Knowledge and Compliance of Staff in using the Clostridium Difficile Bundle

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# Table of Contents

Abstract ......................................................................................................................... 05

Introduction .................................................................................................................. 06

Background of the Problem ............................................................................................ 06

Purpose and Significance of the Study ........................................................................... 08

Problem Statement ........................................................................................................ 09

Theoretical Framework .................................................................................................. 09

Definition of Terms ....................................................................................................... 11

Review of Literature ...................................................................................................... 13

Project Design .............................................................................................................. 18

  Project Outcomes ....................................................................................................... 18

  Setting and Population ............................................................................................... 18

Instrument ....................................................................................................................... 19

Methodology .................................................................................................................. 21

Ethical Considerations .................................................................................................. 22

Data Analysis ................................................................................................................ 23

Results ............................................................................................................................ 24

Discussion ...................................................................................................................... 28

Limitations ..................................................................................................................... 32

Implications for Practice ............................................................................................... 32

Recommendations ......................................................................................................... 33

Conclusion ...................................................................................................................... 34

References ..................................................................................................................... 45
Appendices

Appendix A: Author Permission to use the Instrument ..............................................35
Appendix B: CDI Questionnaire ..................................................................................36
Appendix C: Informed Consent and Jacksonville University IRB Approval .................37
Appendix D: Clostridium difficile infection Bundle.....................................................39
Appendix E: Hand washing signage ...........................................................................40
Appendix F: Institutional Review Board Mayo Clinic Approval ..................................41
Appendix G: Percentage of Pre-test and Post-test Scores of RNs..............................42
Appendix H: Percentage of Pre-test and Post-test Scores of PCTs ..............................43
Appendix I: Summary of Staff CDI Compliance in each unit ....................................44
Abstract

Clostridium difficile infection (CDI) is a nosocomial infection that has a significant risk to patient morbidity and mortality. Nurses and patient care technicians (PCTs) provide the most direct care to patients making them at risk of transmitting CDI to patients. It is a collaborative effort of healthcare personnel who provide direct care to patients to prevent transmission of CDI from one patient to another. The objective of this project was to measure staff knowledge about CDI and to evaluate their compliance in using the CDI bundle. A pre- and post-test design involving a sample population of 143 staff (124 nurses, 19 PCTs) from three inpatient care units (medical ICU, surgical ICU, and progressive care unit) at a teaching hospital in Northeast Florida was conducted after a staff education on CDI bundle was done. The test includes a 21-item questionnaire which incorporates information on prevention and management of CDI. After staff education was provided, there was a significant increase in mean test scores (pre-test mean= 14.61, post-test mean=18.72) of staff knowledge about CDI. Compliance with the bundle in clinical practice was determined through observation in daily practice of all the components of the CDI bundle. The overall staff compliance rate of the CDI bundle was 95.1%. However, the staff needs more improvement in CDI bundle compliance in areas of hand hygiene and the use of protective personal equipment (PPE). In addition, there was also a drop in CDI rates within the three inpatient care units from seven reported CDI cases to three cases within three months after staff education was provided. Lastly, this project concludes that staff knowledge had significantly influenced CDI bundle staff compliance as well as decreased the CDI incidence rates.

Keywords: Clostridium difficile infection, Clostridium difficile bundle, staff compliance
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Introduction

Clostridium difficile (C. difficile) is a bacterium found in feces causing infection of the colon with symptoms such as diarrhea and colitis which can lead to life threatening condition if untreated promptly (Centers for Disease Control (CDC), 2016). C. difficile spores may spread from person to person or from surface to person through fecal-oral route and can live for long periods on surfaces (Boyle, Ruth-Sahd, & Zhou, 2015; Smith et al., 2014; Yakob, Riley, Paterson, Marquess, & Clements, 2014). And since it is resistant to routine alcohol rubs, the CDC (2016) states that preventing the spread of C. difficile greatly depends on staff compliance. In fact, a study by Starr, Campbell, Renshaw, Poxton, and Gibson (2009) concludes that preventive measures to reduce patient susceptibility to C. difficile infections (CDI) are more effective in lowering transmission rates. Thus, preventive measures, such as hand washing, protective precautions, and environmental cleaning, to name a few, are deemed necessary in reducing transmission of C. difficile spores. These preventive measures, known as the CDI bundle, can be utilized to reduce the incidence rates of CDI within the hospital. However, despite the current preventive strategies being implemented, the hospital CDI incidence rates were still increasing in the past years. This quality improvement project was conducted with a purpose to increase staff knowledge, improve CDI staff compliance, and lower CDI incidence rates. What the staff know about CDI and how they recognize the impact on patient outcomes may significantly influence staff compliance in applying the bundle in their practice.
Knowledge and Compliance of Staff

Background of the Problem

Clostridium difficile infection (CDI) is considered as one of hospital-acquired infections (HAIs) that has been a primary concern due to its increasing prevalence and its significant effect on patient outcomes. According to the Agency for Healthcare Research and Quality (AHRQ, 2014), the mortality rate of CDI in 2011 is estimated at 2.4 deaths per 100,000 population. Likewise, in the same year, 93% of deaths from CDI occurred in older persons 65 years and above making it the 17th leading cause of death in this age group (AHRQ, 2014). In Mayo Clinic Jacksonville, the increasing trend of CDI cases was also significantly alarming. Hospital data reported 46 CDI cases in 2014 alone and it increased to 53 reported CDI cases in the year 2015 and 43 cases in 2016 (Mayo Clinic Jacksonville, 2017). In 2017, inpatient care units such as the medical intensive care unit (MICU), surgical intensive care unit (SICU), and progressive care unit (PCU) also had reported CDI cases. From May-July 2017, SICU and PCU both have three reported CDI cases while MICU has one reported CDI case (Mayo Clinic Jacksonville, 2017). The alarming incidence rates of CDI brought increased attention among health organizations because of its significant impact associated with increased length of stay, economic costs, and mortality (AHRQ, 2010; Makic, Martin, Burns, Philbrick, & Rauen, 2013; Smith et al., 2014). As a result, the Centers for Medicare and Medicaid Services (CMS) added CDI as part of the reimbursement payment system where hospitals receive lower reimbursement rates if CDI is acquired during hospital stay (AHRQ, 2010; Makic et al., 2013; Smith et al., 2014). Consequently, due to its financial burden on hospital costs and patient outcomes, significant efforts are needed to improve prevention and control strategies of CDI.
Studies have shown that implementing a combination of evidence-based interventions (CDI bundle) can reduce the prevalence of CDI (Abbett et al., 2009). A CDI bundle consists of multidisciplinary roles from each member of the healthcare team (doctors, nurses, nursing assistants, and housekeepers). The components of CDI bundle include (1) antibiotic stewardship, (2) use of blacklight testing, (3) observing modified contact precautions in patient care, (4) hand washing, and (5) use of dedicated equipment (i.e. disposable stethoscopes, etc.). However, despite the availability of the CDI bundles, there is still an increasing trend of CDI cases. Factors such as lack of awareness and limited understanding may be associated to noncompliance of staff in implementing the CDI bundle in their practice. These barriers must be identified and addressed appropriately in order to successfully implement CDI bundle compliance in decreasing the CDI incidence rates.

**Purpose and Significance of the Project**

Due to concerns of increasing incidence rates of CDI, several points were addressed on how to prevent and reduce CDI rates within the hospital. Some of the issues and concerns that were determined that may cause the spread of CDI were limited education on staff and patient/family, inadequate environmental cleaning, and noncompliance of staff in isolation precautions. This QI project was developed to focus on compliance with the CDI bundle. The main purpose of this QI project was to increase staff knowledge about CDI, improve compliance with the CDI bundle, and decrease the incidence of CDI. Educating the staff to understand the importance of using the CDI bundle can significantly influence their compliance in utilizing the bundle in their practice. The following were formulated as the project objectives:
1. Evaluate staff (nurses and PCTs) knowledge about the CDI bundle.
2. Provide staff education to MICU, SICU, and PCU staff about CDI and the importance of utilizing CDI bundle.
3. Evaluate staff compliance in applying CDI bundle.
4. Determine CDI rates in MICU, SICU, and PCU before and after staff education about CDI.

The significance of this project can be used in future research to evaluate staff knowledge and compliance in utilizing other hospital-acquired infection bundles (such as CLABSI, CAUTI, and VAP) to effectively control the spread of infection hospital wide. Once barriers to staff compliance in utilizing hospital-acquired infection bundles are identified, appropriate measures can be done to address the problem and to improve the quality of patient care. In addition, the results of this project will have a great impact on healthcare costs in improving patient outcomes.

