results

Overview of respondents

Although 214 respondents indicated their consent to complete the survey, only 198 surveys were completed, a response rate of approximately 30% of potential respondents. Almost all respondents (89.9%, $n = 178$) stated they worked in wards at the principal referral hospital; 5.6% ($n = 11$) respondents worked at one of the smaller health facilities within the health service; 4.5% ($n = 9$) did not indicate their principal place of employment. Most respondents were Registered Nurses (refer to Table 1). Only 16% ($n = 32$) of respondents had less than two years'

experience and more than half of the respondents (54.6%, $n = 108$) identified as having had up to 10 years of nursing experience (refer to Table 2).

Educational opportunities with respect to CDI

Almost three quarters (73.2%, $n = 145$) of respondents could not recall having received any education about CDI within the previous two years; 7.1% ($n = 14$) recalled having received education, and the remaining 19.7% ($n = 39$) respondents were unsure. However, 94.9% ($n = 188$) agreed with the statement, "Education for nursing staff is important in order to understand and manage cases of inpatients with CDI". The level of agreement to the statement "CDI is a significant healthcare associated infection issue in Australia", was 80.8% ($n = 160$); 8.0% ($n = 16$) disagreed, and 11.1% ($n = 22$) were unsure.

Knowledge and practices relating to CDI

Table 3 presents the correct and incorrect answers to questions relating to knowledge about CDI and practices relating to the management of CDI. The correct response to each question is indicated in the table. Items with highest proportion correct related to the: ideal selection of bed placement for a patient with CDI (93.4%, $n = 185$); need for visitors to adhere to precautions (89.4%, $n = 177$); type of product to use when cleaning the patient environment (86.4%, $n = 171$); understanding that CDI is the most common cause of infectious diarrhoea in the hospital environment (77.8%, $n = 154$). Items with lowest proportion correct related to the: appropriate product to clean shared equipment (4.0%, $n = 8$); testing of children under two years (9.1%, $n = 18$); identification of which patients with diarrhoea should be tested for CDI (16.2%, $n = 32$); and carriage of CDI in children under two years (16.7%, $n = 33$).

There was a statistically significant difference in one area of knowledge related to respondents' years of nursing/midwifery experience. The association between

Table 1 Designation of respondents.

Designation	Frequency	%
Registered Nurse	158	79.8
Enrolled Nurse	24	12.1
Assistant in Nursing	4	2.0
Not stated	12	6.1

Table 2 Years working as a nurse.

Experience	Frequency	%
Less than 2 years	32	16.2
2–5 years	50	25.3
6–10 years	26	13.1
More than 10 years	76	38.4
Not stated	14	7.1

Table 3 Knowledge about and practices relating to CDI^a.

