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# Enhancing Environmental Staff Cleaning Process and Adenosine Triphosphate (ATP)

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# Enhancing Environmental Staff Cleaning Process and Adenosine Triphosphate (ATP) Bioluminometers Test to Improve Cleaning Efficacy

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## Abstract

*Clostridium difficile* (*C. difficile*) has become the most common microbial cause of healthcare-associated infections (HAI) in U.S. hospitals and costs billions of dollars each year in excess of health care costs for acute care facilities alone (Centers for Disease Control and Prevention [CDC], 2015, para. 2). Inadequate cleaning of contaminated surfaces in the hospital environment may lead to an HAI. Potential barriers related to environmental cleaning of *C. difficile* infected rooms were identified at a small safety net hospital. The investigator used a convenience sample of 12 environmental staff (EVS) and a quasi-experimental pre-posttest design, to explore whether or not an educational intervention with EVS on a new cleaning process and Adenosine triphosphate (ATP) testing would improve environmental staff understanding of the cleaning process, as well as decrease the incidence of *C. difficile* HAI. Overall, the study supported the use of an educational intervention to improve cleaning efficacy with statistically significant results from the EVS staff educational pre-posttest (*t= -2.680, p=.021)* and pre-post ATP tests (t=*12.520, p=.000)*. The study site's *C. difficile* incidence rates changed from *3.76* to *1*.86. The major limitation of this study was the small sample size. The most significant implication of this study is the investigator plans to continue implementing the new cleaning process with follow-up ATP testing, as well as conduct future research to assess other possible risk factors for *C. difficile* HAI.


*Key words*: DNP project, Healthcare-associated infections, Preventing *C. difficile*

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## Executive Summary


### Problem

*Clostridium difficile* (*C. difficile*) has become the most common microbial cause of healthcare-associated infections in U.S. hospitals and costs up to $4.8 billion each year in excess health care costs for acute care facilities alone (Centers for Disease Control and Prevention [CDC], 2015, para. 2). After analyzing a hospital's data on healthcare-acquired infections and reviewing the national and state benchmark for *C. difficile* infection, the investigator realized there were opportunities for improvement in this area.

### Purpose

This quality improvement project explored the use of evidence-based guidelines related to cleaning efficacy in rooms previously occupied by patients on transmission-based precautions for *C. difficile* and Adenosine Triphosphate (ATP) testing.

### Goals

This project specifically investigated if an educational intervention, on a two-step cleaning process supplemented with a high-touch checklist and follow-up ATP testing, with environmental staff would increase their knowledge of the cleaning process with a subsequent decrease in the rate of the healthcare associated infection, *C. difficile*.

### Objectives

The major objectives of this study were to measure the differences between pre-posttest ATP test results in rooms previously occupied by patients on transmission-based precautions for *C. difficile,* as well as the differences between the pre-posttest environmental staff (EVS) educational session test results, and compare hospital *C. difficile* rates pre-post intervention to assess for an improvement.

### Plan

After obtaining Institutional Review Board approval, the primary investigator utilized a quasi-experimental pre-posttest design that involved 12 EVS at a small safety net hospital. An educational session on evidence-based guidelines for cleaning *C. difficile* was presented to the EVS staff followed by ATP testing of infected rooms. SPSS 23 was used to perform quantitative analysis on the data.

### Outcomes and Results

The educational intervention resulted in a statistically significant improvement in the EVS knowledge of the new cleaning process [pre-post EVS test ($t = -2.680$, $p = .021$) and pre-post ATP test ($t = 12.520$, $p = .000$]. The incidence rate for *C. difficile* decreased from 3.76 to 1.86. These results support the use of an educational intervention based on evidence-based guidelines, in improving cleaning efficacy, decreasing risk of healthcare acquired infections and most important, ensuring a safe environment for patients, staff, and visitors.