**Problem Statement**

A PICO question was formulated which states: Will Clostridium difficile infection (CDI) education impact staff compliance and lower the CDI incidence rates within the hospital? The aim of the project is that staff knowledge about CDI (independent variable) will: (1) significantly influence compliance in applying the CDI bundle (dependent variable) and (2) help lower the incidence rates of CDI (dependent variable). Staff knowledge was measured through a pre- and post test after staff education about CDI was provided. Staff compliance was determined through CDI bundle check off list and direct observation while incidence rates of CDI within the three hospital inpatient...
units (MICU, SICU, and PCU) was measured before and after staff education and CDI bundle implementation.

**Theoretical Framework**

This quality improvement project used the Health Belief Model (HBM) by Rosenstock (1974) as the theoretical framework. The model states that a person's belief about health problems and perceived benefits can influence engagement in health behavior. HBM has six major concepts that can greatly influence a person’s decision for action or change: (1) perceived threat to the disease (perceived susceptibility), (2) belief about the seriousness of a condition and its consequences (perceived severity), (3) belief about the effectiveness of taking action to reduce risk or seriousness (perceived benefits), (4) beliefs about the material and psychological costs of taking action (perceived barriers), (5) factors that activate “readiness to change” (cues to action), and (6) confidence in ability to succeed (self-efficacy). These six concepts are factors used to understand what guides people to take positive actions towards their health.

In applying HBM in the QI project, the major concepts of the model were applied on how nurses and PCTs were led to make decisions or behavior change in providing care to their patients with CDI. The HBM provides guidance for understanding staff compliance to the CDI bundle by assessing staff knowledge about CDI and the bundle’s usefulness. Nurses and PCTs may not fully comply to follow the CDI bundle regimen unless they are aware of the seriousness of the disease (its complications as well as its impact on patient and institutional outcomes) and its increasing incidence rates within the hospital (*perceived susceptibility*). The staff need to understand that CDI can lead to serious complications, even death, if not treated promptly (*perceived severity*). Thus, it
is important to help the staff realize that compliance with the CDI bundle is vital in the treatment and prevention of CDI (perceived benefits). Consequently, when each member of the healthcare team (doctors, nurses, PCTs) work collaboratively in managing and preventing CDI, it will significantly impact patient outcomes and reduce hospital costs. Thus, noncompliance of staff in using the CDI bundle may hinder the goal of reducing CDI incidence rates within the hospital (perceived barriers). In implementing this QI project, education about CDI was provided to nurses and PCTs to help encourage the staff to consistently follow the CDI bundle in their everyday practice (cues to action). By increasing staff understanding of the disease condition, management, and prevention, the quality of patient care can significantly improve. And in order to maintain compliance with the CDI bundle, providing verbal reinforcement, guidance, feedback, and evaluation is needed to achieve the goal to increase staff compliance and decrease CDI incidence rates (self-efficacy). Table 1 summarizes the strategies used in applying the concepts HBM model in the project implementation.

**Definition of Terms**

The following terms used in the project were defined for better understanding of these concepts:

**Clostridium difficile infection (CDI)** is a gram-positive spore-forming bacterium that may spread from person to person or from surface to person through fecal-oral route (Boyle et al., 2015; Smith et al., 2014; Yakob et al., 2014). Once ingested, C. difficile spores germinate in the intestines and may rapidly outgrow the normal intestinal flora. C. difficile spores can survive in surfaces for more than three months and it is difficult to eradicate from surfaces (Boyle et al., 2015). One of the primary risk factors associated
Table 1. Application of the Health Belief Model

<table>
<thead>
<tr>
<th>Concept</th>
<th>Definition</th>
<th>Application</th>
</tr>
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<tbody>
<tr>
<td>Perceived susceptibility</td>
<td>Perceived threat to the disease</td>
<td>- awareness of the hospital incidence rates of CDI specifically in MICU, SICU and PCU</td>
</tr>
<tr>
<td>Perceived severity</td>
<td>Beliefs about the seriousness of a condition and its consequences</td>
<td>- assess staff knowledge about CDI (pre-test prior staff education)</td>
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<tr>
<td></td>
<td></td>
<td>- information about the seriousness, complications, and consequences of CDI</td>
</tr>
<tr>
<td>Perceived benefits</td>
<td>Beliefs about the effectiveness of taking action to reduce risk or seriousness</td>
<td>- explain how to take action and the benefits of applying the CDI bundle in practice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- emphasis on infection prevention</td>
</tr>
<tr>
<td>Perceived barriers</td>
<td>Beliefs about the material and psychological costs of taking action</td>
<td>- provide information about the impact of CDI on patient outcomes and hospital costs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- emphasis on the role of each member of the healthcare team in the CDI bundle</td>
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<td></td>
<td>- correct misinformation/misconceptions about CDI</td>
</tr>
<tr>
<td>Cues to action</td>
<td>Factors that activate &quot;readiness to change&quot;</td>
<td>- provide staff education about CDI and the use of the bundle</td>
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<tr>
<td></td>
<td></td>
<td>- promote awareness on infection prevention</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>Confidence in one’s ability to take action</td>
<td>- provide guidance, reassurance, and verbal reinforcement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- periodic evaluation and feedback</td>
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for developing CDI are patients on antibiotic therapy that results in disturbance in intestinal microbiota (Abbett et al., 2009; Boyle et al., 2015; Grigoras, Zervou, Zacharioudakis, Siettos, & Mylonakis, 2016; Yakob et al., 2014). C. difficile infection is characterized by a new onset of watery diarrhea (three or more stools a day) while on antibiotics that may worsen to toxic megacolon and death if not treated promptly (Abbett et al., 2009; Rubin et al., 2013; Smith et al., 2014). According to Boyle et al. (2015), patients in critical care units are at high risk of developing CDI due to the following factors: history of antibiotic use, use of proton pump inhibitors, gastrointestinal surgery, prolonged hospitalization, increased age, and immunocompromised conditions.
**CDI bundle** is a set of evidenced-based practices that are performed collaboratively by different members of the healthcare team and is proven to be effective in reducing CDI rates. The CDI bundle consists of the following components: (1) antibiotic stewardship, (2) hand hygiene, (3) environmental decontamination, (4) personal protective equipment (PPE), (5) isolation/cohorting, (6) use of dedicated equipment, and (7) staff and patient education. These intervention bundles proved to be effective in reducing CDI rates when all are performed in everyday practice (Abbett et al., 2009; Barker, Ngam, Musuuza, Vaughn, & Safdar, 2017; Gouliouris, Brown, & Aliyu, 2011; Muto et al., 2005). The risk of infection, on the other hand, increases when one or more of the components are not performed (Department of Health, 2007).

**Compliance** is defined as an active decision to support a clinical practice and make behavior changes accordingly (Kiyoshi-Teo, Cabana, Froelicher, & Blegen, 2013). In relation to the project, compliance means completion of all CDI bundle interventions by each member of the healthcare team as determined by the hospital’s policy. Thus, compliance to the CDI bundle is met if all components of the bundle were accomplished.

**Literature Review**

A literature search was conducted about examining compliance with CDI bundle in relationship to incidence rates of CDI. Key terms used in the search strategy include: “Clostridium difficile infection”, “Clostridium difficile bundle”, and “staff compliance”. Cumulative Index to Nursing and Allied Health Literature (CINAHL) and PubMed were the main electronic databases used for searching articles. Search time period included 2005 to 2017. Studies eligible for inclusion were studies that evaluated staff compliance
of CDI bundles and other hospital-acquired infections bundles. After reviewing the abstracts and those not meeting the inclusion criteria, 19 articles were included for review and analysis.

Clostridium difficile can be a life-threatening hospital-acquired infection due to its serious effect on patient outcomes if prompt treatment is not done. Like most hospital-acquired infections, trends in CDI rates are increasing. In fact, in the year 2008-2009, Clostridium difficile infection rates surpassed Methicillin-resistant Staphylococcus aureus (MRSA) infections with 847 and 680 documented cases respectively (Miller, Chen, Sexton, & Anderson, 2011). In addition, the authors concluded that with the increasing rates of CDI, the current infection control measures used may not be extensive enough. Due to the fact the Clostridium difficile spores can last for months and are difficult to kill contributes to increasing CDI rates. Thus, the use of alcohol rubs is proven to be not effective in killing C. difficile spores. It was proven through a study done by Jabbar et al. (2010) that C. difficile spores were still evident in the hands of healthcare workers after cultures were done before and after hand hygiene using alcohol-based hand rubs. Furthermore, the study concluded that using soap and water is proven to be the most effective in removing C. difficile spores than using alcohol-based hand rubs.

**Risk of Transmitting Infection**

Healthcare workers have the most direct contact with patients making them at risk of transmitting CDI from one patient to another. In fact, a study done by Landelle et al. (2014) found out that certified nurse assistants (CNAs) had the highest rate of C. difficile contaminated hands after contact with infected patients. Moreover, a study by Sax et al.
(2005) showed that 44.1% of healthcare workers have insufficient knowledge about transmission precautions and believed that lack of knowledge was a contributing factor to noncompliance in infection prevention. Therefore, it is imperative that not only nurses, but all healthcare workers who provide direct patient care should have knowledge about preventing the spread of any infection. It is vital that each member of the healthcare team understand their responsibility in the treatment and prevention of CDI. Thus, promoting accountability will help the staff to consistently comply in applying the CDI bundle in everyday practice.