	N = 198	
Questions about knowledge (correct response)	Correct answer ('correct' response provided) n (%)	Incorrect answer (including 'incorrect', 'unsure' or 'no response') n (%)
Diarrhoea for the purpose of CDI identification is at least one loose stool within the past 24 h (False)	64 (32.3%)	134 (67.7%)
<i>Clostridium difficile</i> is an anaerobic, spore-forming, gram-positive bacillus and is the most common cause of infectious diarrhoea in hospitalised patients (True)	154 (77.8%)	45 (22.2%)
It is estimated that most cases of CDI are due to the healthcare delivered in the current inpatient admission (False)	59 (29.8%)	139 (70.2%)
CDI has not been known to result in significant adverse patient outcomes, such as surgery or death (False)	105 (53.0%)	93 (47.0%)
Asymptomatic carriage of CDI is rarely seen in children under two (False)	33 (16.7%)	165 (83.3%)
The most important risk factor for CDI is cancer treatments like chemotherapy (False)	42 (21.2%)	156 (78.8%)
Testing for CDI is recommended for all hospitalised patients with diarrhoea (False)	32 (16.2%)	166 (83.8%)
Testing for children under two years is not recommended (True)	18 (9.1%)	180 (90.9%)
The route of transmission for CDI is via droplet transmission due to diarrhoea (False)	102 (51.5%)	96 (48.5%)
Minimising frequency and duration of antibiotic use is a key strategy to minimise risk of CDI (True)	115 (58.1%)	83 (41.9%)
A relapse of CDI occurs in around 20% patients (True)	98 (49.5%)	100 (50.5%)
Testing of faeces for CDI aims at identifying toxins or the genetic potential for toxin productions that cause CDI (True)	126 (63.6%)	72 (36.4%)
The ideal bed placement for a patient with CDI is a four-bed bay (False)	185 (93.4%)	13 (6.6%)
You should wait until 24 h after the last loose stool before ceasing enteric contact precautions for CDI patients (False)	56 (28.3%)	142 (71.7%)
The patient environment should be cleaned with detergent and bleach (such as Actichlor plus) or sporicidal impregnated wipes (True)	171 (86.4%)	27 (13.6%)
It is ideal to have dedicated patient equipment, however if equipment is shared it should be thoroughly cleaned with detergent between patients (False)	8 (4.0%)	190 (96.0%)
Visitors do not need to take any special precautions when visiting a patient with CDI (False)	177 (89.4%)	21 (10.6%)
Questions about management practices		
I always wash my hands with soap and water for all CDI patients (Correct practice)	192 (97.0%)	6 (3.0%)
I always wear Personal Protective Equipment (such as gowns/ aprons and gloves) on entry to a CDI patient room or bed area (Correct practice)	190 (96.0%)	8 (4.0%)
I place all linen from a patient with CDI into a leak proof lined bag (Incorrect practice)	36 (18.2%)	162 (81.8%)
I place all waste from a CDI patient into a clinical waste bag (Incorrect practice)	43 (21.7%)	155 (78.3%)
I do not prioritise isolating patients with CDI in a single room or within a bed space with a dedicated toilet/ensuite/ commode as this is not necessary (Incorrect practice)	167 (84.3%)	31 (15.7%)

^a CDI = *Clostridioides difficile* infection.

Table 4 Knowledge of risk factors for CDI^a by years of nursing experience.

Years of experience	Correct answer n (%)	Incorrect, Unsure or Missing answer	Total
Up to 5 years	11 (13.4%)	71 (86.6%)	82 (100%)
More than 5 years	29 (28.4%)	73 (71.6%)	103 (100%)
Total	40 (21.7%)	145 (78.3%)	185 (100%)

Test statistic: χ^2 with Yate's continuity correction (1, n = 184) = 5.175, p = 0.023, phi = -0.181.

^a CDI = *Clostridioides difficile* infection.

years of experience and correctly answering the question pertaining to the most important risk factor for CDI was analysed using chi-square test. Nurses with more than 5 years' experience were more likely to answer this question correctly (χ^2 with Yate's continuity correction (1, n = 184) = 5.175, p = 0.023, phi = -0.181). The odds ratio for the more experienced nurses having the correct knowledge was 2.56 (95% CI 1.2–5.52) compared to the nurses with up to five years' experience (Refer to Table 4).

Barriers and enablers to implementing relevant infection control strategies

Most respondents (n = 152) proffered responses to these questions. Barriers were grouped into four themes: Facility limitations; Less than optimal implementation of correct infection control precautions; Organisational considerations

relating to diagnosis; Isolation impractical or unsafe. The lack of single isolation rooms, suitably equipped, was identified as a barrier by 115/152 respondents. Respondents identified enablers to implementing correct and consistent infection control strategies that could counteract the barriers. Three themes of enablers were identified: Improved facility infrastructure; Systems need to support implementation of appropriate infection control practices; Address knowledge deficits about CDI. These themes and sub-themes are listed in Table 5.

Discussion

The fact that so few of the respondents could recall having had education regarding CDI in the previous two years was evident by the gaps in knowledge revealed in the survey. Whilst most nurses (95%) surveyed in a UK study knew that

Table 5 Themes and sub-themes related to barriers and enablers.