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# Enhancing Environmental Staff Cleaning Process and Adenosine Triphosphate (ATP) Bioluminometers Test to Improve Cleaning Efficacy

Healthcare-acquired infection is an issue that affects most hospitals. It is imperative that hospitals consider the environmental surfaces as a possible link in the transmission of *Clostridium difficile* (C. *difficile)* to the patient. According to Dubberke et al. (2014), *C. difficile* is a gram-positive bacterium that is spore-forming, and the formation of spores poses unique challenges for hand hygiene and environmental disinfection practices. *C. difficile* spores are resistant to the bactericidal effects of alcohol and the most commonly used hospital disinfectants (CDC, 2018). Ensuring the cleaning efficacy by environmental staff (EVS) in rooms previously occupied by patients on transmission-based precautions may decrease healthcare-acquired infections. Because of an increase in infectious organisms that are resistant to antimicrobials and standard disinfectants, it is important that hospitals enhance their cleaning process and use tools to confirm the cleaning efficacy in rooms previously occupied by patients on transmission-based precautions for *C. difficile*. Visual inspections alone cannot detect infectious organisms such as *C. difficile*. This paper discusses the problem statement and its significance and scope, the related nursing theory and systematic review of the literature pertinent to the practice issue, and the market and risk analysis. It also clearly delineates the research study objectives and methodology and evaluation plan as well as analysis of findings, recommendations, limitations and implications for change in practice related to managing *C. difficile* infections in a hospital.

## Problem Recognition and Definition

### Statement of Purpose

The purpose of this quality improvement project was to explore the use of evidence-based guidelines related to the cleaning efficacy in rooms previously occupied by patients on

transmission-based precautions for *C. difficile* and Adenosine Triphosphate (ATP) testing. The primary investigator studied whether or not an educational intervention with environmental staff (EVS), on a 2-step cleaning process supplemented with a high-touch checklist as well as follow-up ATP testing, would improve environmental staff understanding of the cleaning process with a subsequent decrease in the rate of healthcare-acquired infections (HAIs) (*C. difficile*).

**Problem Statement**

The problem statement for this research study was as follows: Inadequate cleaning of contaminated surfaces in the hospital environment may lead to healthcare-acquired infections. Contaminated surfaces are a direct link to the transmission of *C. difficile* in rooms previously occupied by patients on transmission-based precautions for *C. difficile*. *C. difficile* can live for long periods on surfaces and as stated previously are resistant to most hospital disinfectants. EVS staff play a significant role in keeping in-patient rooms clean. This quality improvement study was conducted to gain insight on how to educate EVS staff in order to improve cleaning efficacy of *C. difficile* rooms.

**PICO/ Practice Question**

This project utilized the acronym "PICO", rather than stating a formal research hypothesis. The acronym stands for: Population or Disease (P), Intervention or Issue of Interest (I), Comparison group or Current Practice (C), and Outcome (O) and is usually framed as a question (Melnyk and Fineout-Overholt, 2011, p. 31). The PICO for this quality improvement project is:

P- Environmental staff in the inpatient units: ICU, Telemetry, and the Medical-Surgical unit

I- Environmental staff education on the 2-step cleaning process supplemented with a cleaning checklist and Adenosine Triphosphate (ATP) testing

C- No checklist/ Pre-test ATP/Pre-test Educational Intervention

O- Increase staff knowledge of disinfecting contaminated surfaces and improved *C. difficile* rates

The main question this quality improvement project addressed was "Will the environmental staff have an increase in knowledge of the disinfection process required for high touch objects in rooms previously occupied by patients on transmission-based precautions for *C. difficile*?" A secondary question included "Will ATP testing in *C. difficile* rooms improve the disinfection process in *C. difficile* infected rooms?" In addition, a change in *C. difficile* rates were monitored before and after implementation.

**Project Significance, Scope, and Rationale**

**Project significance**. *Clostridium difficile* infection (CDI) has become more prevalent as a healthcare-associated infection, causing diarrhea that can lead to colitis, colon perforation, sepsis, and, according to the Center for Disease Control and Prevention (CDC, 2015), is fatal in approximately 14,000 Americans annually. According to the Association of Professionals in Infection Control and Epidemiology (APIC), the average total cost for a single inpatient *C. difficile* infection (CDI) is more than $35,000, and the estimated annual cost burden for the healthcare system exceeds $3 billion (2013, p.8). CDI increases hospital length of stay by 2.8 to 5.5 days (SHEA, 2013). This quality improvement project may have a financial impact at the site for this study (AB hospital), as it is expected that the cost associated with an increase in the patient's length of stay and treating *C. difficile* will decrease over time. More importantly, the patient environment will be free of potentially infectious organisms found on high touched

objects, which can ensure quality assurance. Publicly reported quality metrics are expected to show improvement in this area, with a decrease in healthcare-acquired infections, zero penalties from the Centers for Medicaid and Medicare, and a safe clean environment.