**Staff Knowledge and Factors Affecting the use of the CDI Bundle**

There has been a limited research about nurse knowledge specifically about CDI. One study by Aroori, Blencowe, Pye, and West (2009) stated that only 38% of nursing staff correctly identified that washing hands with soap and water was the best way to prevent the spread of CDI. Studies have shown that knowledge of nurses about *Clostridium difficile* was insufficient when it comes to understanding and awareness about CDI (Burnett, Kearney, Johnston, Corlett, & MacGillivray, 2013; Tsagkaraki, Sampaziotis, Cooke, & Gkrania-Klotsas, 2009; Vaughn, Randle, & Adams, 2006). Furthermore, a study by Fayerberg, Bouchard, and Kellie (2013) concluded that physicians also have inadequate knowledge about CDI. The authors concluded that there were significant gaps in knowledge about facility policies and CDI clinical practice guidelines. It is alarming that these studies concluded that there is knowledge deficit among healthcare staff about CDI. Nurses, being front line caregivers, should have clear understanding of the management and prevention of CDI. Lack of knowledge can make nurses transmitting the infection from patient to another instead of preventing the
disease. Abbett et al. (2009) states that providing education to healthcare staff, the patient, and families is vital and should be included in implementing the CDI bundle. Promoting accountability not only on each individual healthcare worker, but also to patients and families, is significantly important for successful practice change in using the CDI bundle. It does entail behavioral change on each healthcare worker when a new practice is being implemented.

Another factor that can influence CDI bundle compliance is staff work environment. Studies proved that utilizing CDI bundle resulted in better patient outcomes through improved coordination of care among multidisciplinary team members. But despite the evidence-based outcome of the CDI bundle, nurses may still not necessarily be implementing the bundle in their everyday practice due to their limited understanding about the bundle or the work environment. In fact, a study by Kelly, Kitney-Lee, Lake, and Aiken (2013) determined the effect of critical care work environment on the frequency of hospital-acquired infections. The authors found out that nurses working in better environments were 36% to 41% less likely to report occurrence of infections than nurses who worked in stressful work environments (inadequate staffing, work overload, etc.). Furthermore, the authors concluded that implementing adequate staff resources could lower risk for development of HAIs. Inconsistency with hospital guidelines can also affect staff compliance. A study by Fayerberg, Bouchard, and Kellie (2013) found out that there were significant gaps in knowledge about facility policies and CDI clinical practice guidelines that led to noncompliance. Therefore, having clear hospital policies and practice guidelines as well as proper information dissemination about CDI management and prevention is significantly important.
The Effectiveness of the CDI Bundle

There have been several studies that showed the effectiveness of CDI bundles in decreasing CDI rates. A study by Muto et al. (2005) revealed that after a CDI prevention bundle was instituted, there was a 78% decrease in CDI cases. The CDI bundle they developed consisted of the following: (1) education using a standardized educational module for patients and providers, (2) increased and early case finding where nurses were given authority to order testing for CDI, (3) expanded infection control measures such as environmental cleaning with bleach, hand hygiene with soap and water, duration of contact precautions until resolution of diarrhea, and infection-control audits, (4) forming a CDI management team, and (5) antimicrobial management that requires approval from infectious disease physicians and pharmacists of certain high-risk antibiotics. A similar bundle approach was done by Abbett et al. (2009) which included an educational campaign, prevention bundle, and a treatment bundle. The educational campaign focused on teaching all hospital personnel about prompt diagnostic testing, isolation precautions (including hand washing), and standardized treatment guidelines for those diagnosed with CDI. The prevention bundle, on the other hand, emphasized on specific infection control responsibilities to each member of the hospital team- from physicians, nurses, microbiology staff, to environmental services personnel. This study by Abbett et al. (2009) significantly decreased the incidence rates of CDI by 40% and the reduction was sustained over a 21-month period.

There are other studies that recognize the need of understanding the knowledge, attitudes, and perception of nurses in utilizing hospital-acquired infection (HAI) bundles. One example was a study done by Pinto and Biancofiore (2016) where they assessed
ICU nurses’ knowledge and attitudes on the use of the bundle. Results showed that only 41% of nurses are aware of the bundle and only 34% consider the bundle applicable in their practice. The authors concluded in their study that understanding nurses’ knowledge and perception of the bundle is important for effective implementation into practice. A similar study done by Kiyoshi-Teo, Cabana, Froelicher, and Blegen (2013) identified factors that influenced adherence of nurses to the bundle. Results showed that the most consistent factor for bundle adherence was nurses’ positive attitude toward the guidelines. They also noted that awareness and perceptions of the quality of the guideline and the overall hospital encouragement is positively correlated with adherence. Lastly, a quality improvement initiative done by Munaco, Dumas, and Edlund (2014) that focused on education, practice performance, and evaluation of nursing documentation significantly improved staff compliance. The authors developed a web-based education module, bundle checklist, and documentation modification to increase bundle compliance. Results of the study revealed a 44% increase between pre- and post-test scores for the education module and overall increase in compliance.

**Summary of Literature Findings**

Overall, these studies showed the importance of identifying and addressing factors influencing staff compliance that may post as a challenge in hindering successful implementation of the bundle. Adherence in using the CDI bundled interventions is indeed a challenging task since it entails compliance of all members of the healthcare team in order to be effective. Moreover, the review of literature provided evidences that there are still some deficits in knowledge about Clostridium difficile among healthcare workers, particularly nurses. Pinto and Biancofiore (2016) emphasized the need for
educational improvement and cultural change to address the knowledge deficit of staff that can be a barrier for effective bundle implementation. Regular educational programs and training for all healthcare workers on infection control is critical part of an effective infection control program (Askarian, Mirzaei, Mundy, & McLaws, 2005; Sodhi, Shrivastava, Arya, & Kumar, 2013). Furthermore, evaluating staff compliance in using the bundle should be ongoing even after the implementation phase. Pinto and Biancofiore (2016) stated that barriers to the bundle’s adoption can remain after it becomes standard of care. Thus, the need to acknowledge these barriers- such as reluctance to follow both new and existing protocols, care coordination, communication barriers, and workload concerns- are highly important.

Project Design

Project Outcomes

The intended outcomes of the project are the following: (1) increase in staff (nurses and PCTs) knowledge about CDI as measured by a pre- and post-test, (2) staff compliance in using the CDI bundle in practice as measured by observation and check off list, and (3) decrease in CDI incidence rates within the three hospital inpatient units (MICU, SICU, and PCU) as measured by hospital data after staff education and CDI bundle implementation.

Setting and Population

The project was conducted at a 304-bed capacity acute care teaching hospital in Northeast Florida. Nurses and PCTs working in medical intensive care unit (MICU), surgical intensive care unit (SICU) and progressive care unit (PCU) were specifically chosen to be the population and setting of the study. Each of these units have 27 bed
capacity with critically ill adults having several co-morbidities and multi-organ failures, to name a few. These units were chosen as the focus of the project due to recent reports of CDI incidence rates. Prior starting the project, SICU and PCU both have three reported CDI cases while MICU has one reported CDI case from May to July 2017 (Mayo Clinic Jacksonville, 2017). In addition, patients in these three units have complex conditions due to their co-morbidities making them sicker and immunocompromised which leads them to be more at risk to CDI infection.

The population of the project focused on nurses and PCTs working within these three inpatient units. The potential number of participants was 166 nurses and 24 PCTs (60 nurses and six PCTs in MICU; 61 nurses and seven PCTs in SICU; 45 nurses and 11 PCTs in PCU). Depending on patient acuity, an average of 10-14 nurses and two PCTs work each shift in MICU and in SICU with a patient-nurse ratio of 2:1 or 3:1. On the other hand, PCU has 8-10 nurses and three PCTs that work each shift with a patient-nurse ratio of 3:1. Inclusion criteria for the project included nurses working either full time (36-40 hours per week) or part time (24-35 hours per week) and worked at least one year in the hospital. The following criteria were excluded in the project if any of the following were met: (1) per diem staff, (2) staff who worked less than one year, or (3) newly hired staff who are still in orientation during the implementation period. The reason these exclusion criteria were included is because those staff who fall under these categories may not be updated with the current policies and changes within the hospital. Based on these exclusion criteria, 29 staff were excluded in the project (11 per diem staff, ten staff who are working less than a year, and eight newly hired staff who
are still in orientation). As a result, only 161 staff (139 nurses and 22 PCTs) were eligible to be included in the project.