BARRIERS	
Theme	Sub-themes
Facility limitations	Lack of single rooms on wards Lack of toilets and/or bathrooms for individual use Unavailability of sinks and supplies in close proximity to where needed Limitations associated with having to nurse patient in shared rooms
Less than optimal implementation of correct infection control precautions	Availability and accessibility of PPE for staff Non-adherence to infection control precautions related to poor signage Patient and visitor behaviour Poor staff knowledge about CDI
Organisational considerations relating to diagnosis	Delay in ordering and/or sending stool samples to pathology or in confirmation of infectious status Consequences of delay in confirmation of infectious status.
Isolation impractical or unsafe	Patient care plans, individual patient care needs, model of care make isolation impractical or unsafe Workload priorities
ENABLERS	
Theme	Sub-themes
Improved facility infrastructure	Single rooms with own bathroom Adequate handwashing sinks outside patient rooms
Systems need to support implementation of appropriate infection control practices	Correct signage relating to the infection control practices to be implemented Clear communication of patient's CDI infectious status Adequate stocks of equipment and supplies Adequate stocks of PPE Collaboration between staff and departments
Address knowledge deficits about CDI	Staff education Provide information to patients and visitors

Note: CDI = *Clostridioides difficile* infection.

CDI could result in death [18], only 52.8% of respondents in our study were aware of this. Our respondents were confident of appropriate patient placement and environmental cleaning requirements, but transmission of CDI via contact (faecal-to-oral route) was not well understood. Overall, as in previous studies [11–13,15,16], our study of nurses and midwives showed that microbiological knowledge was poor. For example, a small study of Infection Control practitioners [11] found infection control precautions were well understood, whereas a study including registered nurses [13] identified that nurses lacked CDI knowledge and knowledge of appropriate hand hygiene and glove use practices.

The correct responses to contact precautions such as patient placement in a single room and environmental cleaning requirements are supported by standardised enteric precautions signs that outline these requirements across our health service. These signs, however, differ slightly from the ASID/ACIPC guidelines [3]. Our local policy for hand hygiene for CDI patients, like that of Roth [12], is washing hands with soap and water compared to the position statement that recommends alcohol-based hand rubs for visibly clean hands and soap and water or antiseptic wash when hands are visibly dirty or soiled.

The COVID-19 (SARS-COV-19) pandemic has affected our study. The survey was distributed at the end of 2020, less than one year after the first case of COVID-19 in Australia. The significant and unprecedented impact of COVID-19 on infection prevention and control resources and priorities during this period may be a contributor to the lack of CDI education provided, and/or to the average response rate. Potential for specific CDI education has been identified in several previous studies [8,12,15]. One study [8] found that knowledge regarding CDI was from initial training, and Aroori [16] found knowledge declined among senior doctors and nurses. If infection prevention practitioners find guidelines and research papers difficult to interpret [17] or find it difficult to keep up-to-date [9], then given the pressures on nurses and midwives at the bedside, they would understandably find it challenging to keep up with best practice evidence.

The increase in workload and perceived additional burden of contact precautions is well reported in the literature and is a key theme particularly of studies that investigated barriers and facilitators to implementation of infection control strategies [10,13] and the impact of CDI on everyday work [8,20]. In our study, workload and lack of time associated with the facility limitations, models of care, communication delays and staffing, were identified and were seen by some of the respondents as a barrier to implementing contact precautions consistently.

The need to provide information about management of CDI to patients and visitors has been identified in previous studies [8,9,14]. In our study, respondents suggested that the provision of information to patients and visitors might improve their compliance with correct infection control precautions. Although brochures about CDI for patients are available in clinical units and from the Infection Prevention and Control nursing team, the availability of these may not be well known. Perhaps the clinical staff may see the dissemination of such information to be the role of an infection control nurse rather than part of everyday nursing or midwifery practice.

It is proposed that frontline healthcare workers are frequently overwhelmed with policies and procedures often without the opportunity to articulate what it means to provide the care. The availability of single isolation rooms and access to sinks are fundamental requirements that either facilitate or hinder the implementation of best practice guidelines for CDI management. Location, accessibility, and number of sinks have been reported as barriers [10,13,14], while Ngam [10] reported access to single isolation rooms and sinks having foot pedals as being facilitators in their study.