**Scope**. The scope of this project was a quality improvement project that was internal to a small safety net hospital in the Midwest (AB hospital). This investigator explored the implementation of a new cleaning process by environmental staff and its impact on cleaning efficacy and C. *difficile* rates.

**Rationale**. A review of the literature demonstrated how contaminated surfaces in the hospital environment may lead to healthcare-acquired infections and how surfaces within the patient environment embraces infectious organisms. The literature also showed the correlation of the cleaning efficacy of high touch objects and contamination of infectious organism in the patient environment. Finally, the literature review provided evidence that indicated that the use of ATP testing as a tool, confirms the cleaning efficacy of high touch objects in the patient environment. This promulgated the primary investigator to investigate whether an educational intervention with environmental staff (EVS), on a 2-step cleaning process supplemented with a high-touch checklist as well as follow-up ATP testing, would improve environmental staff understanding of the cleaning process with a subsequent decrease in the rate of healthcare-acquired *C. difficile*.

## Theoretical Foundation for Project and Change

The investigator used a nursing and non-nursing theory as the theoretical framework for this DNP project, Betty Neuman's System Theory and the Avedis Donabedian Quality Model. Betty Neuman's System Theory (See Appendix A) is a nursing theory that focuses on the response of the patient system to actual or potential environmental stressors and the use of

primary, secondary, and tertiary nursing prevention interventions for retention, attainment, and maintenance of patient system wellness (McEwen & Wills, 2014). The investigator applied the concept of "primary prevention" in the study's intervention and in identification and reduction of possible or actual risk factors. Cleaning the identified high touched objects in the patient environment previously occupied by a patient on transmission-based precautions for *C. difficile* reduces possible or actual risk factors. Secondary prevention relates to symptomatology following a reaction to stressors, appropriate ranking of intervention priorities, and treatment to reduce their noxious effects. Tertiary prevention relates to adjustive processes taking place as reconstitution begins, and maintenance factors move them back in a cycle toward primary prevention. Providing just-in-time education on the 2-step cleaning process to environmental staff and re-cleaning rooms that fail ATP testing was "tertiary prevention".

Neuman's model focuses on attaining and maintaining system stability and prevention as an intervention (McEwen & Wills, 2014). The purpose of this DNP project was to explore ways to prevent infections by streamlining/ enhancing current processes according to evidence-based practice. Employing Neuman's theory as a framework for the investigator's DNP project allowed the investigator to implement "prevention interventions" to minimize risk of *C. difficile* transmission from surfaces in the patient's environment specifically, the bedrail, call light, and phone to the patient. Neuman's theory allows adjustment of processes if needed to ensure prevention of potential harm to the patient, such as a healthcare-acquired infection from the patient's environment. Using ATP to test rooms previously occupied by patients on transmission-based precautions for *C. difficile* determined if high- touch surfaces were clean.

Avedis Donabedian Quality Model (See Appendix B) is a non-nursing theory that assesses structure, instrumentalities, care processes, adequacies of facilities, required equipment,

administrative support, technical skills, medical evidence, redundancy, outcomes, recovery, and restoration (Cohen & Shang, 2015). Donabedian defines the concepts of structure, process, and outcome, and clarifies that these categories are not to be mistaken for attributes of quality. Rather, they are the classifications for the types of information used to infer whether the quality of care is poor, fair, or good. To make inferences about quality, there needs to be an established relationship between the three categories and this relationship between categories is a probability rather than a certainty (Donabedian, 2003). Confirming the cleaning efficacy in rooms previously occupied by patients on transmission-based precautions for *C. difficile* required the environmental staff to have knowledge of the 2-step cleaning process, technical skills, necessary cleaning equipment, instrumentality such as the ATP machine and administrative support.