**Instrument**

The instrument used was adopted from Tsagkaraki et al.’s (2009) CDI knowledge assessment tool after permission from the authors (Appendix A) was obtained. The questionnaire (Appendix B) includes 21-item true or false statements about CDI which are divided into three categories: (1) questions 1-7 about characteristics of CDI (signs, symptoms, risk factors, mode of transmission, and diagnosis), (2) questions 8-17 about treatment/management, and (3) questions 18-21 about CDI prevention. At the end of the questionnaire, an open-ended section was added to allow participants to provide comments about CDI and recommendations in improving staff compliance. This questionnaire was chosen as the instrument for the project since it is not complicated for the staff to answer the questions. Completing the questionnaire can approximately take about five to ten minutes to finish.

The CDI knowledge assessment tool questionnaire was created by Tsagkaraki et al. (2009) in their study to assess the knowledge of doctors and nurses about CDI. However, the authors acknowledged that despite running a pilot questionnaire, some of the wording of the questions was open to misinterpretation. The validity and reliability of this questionnaire was further evaluated in a study by Brady et al. (2012). The content was reviewed by a panel of five CDI experts where the accuracy, clarity, and the representation of basic CDI knowledge of each statement in the questionnaire was assessed. The evaluation of the questionnaire revealed that there are some statements that require rewording to improve the clarity of statements and that some may have
local practice variation (Brady et al., 2012). The questionnaire was tested in populations of infection control nurses and doctors and showed a reliability coefficient of 0.95.

The questionnaire was printed in hard copies and was distributed to the staff over a period of one week. Participation to the survey was voluntary. Consent to participate (Appendix C) was provided with each questionnaire. Return of the completed questionnaire indicated voluntary agreement of the staff to participate in the project. A dedicated sealed brown envelope located at the team leader desk in each unit was provided to collect the returned questionnaires.

Methodology

A convenience sampling was done to collect data from nurses and PCTs working in MICU, SICU, and PCU. Data was collected from a sample size of 124 nurses and 19 PCTs (N=143). Baseline data was collected prior project implementation by: (1) determining the CDI rates in each unit (MICU, SICU, and PCU) for the past three months from May to July 2017, and (2) distributing the questionnaire as a pre-test to all nurses and PCTs in each three units (MICU, SICU, and PCU). The week of August 1-7, 2017 was designated to distribute the questionnaire in all the three units for the staff to complete and return the pre-test questionnaire. One week was allotted for completion to allow enough time for the staff to complete at their own convenience. After a week, results of the pre-test were collected to identify areas where staff needs more information about CDI.

The following week (August 8-14, 2017), staff education about CDI and the CDI bundle (Appendix D) was provided to all staff in MICU, SICU and PCU. Coordination was done with the respective nurse managers of each unit about the place and time of
the class and in disseminating the information to their staff. A 30-45 minute class was provided twice a day (every 0600 and 1800) for a week to accommodate the day and night shift staff. The class was conducted in class at the fourth floor conference room for all the staff in MICU, SICU, and PCU to attend. The education was done by the primary investigator and presented through a PowerPoint presentation about CDI which focused primarily on the following: (1) what is CDI, (2) CDI incidence rates within the hospital and in each unit, (3) the impact of CDI on patient outcomes and the hospital, and (4) compliance with CDI bundle to prevent its transmission. At the end of the class, time was allotted for staff to ask questions. Reinforcing accountability on each specific role was the focus of the CDI bundle education. Hand washing campaign was also reinforced during the project implementation as part of the infection prevention awareness. “HANDWASH before and after patient contact” signs (Appendix E) were posted in all patient rooms in MICU, SICU, and PCU to remind staff to do hand washing prior to leaving patient’s room. After a week of conducting the staff education daily, there was a 100% turn out of staff attendance.

After a week of providing staff education, the same questionnaire was distributed to all staff in MICU, SICU, and PCU as a post-test. The week of August 15-21, 2017 was allotted for the staff to complete and return the questionnaire. The pre- and post-test results were then compared to determine if there was a change in knowledge and understanding of staff about CDI after a staff education was provided. During the week of August 22-31, 2017, surveillance was done to observe staff compliance of the CDI bundle. Observation was done by the primary investigator daily for ten days (week of August 22-31, 2017) on each CDI patients to see if the entire CDI bundle check list was
implemented and practiced daily. Random checks were done at different times of the day (approximately for one hour or more) for each CDI patient. Also, the staff was not notified during this observation period. For each CDI patient, if the staff missed a specific task in the CDI bundle, it will be a point deducted for that day. After the project implementation, the following outcomes were evaluated: (1) knowledge of staff about CDI and the CDI bundle as measured by the pre- and post-test, (2) staff compliance in applying the CDI bundle as measured by observation and check off list, (3) incidence rates of CDI in MICU, SICU, and PCU within three months (September 2017 to November 2017) as measured by hospital data.

Ethical Considerations

The project was approved by the Institutional Review Board (IRB) of both Jacksonville University (IRB# 2017-056) and Mayo Clinic Jacksonville (IRB application # 17-006933) (Appendices C and F). It was determined that the project met the requirements for minimizing risk and protecting the rights of the participants. The primary investigator had no conflict of interest on the project. The sample population was informed about the project through a letter of consent (Appendix C). The informed consent explained the following: (1) what the project is all about, (2) the risks to the staff were minimal, (3) their answers will remain confidential throughout the entire project, and (4) their participation will not affect their employment.

Furthermore, the collected data was shared only between the primary investigator and advising faculty. During data collection, answered questionnaires were coded and the data were entered into spreadsheets using SPSS. To avoid mistakes during data encoding, all data were double-checked once entered in the spreadsheet. The files
were also saved on a password protected hard drive in the hospital which acted as a back-up file location for the computer file. The hard copy questionnaires were compiled in a sealed brown envelope and stored in a locked filing cabinet in the hospital and kept until the presentation of the project results.

**Data Analysis**

Frequencies of the pre-test and post-test scores were determined to calculate the average percentage of correct scores of nurses and PCTs. A paired $t$ test was used to compare the pre-test and post-test scores of RNs and PCTs using SPSS (Software package used for statistical analysis software). To measure staff compliance with CDI bundle, a check off list was done on all patients with CDI. Compliance was met if all components of the bundle were accomplished. Compliance scores were calculated by determining average percentage scores on staff compliance on each CDI bundle component of each inpatient units.

**Results**

Results of the project will be discussed in detail based on three projected outcomes: (1) staff knowledge as measured by pre- and post- test, (2) staff compliance in using the CDI bundle, and (3) incidence of CDI post intervention.

**Staff Knowledge**

A total of 190 questionnaires were distributed with a final response rate of 75% ($N=143$, RNs=124, PCTs=19). Overall, the pre-test results (Appendices G and H) showed that the staff had knowledge about CDI. Questions 1-5 were related to signs and symptoms of CDI. Most nurses (36.3%) missed the question that CDI is usually accompanied by fever (question #3). In the category about causes and risk factors of
CDI (question #7), majority of staff were able to identify all the risk factors for CDI.

However, most PCTs (15.8%) thought that the use of beta blocker can cause CDI. All the staff knew the severity of CDI and how it can lead to serious problem such as colitis (100%). When it comes to diagnosis of CDI, most of the staff (RNs=29%, PCTs=10.5%) thought that stool culture is the gold standard in diagnosing CDI. With CDI treatment and prevention, nurses did well with questions on prevention but missed the question (question #9) on using oral Vancomycin as the first line of treatment for CDI (39.5%).

Alarmingly, only 57.9% of PCTs knew that use of alcohol gel is not effective in preventing CDI (question #18) and that there are more ways to spread CDI other than just direct contact with an infected patient stool (question #17). At the end of the questionnaire, an open-ended question was provided for the staff to give insights or comments about the CDI bundle. Results showed that majority of the respondents reported that they feel the need for more information about CDI. In general, the pre-test results showed that although the staff had knowledge about CDI, there were still some areas where staff has limited understanding about the disease. It is important to know where the knowledge deficits were in order to improve staff education and address knowledge gaps. With all the questions missed by the staff, these were the areas of concern that were addressed during staff education. Emphasis on signs and symptoms of CDI, diagnosis, treatment, transmission, and importance of hand washing were the topics that were highlighted in the staff education. It is extremely important especially for nurses to identify patients who are at high risk of having CDI. Staff needs to be vigilant in looking for signs and symptoms in high risk patients and take extra
precautions to prevent the spread of CDI. In addition, it is also crucial that all staff should understand that hand washing is the most effective way to kill C. difficile spores.

After staff education was provided, the post test scores showed a significant improvement in the knowledge of staff about CDI (Appendices G and H). Compared to the results of the pre-test, all RNs and PCTs scored a 100% in recognizing that CDI may have a fatal outcome if not treated promptly (question#12) and that it could lead to complications such as pseudomembranous colitis (question #6). The staff is more knowledgeable when it comes to identifying the signs and symptoms of CDI. RNs (from 89.5% to 96.5%) and PCTs (from 73.7% to 90.2%) were now aware that bloody diarrhea does not suggest CDI (question#2). In diagnosing CDI, staff had an increased understanding that stool culture is not the gold standard in diagnosing CDI (from RNs=29% to 98.2%; PCTs=10.5% to 98%). Two of the main concerns of the pre-test results were the staff knowledge on treatment and prevention of CDI. After the staff education, RNs knew that oral Vancomycin is not the first line of treatment (question #9 from 39.5% to 99.9%). Intravenous Vancomycin is considered the first line of treatment of CDI rather than oral route.