Limitations

The survey was designed for this specific setting and we do not intend to convey that the findings are generalisable to other settings. However, the findings do provide guidance to the Infection Prevention and Control team about strategies to enable staff to provide care to patients with CDI that meet the organisation's policies and guidelines, and about areas of knowledge deficits. The initial intent was to include nurses and midwives; however, only one of the initial respondents identified as a Registered Midwife only, and that person's responses have been excluded from the analysis. The lack of responses from midwives may reflect the fact that there have only been two cases of CDI in the maternity inpatient ward since 2012 (internal email communication from Infection Prevention and Control, 20 June 2022). Given the higher adverse outcomes associated with CDI in pregnant women [21] it is important to pursue an understanding of midwives' knowledge of CDI.

The response rate of 30% is historically good for surveys undertaken in this health service, although this may have been higher if not for the extra pressures on staff related to Covid-19. The decision to continue with the study during the pandemic was made due to the importance of maintaining a focus on multiple infections associated with healthcare, including the monitoring of CDI [22].

The precise wording of some questions, particularly those regarding linen and waste management, may have been open to misinterpretation resulting in fewer correct responses than anticipated. Although Vaughn and colleagues [11] did not find in their study a significant difference in knowledge between nurses with or without post registration qualifications in infection control, it may have been prudent to include nurses working in the wards, in addition to the infection control nurses, in the pilot testing of the questionnaire.

It is acknowledged that the self-reporting nature of the questions relating to management practices may have led to an overestimation of compliance. We cannot be certain that nurses always wash their hands correctly with soap and water, or that they always wear the required personal protective equipment in the correct way.

Implications for practice, policy, and research

It is the characteristics of CDI such as spore resistance to alcohol-based hand rubs, persistence in the environment, the recurrence of infection, the transmission of spores by health care workers' hands, and that CDI in many cases can

be linked to health care, that make it important for health care workers to understand the best way to manage patients with CDI. This is important to help minimise transmission of the bacterium and thus prevent cases of CDI in the current or future admission periods. Implications for future policy review is the investigation and addressing of organisational and system barriers that make caring for CDI patients frustrating for frontline staff. For example, nearly all respondents knew the “gold standard” of care being the prioritising of single room isolation for patients with CDI. Facility limitations, however mean that workarounds are required and subsequent sequelae impact workload and increase the risk of colonisation to other patients.

Conclusion

The potentially life-threatening nature of CDI, the increase in CDI cases in Australia and the association of CDI with the provision of healthcare demands further research. Respondents to this study have identified many factors that could contribute to less-than-optimal care and management of inpatients with CDI. Respondents have also identified some solutions that would enable the provision of best practice. Findings from the study have been disseminated locally and used to inform a multifaceted educational intervention which has focused on the areas of greatest knowledge deficits.

Ethics

This negligible risk study was approved by the <name of HREC blinded for review> Human Research Ethics Committee, approval number HREC/QTHS/61164. Participant information was provided in the invitation email and at the start of the electronic questionnaire. Consent was implied.

Authors contribution

Kara Finnimore conceptualised the study, applied for funding, reviewed literature, designed the study, acquired the data, analysed data and interpreted the results, drafted and revised the manuscript, approved the version of the manuscript prior to submission.

Wendy Smyth prepared grant funding, ethics and governance applications, designed the study, analysed data and interpreted the results, drafted and revised the manuscript, approved the version of the manuscript prior to submission.

Janine Carrucan had input into the conceptualisation and design of study, analysed data and interpreted the results, reviewed drafts of the manuscript, approved the version of the manuscript prior to submission.

Cate Nagle conceptualised the study, applied for funding, designed the study, analysed data and interpreted the results, reviewed drafts of the manuscript, approved the version of the manuscript prior to submission.

Conflict of interest

The authors declare no conflicts of interest.

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Provenance and peer review

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