The other alarming result of the pre-test is the knowledge of PCTs on CDI prevention. PCTs scored 100% (from 57.9%) on question #18 about the ineffectiveness of alcohol gel in preventing CDI. Overall, the result of the post test showed a significant increase in knowledge and understanding of staff about CDI. The areas of concern that the staff missed in the pre-test, mostly in treatment and prevention, showed significant improvement in test scores.
The results of the pre-test were compared with the post-test scores. Results from the data analysis revealed an increase between pre-test and post-test scores after the staff education. Mean post-test scores \((m=18.72, s=1.770)\) were improved compared to the pre-test scores \((m=14.61, s=2.678)\) of staff. Using a paired \(t\) test, post-test scores of RNs \((p = 0.012)\) and PCTs \((p = 0.040)\) showed a significant improvement compared to the pre-test scores after staff education was provided. Using the alpha value of .05, there was a statistically significant difference from the pre-test and post-test scores. This supports that after education was provided, the staff had an increased level of knowledge about CDI and the CDI bundle.

**Staff Compliance**

Compliance was measured by using the CDI bundle checklist to make sure all components of the bundle were completed. The goal of observing and checking staff compliance was the implementation of all the components of the CDI bundle. A 100% compliance rate was achieved if all components of the CDI bundle were performed in each patient. If there are components in the CDI bundle that were missed on a specific CDI patient, the compliance rate will be less than 100%. Those areas in the CDI bundle which were not consistently implemented will help in providing immediate feedback to the staff in improving compliance.

During the month of August 2017, there were a total of five CDI cases (one in MICU, two in SICU and two in PCU). During the staff compliance observation period, the staff were observed if the CDI bundle was implemented and practiced daily in these five patients. The observation was done by the primary investigator daily for ten days (week of August 22-31, 2017) on each CDI patients. For each CDI patient, if the staff missed a
specific task in the CDI bundle, it will be a point deducted for that day. As illustrated in Table 2, MICU, having one CDI patient, has only 90% overall RN compliance in observing PPE. This means that out of the ten days observation period, there was a day when a staff was observed not doing the appropriate use of PPE on that specific patient. Same thing with hand hygiene practice and the use of dedicated equipment which both showed 80% compliance rate in MICU. This means that out of ten observation days, there were a couple of days when RN staff was not observing this specific component of the CDI bundle on that patient. On the other hand, SICU, having two CDI patients, has 80% RN staff compliance rate on observing PPE, hand hygiene, and use of dedicated equipment. The primary investigator observed that two out of the ten-day observation period that some staff were not observing these three elements of the CDI bundle on each of these two CDI patients. Lastly, PCU, with two CDI patients, have 90% RN compliance rate in observing PPE which means that an RN was observed not using appropriate PPE when taking care of one of the CDI patients.

Overall, the compliance rate of team leaders, healthcare unit coordinators, and housekeepers in the CDI bundle in all inpatient units achieved a 100% score. However, RNs and PCTs need some improvement in practicing the following components of the CDI bundle: (1) observing personal protective equipment (PPE), (2) hand hygiene compliance, and (3) use of dedicated equipment. In MICU, results showed that some nurses are not consistent with use of the PPE (90%), hand hygiene before and after patient care (80%), and the use of dedicated equipment (80%). The PCTs working in MICU also have compliance rate of 80% in both components of hand hygiene and the use of PPE. The same thing was observed in SICU for both RNs and PCTs. Both RNs
and PCTs got 80% compliance rate in each of the following areas: use of PPE, hand hygiene compliance, and the use of dedicated equipment. In this case, the primary investigator observed that the staff taking care of these two CDI patients in SICU, both missed implementing these specific components of the CDI bundle. Meanwhile, staff in PCU performed better compliance rate compared to MICU and SICU. RNs in PCU complied 90% both in observing PPE and in using dedicated equipment, while 80% compliance in hand hygiene before and after patient contact. PCTs, on the other hand, had a compliance rate of 90% in hand hygiene and 80% in the use of PPE. Overall, the average CDI bundle staff compliance rate in these three inpatient units was 95.1%.

Table 2 shows the summary of the CDI bundle compliance rate in each unit during the ten-day observation period.

**CDI Incidence Rates**

There was a decrease in CDI incidence rates within the three inpatient units after the project was implemented. Prior the project implementation there were seven cases of CDI from May-July 2017 (one in MICU, three in SICU, and three in PCU). During the intervention period (August 2017), it decreased to five CDI cases (one in MICU, two in SICU, and two in PCU). And after the project was implemented, the CDI incidence rate was three in September 2017 (one in MICU, two in SICU, zero in PCU). And on the months of October to November 2017, there was zero CDI incidence rate in all the three inpatient units. This shows a significant effect of CDI bundle staff compliance in decreasing the CDI incidence rates. Figure 1 illustrates the rates of CDI in three hospital inpatient units before and after the project implementation.
Discussion

The implementation of CDI staff education and the CDI bundle was associated with a significant decrease in the incidence rate of CDI in a three-month span of time. Fostering staff awareness and compliance with the CDI bundle are the contributing factors that effectively decrease the CDI rates in the three hospital inpatient units. It is noted that in the pre-test scores, staff already have knowledge about CDI. However, there is still limited understanding or lack of knowledge in some areas about CDI. Staff are not fully aware of their respective responsibilities in the CDI bundle. Thus, providing staff education significantly helped the RNs and PCTs to be more knowledgeable about the CDI bundle. The improved results of the post-test scores and the decrease in CDI incidence rates after project

![Figure 1 Rate of CDI over time in three hospital inpatient units before and after the project intervention. The vertical arrows represent the project intervention period.](image-url)
implementation showed that the staff education and compliance with the CDI bundle effectively helped to achieve the goals of the project.

One of the expected benefits of this project was a change in practice behavior (compliance) of staff in applying the CDI bundle. Tracking staff compliance was monitored by direct observation if the staff were implementing the CDI bundle in their daily practice. Based on the evaluation of staff compliance with the CDI bundle, PCU had a better compliance rate of 96.1% compared to MICU (95%) and SICU (94.4%). It was observed that RNs and PCTs in each unit consistently missed on hand hygiene and the use of PPE. The overall compliance rate of each unit was considered a good performance but there is still room for improvement in practice. The percentage compliance rate for each individual component of the CDI bundle showed where is the need to focus the effort in improving overall compliance. The bundle checklist served as a guide to provide immediate feedback for the staff on those components missed and provide actions that can then be taken to improve on compliance levels. More importantly, compliance of staff in implementing the CDI bundle in their practice entails a change of behavior in the long run. And this change in behavior needs to be sustained until it becomes part of their daily routine in nursing practice. It is also important to note that when initiating a change in practice, there should be open-mindedness of the staff about the current situation or problem about CDI. Thus, staff education is necessary to promote staff awareness about CDI. The performance of staff compliance with the CDI bundle may also be attributed to work environment, nurse load, and patient acuity. One factor that may be considered why MICU (95%) and SICU (94.4%) have lower overall compliance rate as compared to PCU (96.1%) may be due to nurse and patient
workload. Patients in MICU and SICU have more complex situations which requires challenging tasks to do each shift as compared to PCU patients. This workload can create stress in their work environment. However, this should not hinder the staff in improving with CDI bundle compliance. It is essential to develop strategies to create change while also addressing challenges and barriers to change such as knowledge deficit of staff, work environment, patient acuity, and nurse workload that can hinder implementation. Moreover, the attitude of staff in using a guideline or protocol is also considered a factor associated with compliance (Kiyoshi-Teo et al., 2013). Tracking compliance with the CDI bundle should not be seen by the staff as a punitive act but rather a constructive criticism that everyone should learn from. Motivation is also another factor that should be promoted to encourage staff and to let them know that their efforts are greatly appreciated.

A successful implementation of the CDI bundle requires an effective and frequent communication among the different healthcare team members. According to Pinto and Biancofiore (2016), quality improvement in health care requires each healthcare team members delivering care with an interdisciplinary perspective and promoting accountability to each member. Teamwork is perceived as a key factor related to care bundled use. Teamwork has a clear relationship with patient safety in high risk clinical settings such as in MICU, SICU, or PCU. In fact, Damkliang et al. (2015) states that effective cooperation among healthcare teams promotes improvement of patient care processes.

Promoting practice change must also include evidence-based practice updates and continued education emphasizing the role of each member of the healthcare team.
should be done routinely. The use of current evidence-based knowledge and best practices should be the goal in every quality improvement projects. Hence, as staff becomes more knowledgeable and aware about the impact of CDI, the more they will eventually realize the importance of practicing the CDI bundle and its significance in improving both patient and institutional outcomes.

It is indeed valuable to assess how knowledge is put into practice. The outcomes of this project evidently showed that knowledge was a key factor in infection prevention of CDI and that lack of adequate knowledge about CDI was significantly related to noncompliance. Therefore, addressing knowledge barrier is necessary to find solutions that could be implemented to overcome these problems. The CDI cases showed a considerable decrease in rates in MICU, SICU, and PCU after the intervention (from seven CDI cases down to three cases after project implementation). The intervention did not completely eradicate CDI rates after project implementation but it is definitely a key factor in decreasing CDI cases. Healthcare workers, particularly nurses and PCTs who have direct contact with patients, must be informed about the severity of Clostridium difficile and the role they can provide in infection prevention. It is hoped that nurses and PCTs will be more conscientious in their practice about preventing CDI within their unit.

**Limitations**

Given the amount of time to implement the project, only three units were chosen to be included in the project which is not a good representation of the knowledge and compliance of staff in the entire hospital. Moreover, evaluation of staff compliance within a week and the CD incidence rates within three months may not be enough to measure compliance and its effect on CDI rates. It would be ideal to increase the length of the
project implementation and evaluation to further evaluate staff knowledge and compliance. Lastly, inclusion of other members of the healthcare teams, such as the doctors and housekeeping, should be included in future quality improvement projects related to CDI bundle use. Everyone in the team should be educated according to their role in the CDI bundle to give emphasis on the multidisciplinary approach of using the bundle.

Implications for Nursing Practice

Nursing Practice

Evaluating a change in practice behavior of staff requires continuous assessment. It is also important to consider that it takes time for the staff to adapt to a new practice and each person adjusts differently. Therefore, periodic evaluation and performance feedback of staff compliance in practicing the CDI bundle should be done routinely. It is also important to note that the CDI bundle is not just the sole responsibility of nurses. Each member of the healthcare team should be held accountable in their respective roles in CDI prevention. Implementing the CDI bundle entails a multidisciplinary approach of different members of the healthcare team (doctors, nurses, PCTs, housekeeping).

Nursing Education

Staff compliance in implementing the CDI bundle is vital in controlling CDI rates and other HAIs. Therefore, staff education for all healthcare personnel (doctors, nurses, PCTs, and housekeeping) is necessary to foster awareness about the increasing incidence rates of CDI within the hospital as well as its impact in patient and institutional outcomes. Informing the staff about the relevance of the project and its impact in
improving patient outcomes can help increase staff compliance to adopt the necessary changes in practice. Second, it is also important to give emphasis on the respective roles of each member of the healthcare team in applying the CDI bundle. Promoting accountability is necessary in disease management and infection prevention.

**Nursing Leadership**

Carling et al. (2008) noted the importance of administrative leadership, institutional flexibility, and commitment in an organization in order to achieve success and sustainability. Nurse leaders play a significant role in creating a culture of evidence-based practice in the work setting. Without managerial support and appropriate resources, the staff may not be empowered to initiate a change on the current practice. Thus, nurse leaders should start creating a culture where nurses are challenged to improve the current nursing practice.

**Recommendations for Future Research**

Based on the limitations noted previously, future replication of this QI project would be to include other members of the healthcare team (doctors and housekeeping) to make the implementation of the CDI bundle more multidisciplinary approach. Also, participation of all staff in each unit of the hospital would be a good population sample in order to educate the entire hospital staff about the impact of CDI and the importance of using the CDI bundle. Moreover, conducting the project by evaluating staff compliance for a year would be a good length of time to continuously assess staff compliance and evaluate a change in practice behavior. The results of this project would also be useful in studying the knowledge and compliance of staff in using the bundle of other HAIs
(CLABSI, VAP, CAUTI, VRE, etc.). Lastly, further research to evaluate the cost-effectiveness of the prevention and treatment bundles of CDI would be useful to know.

**Conclusion**

Effective implementation of the CDI bundle plays an important role in breaking the chain of infection of CDI. This project concluded that staff knowledge was associated with staff compliance and in decreasing CDI incidence rates. The results of the project showed that there was a substantial need for educational improvement about CDI bundle and cultural change among the healthcare team. Educating healthcare workers about infection prevention is a key factor for an effective infection control program. Moreover, determining staff knowledge and addressing barriers of staff compliance are essential guides when implementing practice change. Lastly, providing an evidence-based practice that promotes quality and safe patient care is not the sole responsibility of nurses. It entails a multidisciplinary team approach where everyone is accountable towards attaining the common goal. And when change in practice results in improved patient care, it will eventually lead to a positive domino effect that can significantly impact patient (i.e. morbidity and mortality) and organizational (i.e. economic costs) outcomes.
Appendix A

Author Permission to use the Instrument

Dear Marissa, I would be delighted if you did. I hope you have a copy of the questionnaire.

All the best

Effrosyni Gkrania-Klotsas

On 2017-05-21 12:14, Trinca, Marissa wrote:
> To whom it may concern:
>
> My name is Marissa Trinca, a DNP student at Jacksonville University in Florida. I am currently in the process of doing my DNP project about nurse knowledge and perception about Clostridium difficile infection bundle. My study aims to explore the ICU nurses’ knowledge and perception about Cdiff bundle and its relationship to staff compliance.
>
> In line with this, the questionnaire in your research appropriately
> fits my study. I would like to ask for your permission to use the said questionnaire in my study. I may do some modifications in the questionnaire if needed. Rest assured that you will all be credited in my research study once you give me the approval.
>
> Your prompt response will be greatly appreciated, if you have further questions you can contact me at mtrinca@jacksonville.edu.
>
> Thank you very much.
>
> Sincerely,
>
> Marissa Trinca
Appendix B

Clostridium Difficile Infection (CDI) Bundle Questionnaire (answer sheet)

Please indicate your role:
- RN ___
- PCT ___

Work status:
- Full time ___
- Part time ___
- Per diem (PRN) ___

How long have you been working at Mayo Clinic?
- less than 1 year ___
- more than one year ___

If working less than a year, are you still under orientation?
- Yes ___
- No ___

Please encircle if the following statements about Clostridium difficile is true or false.

1. Antibiotic-related diarrhea that occurs in hospital is due to C. difficile
   - True
   - False

2. Bloody diarrhea suggests a diagnosis of CDI
   - True
   - False

3. CDI is usually accompanied by fever
   - True
   - False

4. After the diarrhea has ceased the patient can be discharged
   - True
   - False

5. After antibiotic use, it characteristically takes about 7 days for CDI to appear
   - True
   - False

6. CDI can cause multiple syndromes, one of which is pseudomembranous colitis
   - True
   - False

7. Risk factors for CDI include:
   - Gastrointestinal Surgery
   - Clindamycin
   - Foreign travel
   - Clinically significant co-morbidities
   - Proton pump inhibitors
   - Ampicillin
   - Recent chemotherapy
   - Age >65 years
   - Beta blockers
   - True
   - False

8. Antibiotic treatment options include oral Vancomycin or IV Metronidazole
   - True
   - False

9. First-line treatment of CDI is with oral Vancomycin
   - True
   - False

10. Reducing the quantity of broad-spectrum antibiotics prescribed is unlikely to reduce the incidence of CDI, because of the ongoing transmission of C. difficile spores.
    - True
    - False

11. Recurrence of CDI after successful treatment is infrequent
    - True
    - False

12. CDI can be fatal
    - True
    - False

13. CDI confers lifelong immunity against C. difficile
    - True
    - False

14. Stool cultures are the gold standard for the diagnosis of CDI
    - True
    - False

15. By contrast to in-hospital CDI, community-acquired CDI is not a frequent issue
    - True
    - False

16. Transmission of C. difficile is by fecal-oral route
    - True
    - False

17. Only those who come into contact with the patient’s stool are able to transfer the microorganisms
    - True
    - False

18. Washing of hands with alcohol gel before and after dealing with CDI patients prevents spread of infection
    - True
    - False

19. The length of hospital stay is not relevant to the percentage of patients colonized with C. difficile
    - True
    - False

20. Chlorine-containing detergent are superior to non-chlorine containing ones in reducing the incidence of CDI
    - True
    - False

21. Deep cleaning has not been shown to alter the number of spores remaining on environmental surfaces.
    - True
    - False

22. What topics do you need to know more about Clostridium difficile?

23. What do you think are the challenges/barriers/hindrances why staff is not compliant with applying CDI bundle in their practice?

24. Comments and recommendations to better improve staff compliance on Clostridium difficile bundle.

Thank you for your time in filing this questionnaire! 😊
Appendix C

Jacksonville University Informed Consent and IRB Approval

You are being asked to take part in a research study. Before you decide whether to take part, please read the information below and ask questions about anything you do not understand.

PARTICIPANT’S NAME: ________________________________

TITLE OF THE RESEARCH STUDY: Knowledge and compliance of staff in using the Clostridium difficile infection bundle

RESEARCH INVESTIGATOR:
Marissa Marie S. Trino
Contact information: mtrino@jacksonville.edu; (904) 859-3175
Jacksonville University, 2800 University Blvd. N., Jacksonville, FL 32211

THE PURPOSE OF THE STUDY is to explore the staff knowledge about Clostridium difficile and determine staff compliance in using the Clostridium difficile preventive care bundle.

You will be asked to answer a pre-test and post-test about Clostridium difficile after a staff education is provided. The test is 21 item true/false questions about what you know about Clostridium difficile and its preventive care bundle. After the pre-test data is collected, an in-class staff education about Clostridium difficile and the use of the bundle will be provided to all staff which will take approximately less than an hour. A post-test will then be provided to all staff a week after the staff education is provided. Also, the staff will be observed on their compliance in observing the preventive care bundle on identified Clostridium difficile patients. You qualify to participate in this study because as a healthcare staff, you provide direct patient care that can increase the risk of transmitting Clostridium difficile infection from one patient to another.

You have a right not to participate in this study and if you exercise that right there will be no repercussions towards your job. If you decide to be in the study, the investigator will collect the following information list what data will be collected, including personal identifiers. A hard copy of questionnaires will be provided to participants. One week will be allotted for participants to return the questionnaire. If you have any questions now or at any time during the study, you may contact anyone listed under Investigators. If you agree, you will take part for approximately three months for the study. About approximately 200 potential Mayo Clinic staff (registered nurses and patient care technicians) will take part in the study.

BENEFITS OF THE STUDY: You may benefit from being in this study. Benefits of participating in this study will increase staff knowledge and awareness on the importance of using the Clostridium difficile prevention care bundle.
RISKS OF THE STUDY: The risks of taking part in this study may be possible loss of confidentiality on the test questionnaires.

COSTS / COMPENSATION: You will not have to pay nor will be paid any amount for taking part in this study.

ALTERNATIVE TO BE IN THE STUDY: The alternative to taking part in this study is opting not to participate in the research study.

RIGHT TO PARTICIPATE OR WITHDRAW: You are free to stop taking part in this research study at any time without penalty and without losing any benefits to which you are entitled. If you decide to stop taking part in this research study for any reason, you should contact Marissa Trino at (904) 859-3175. If you have any questions regarding your rights as a research participant, you may call the JU Institutional Review Board at (904) 256-7151.

CONFIDENTIALITY: Only the researchers and certain Jacksonville University officials have the legal right to review research records, and they will protect the secrecy (confidentiality) of these records as much as the law allows. Otherwise, your research records will not be released without your permission unless required by law or a court order.

CONFLICT OF INTEREST: In general, presenting research results helps the career of a scientist. The researchers may benefit if the results of this study are presented at scientific meetings or published in scientific journals but your name and/or pictures will not be used. There is no conflict of interest in conducting this research study.

CONSENT TO PARTICIPATE: You have been informed about this study’s purpose, procedures, possible benefits, and risks; and the alternatives to being in the study. You have been given the opportunity to ask questions before you give consent, and you have been told that you can ask other questions at any time.

You indicate your voluntary agreement to participate by completing and returning this survey questionnaire.

Thank you for your time.

Sincerely,

Marissa Trino, MSN, RN
Primary Investigator
Date: July 21, 2017
Appendix D

Clostridium Difficile Infection (CDI) Bundle Checklist

**Clostridium difficile Infection (CDI) Bundle Checklist**

<table>
<thead>
<tr>
<th>TEAM LEADERS</th>
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<tr>
<td>□ Perform blacklight testing after every room is cleaned</td>
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<table>
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<tr>
<th>NURSES</th>
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<tr>
<td>□ Appropriate testing for C. difficile done (diarrhea = 3 or more loose stools/24 hours)</td>
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<tr>
<td>□ Appropriate antibiotic ordered by physician (Vancomycin, and/or Metronidazole)</td>
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<tr>
<td>□ Initiate isolation precautions:</td>
</tr>
<tr>
<td>□ Place modified contact precaution door signage. Place all patients with suspected C. difficile on contact precautions until ruled out.</td>
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<tr>
<td>□ Observe appropriate PPE (use of gloves and gown)</td>
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<tr>
<td>□ Hand hygiene before and after patient care</td>
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<tr>
<td>□ Use of dedicated equipment (disposable stethoscope, etc.)</td>
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<tr>
<td>□ Provide patient and family education about CDI</td>
</tr>
<tr>
<td>□ Provide CHG baths on patients</td>
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<tr>
<td>□ Dispose medications in the nurse server appropriately after every patient discharge</td>
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<tr>
<th>PATIENT CARE TECHS (PCTs)</th>
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<tbody>
<tr>
<td>□ Dispose all contents inside the nurse server after every patient discharge</td>
</tr>
<tr>
<td>□ Hand hygiene before and after patient care</td>
</tr>
<tr>
<td>□ Observe appropriate PPE (use of gloves and gown)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HEALTH UNIT COORDINATORS (HUCs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Daily audit of CHG baths on all patients</td>
</tr>
<tr>
<td>□ Clean and refill nurse servers after every patient discharge</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HOUSEKEEPING</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Daily cleaning of patient room and high touch surfaces</td>
</tr>
<tr>
<td>□ Environmental cleaning and disinfection upon every patient discharge</td>
</tr>
<tr>
<td>□ Observe appropriate PPE (compliance with hand hygiene, use of gloves and gown)</td>
</tr>
</tbody>
</table>
Appendix E

Hand Washing Signage

Remember:

Wash your hands with soap and water before and after patient contact
Appendix F

Mayo Clinic Institutional Review Board Approval

Principal Investigator Notification:

From: Mayo Clinic IRB
To: Marissa Marie Trino
CC: Marissa Marie Trino
Re: IRB Application #: 17-006933

Title: Knowledge and compliance of staff in using the Clostridium difficile bundle
IRBe Protocol Version: 0.01
IRBe Version Date: 8/12/2017 6:11 PM
IRB Approval Date: 8/21/2017
IRB Expiration Date:

The above referenced application was reviewed by expedited review procedures and is determined to be exempt from the requirement for IRB approval (45 CFR 46.101b, item 4). Continued IRB review of this study is not required as it is currently written. However, any modifications to the study design or procedures must be submitted to the IRB to determine whether the study continues to be exempt.

AS THE PRINCIPAL INVESTIGATOR OF THIS PROJECT, YOU ARE RESPONSIBLE FOR THE FOLLOWING RELATING TO THIS STUDY.
1) When applicable, use only IRB approved materials which are located under the documents tab of the IRBe workspace. Materials include consent forms, HIPAA, questionnaires, contact letters, advertisements, etc.
2) Submission to the IRB of any modifications to approved research along with any supporting documents for review and approval prior to initiation of the changes.
3) Submission to the IRB of all Unanticipated Problems Involving Risks to Subjects or Others (UPIRTSO) and major protocol violations/deviations within 5 working days of becoming aware of the occurrence.
4) Compliance with applicable regulations for the protection of human subjects and with Mayo Clinic Institutional Policies.

Mayo Clinic Institutional Reviewer
### Appendix G

#### Percentage of Pre-Test and Post-Test Scores of RNs

<table>
<thead>
<tr>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Antibiotic-related diarrhea that occurs in hospital is due to C. difficile</td>
</tr>
<tr>
<td>2. Bloody diarrhea suggests a diagnosis of CDI</td>
</tr>
<tr>
<td>3. CDI is usually accompanied by fever</td>
</tr>
<tr>
<td>4. After the diarrhea has ceased the patient can be discharged</td>
</tr>
<tr>
<td>5. After antibiotic use, it characteristically takes about 7 days for CDI to appear</td>
</tr>
<tr>
<td>6. CDI can cause multiple syndromes, one of which is pseudomembranous colitis</td>
</tr>
<tr>
<td>7. Risk factors for CDI include:</td>
</tr>
<tr>
<td>Gastrointestinal Surgery</td>
</tr>
<tr>
<td>Clindamycin</td>
</tr>
<tr>
<td>Foreign travel</td>
</tr>
<tr>
<td>Clinically significant co-morbidities</td>
</tr>
<tr>
<td>Proton pump inhibitors</td>
</tr>
<tr>
<td>Ampicillin</td>
</tr>
<tr>
<td>Recent chemotherapy</td>
</tr>
<tr>
<td>Age &gt;65 years</td>
</tr>
<tr>
<td>Beta blockers</td>
</tr>
<tr>
<td>8. Antibiotic treatment options include oral Vancomycin or IV Metronidazole</td>
</tr>
<tr>
<td>9. First-line treatment of CDI is with oral Vancomycin</td>
</tr>
<tr>
<td>10. Reducing the quantity of broad-spectrum antibiotics prescribed is unlikely to reduce the incidence of CDI, because of the ongoing transmission of C. difficile spores.</td>
</tr>
<tr>
<td>11. Recurrence of CDI after successful treatment is infrequent</td>
</tr>
<tr>
<td>12. CDI can be fatal</td>
</tr>
<tr>
<td>13. CDI confers lifelong immunity against C. difficile</td>
</tr>
<tr>
<td>14. Stool cultures are the gold standard for the diagnosis of CDI</td>
</tr>
<tr>
<td>15. By contrast to in-hospital CDI, community-acquired CDI is not a frequent issue</td>
</tr>
<tr>
<td>16. Transmission of C. difficile is by fecal-oral route</td>
</tr>
<tr>
<td>17. Only those who come into contact with the patient’s stool are able to transfer the microorganisms</td>
</tr>
<tr>
<td>18. Washing of hands with alcohol gel before and after dealing with CDI patients prevents spread of infection</td>
</tr>
<tr>
<td>19. The length of hospital stay is not relevant to the percentage of patients colonized with C. difficile</td>
</tr>
<tr>
<td>20. Chlorine-containing detergent are superior to non-chlorine containing ones in reducing the incidence of CDI</td>
</tr>
<tr>
<td>21. Deep cleaning has not been shown to alter the number of spores remaining on environmental surfaces.</td>
</tr>
</tbody>
</table>
### Appendix H

**Percentage of Pre-Test and Post-Test of PCTs**

<table>
<thead>
<tr>
<th>Questions</th>
<th>Correct Answer</th>
<th>PRE TEST</th>
<th>POST TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Antibiotic-related diarrhea that occurs in hospital is due to C. difficile</td>
<td>False</td>
<td>31.6%</td>
<td>75.4%</td>
</tr>
<tr>
<td>2. Bloody diarrhea suggests a diagnosis of CDI</td>
<td>False</td>
<td>73.7%</td>
<td>90.2%</td>
</tr>
<tr>
<td>3. CDI is usually accompanied by fever</td>
<td>True</td>
<td>68.4%</td>
<td>90.7%</td>
</tr>
<tr>
<td>4. After the diarrhea has ceased the patient can be discharged</td>
<td>True</td>
<td>47.4%</td>
<td>98.1%</td>
</tr>
<tr>
<td>5. After antibiotic use, it characteristically takes about 7 days for CDI to appear</td>
<td>False</td>
<td>73.7%</td>
<td>89.9%</td>
</tr>
<tr>
<td>6. CDI can cause multiple syndromes, one of which is pseudomembranous colitis</td>
<td>True</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>7. Risk factors for CDI include:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Gastrointestinal Surgery</td>
<td>True</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>- Clindamycin</td>
<td>True</td>
<td>89.5%</td>
<td>98.2%</td>
</tr>
<tr>
<td>- Foreign travel</td>
<td>False</td>
<td>84.2%</td>
<td>92.5%</td>
</tr>
<tr>
<td>- Clinically significant co-morbidities</td>
<td>True</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>- Proton pump inhibitors</td>
<td>True</td>
<td>73.7%</td>
<td>98.4%</td>
</tr>
<tr>
<td>- Ampicillin</td>
<td>True</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>- Recent chemotherapy</td>
<td>True</td>
<td>89.5%</td>
<td>96.8%</td>
</tr>
<tr>
<td>- Age &gt;65 years</td>
<td>True</td>
<td>84.2%</td>
<td>99.7%</td>
</tr>
<tr>
<td>- Beta blockers</td>
<td>False</td>
<td>15.8%</td>
<td>97.9%</td>
</tr>
<tr>
<td>8. Antibiotic treatment options include oral Vancomycin or IV Metronidazole</td>
<td>True</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>9. First-line treatment of CDI is with oral Vancomycin</td>
<td>False</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>10. Reducing the quantity of broad-spectrum antibiotics prescribed is unlikely to reduce the incidence of CDI, because of the ongoing transmission of C. difficile spores.</td>
<td>False</td>
<td>68.4%</td>
<td>95.1%</td>
</tr>
<tr>
<td>11. Recurrence of CDI after successful treatment is infrequent</td>
<td>False</td>
<td>63.2%</td>
<td>87.1%</td>
</tr>
<tr>
<td>12. CDI can be fatal</td>
<td>True</td>
<td>84.2%</td>
<td>100%</td>
</tr>
<tr>
<td>13. CDI confers lifelong immunity against C. difficile</td>
<td>False</td>
<td>52.6%</td>
<td>90.7%</td>
</tr>
<tr>
<td>14. Stool cultures are the gold standard for the diagnosis of CDI</td>
<td>False</td>
<td>10.5%</td>
<td>98%</td>
</tr>
<tr>
<td>15. By contrast to in-hospital CDI, community-acquired CDI is not a frequent issue</td>
<td>True</td>
<td>36.8%</td>
<td>87%</td>
</tr>
<tr>
<td>16. Transmission of C. difficile is by fecal-oral route</td>
<td>True</td>
<td>57.9%</td>
<td>99.1%</td>
</tr>
<tr>
<td>17. Only those who come into contact with the patient’s stool are able to transfer the microorganisms</td>
<td>False</td>
<td>57.9%</td>
<td>98.9%</td>
</tr>
<tr>
<td>18. Washing of hands with alcohol gel before and after dealing with CDI patients prevents spread of infection</td>
<td>False</td>
<td>57.9%</td>
<td>100%</td>
</tr>
<tr>
<td>19. The length of hospital stay is not relevant to the percentage of patients colonized with C. difficile</td>
<td>False</td>
<td>68.4%</td>
<td>88.8%</td>
</tr>
<tr>
<td>20. Chlorine-containing detergent are superior to non-chlorine containing ones in reducing the incidence of CDI</td>
<td>True</td>
<td>63.2%</td>
<td>89.7%</td>
</tr>
<tr>
<td>21. Deep cleaning has not been shown to alter the number of spores remaining on environmental surfaces.</td>
<td>False</td>
<td>84.2%</td>
<td>90%</td>
</tr>
</tbody>
</table>
## Appendix I

Summary of CDI Staff Compliance in each Unit

<table>
<thead>
<tr>
<th>CDI Bundle</th>
<th>MICU</th>
<th>SICU</th>
<th>PCU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Team Leaders:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perform blacklight testing after every room is cleaned</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

| **Nurses:**                                     |      |      |      |
| Appropriate testing for C. difficile done (diarrhea = 3 or more loose stools/24 hours) | 100% | 100% | 100% |
| Appropriate antibiotic ordered by physician (Vancomycin, and/or Metronidazole) | 100% | 100% | 100% |

Initiate isolation precautions:
|                                      |      |      |      |
| Place modified contact precaution door signage. | 100% | 100% | 100% |
| Observe appropriate PPE (use of gloves and gown) | 90%  | 80%  | 90%  |
| Hand hygiene before and after patient care | 80%  | 80%  | 80%  |
| Use of dedicated equipment (disposable stethoscope, etc.) | 80%  | 80%  | 90%  |

Provide patient and family education about CDI | 100% | 100% | 100% |
Provide CHG baths on patients | 100% | 100% | 100% |
Dispose medications in the nurse server appropriately after every patient discharge | 100% | 100% | 100% |

| **Patient Care Techs (PCTs):**                  |      |      |      |
| Dispose all contents inside the nurse server after very patient discharge | 100% | 100% | 100% |
| Hand hygiene before and after patient care | 80%  | 80%  | 90%  |
| Observe appropriate PPE (use of gloves and gown) | 80%  | 80%  | 80%  |

| **Health Unit Coordinators (HUCs):**             |      |      |      |
| Daily audit of CHG baths on all patients | 100% | 100% | 100% |
| Clean and refill nurse servers after every patient discharge | 100% | 100% | 100% |

| **Housekeeping:**                               |      |      |      |
| Daily cleaning of patient room and high touch surfaces | 100% | 100% | 100% |
| Environmental cleaning and disinfection upon every patient discharge | 100% | 100% | 100% |
| Observe appropriate PPE (hand hygiene, use of gown and gloves) | 100% | 100% | 100% |

| Overall Compliance Rate | 95%  | 94.4% | 96.1% |
References


Clostridium difficile in the inpatient setting: A systematic review of the adherence to and effectiveness of C. difficile prevention bundles. *Infection Control and Hospital Epidemiology, 38*(6), 639-650. doi: 10.1017/ice.2017.7


Kiyoshi-Teo, H., Cabana, M.D., Froelicher, E. S., & Blegen, M. A. (2013). Adherence to
institution-specific ventilator-associated pneumonia prevention guidelines.


Muto, C., Pokrywka, M., Shutt, M., Mendelsohn, A., Nouri, K., Posey, K., . . .Harrison, L.