**Literature Selection/ Systematic Process**

Keywords for the literature search included: ATP, Environmental, Healthcare-associated infections, Preventing *C. diff*, Environmental Cleaning, and Visual Inspection. The investigator found 86 articles using the following search engines: Cumulative Index to Nursing and Allied Health Literature (CINAHL), Google Scholar, and Academic Search Primer and PubMed. After using the keywords: ATP, Environmental, Healthcare-associated infections, Preventing *C. diff*, Environmental Cleaning, and the dates 2012-2017, the investigator narrowed the search to 40 articles, then to 25 articles. The search was limited to the English language and excluded articles on antimicrobial stewardship. In addition, the investigator selected infection control guidelines from national governing bodies as part of the literature review.

**Scope of Evidence**

The research design for the studies varied from experimental, prospective, and a literature review. The level of evidence based on Melnyk and Fineout-Overholt (2005) varied from a Level

1- systematic review and meta-analysis of randomized controlled trials and clinical guidelines based on systematic reviews or meta-analyses to a Level V – evidence from systematic review of descriptive and qualitative studies. All studies were evidence-based, quality improvement programs that used a pre-post design. After careful analysis of the related literature, 25 articles were used to support this quality improvement project. The investigator identified the 25 articles falling into the following categories:

- Level I – evidence from systematic review and meta-analysis of randomized controlled; clinical guidelines based on systematic reviews or meta-analyses - 6
- Level II – evidence from one or more randomized controlled trials - 14
- Level III – evidence from controlled trial (no randomization) - 1
- Level IV – evidence from case-control or cohort study- 2
- Level V – evidence from systematic review of descriptive and qualitative studies - 2

## Review of Evidence

### Background of the Problem

*Clostridium difficile* (*C. difficile*) has become the most common microbial cause of healthcare-associated infections in U.S. hospitals and costs up to $4.8 billion each year in excess health care costs for acute care facilities alone (Centers for Disease Control and Prevention [CDC], 2015, para. 2). After analyzing the hospital's data on healthcare-acquired infections and reviewing the national and state benchmark for *C. difficile* infection, this investigator realized there were opportunities for improvement in this area.

In 2017, a safety net hospital in the Midwest, which the investigator will refer to as AB hospital, had twenty-one Lab Identified (Lab ID) *C. difficile* events, with six classified as a healthcare-acquired infection. The goal of AB hospital is to be a high-reliability organization and

to have zero infections. *C. difficile* is a publicly reported quality metric and is a healthcare-acquired condition that affects hospital's reimbursement from the Centers for Medicare and Medicaid Services (CMS). Hospitals will lose 1% of Medicare payments from fines resulting from a healthcare-acquired infection.

In October 2016, the U.S. Department of Health and Human Services (HHS) announced new targets for the national acute care hospital metrics for the National Action Plan to Prevent Health Care-Associated Infections: Road Map to Elimination (HAI Action Plan). *Clostridium difficile* is a target metric in the action plan and the goal is to reduce facility-onset *C. difficile* infections (CDI) in facility-wide health care.

The national benchmark for *C. difficile* is 0.92 (CDC, 2014). AB hospital's rate for *C. difficile* in 2017 was 0.56. The national benchmark or standardized infection ratio (SIR) is based on data reported to the National Health Safety Network, (NHSN) in 2015. The standardized infection ratio (SIR) is a summary measure used to track HAIs at a national, state, or local level over time. The standardized infection ratio is a risk-adjusted summary measure that compares the observed number of infections to the expected number of infections based on NHSN aggregate data (NHSN, 2018). Even though AB's hospital rate is below the national benchmark, the goal of AB hospital is to be a high-reliability organization and to have zero infections.

In speaking with the manager of environmental services at AB hospital, this investigator learned the possible barriers to ensuring the cleaning efficacy in rooms previously occupied by patients on transmission-based precautions for *C. difficile*. The barriers identified included lack of communication between nursing staff and the environmental staff, knowledge deficit on the disinfection process required for *C. difficile*, and a checklist to guide staff on the cleaning process, as well as random ATP testing of patient rooms. These healthcare-acquired infections

may have been prevented if the process of informing the environmental staff about patients previously on transmission-based precautions for *C. difficile* were clear and the recommended guidelines for disinfecting rooms previously occupied by patients on transmission-based precautions for *C. difficile* were followed. Simple measures such as changing the way the environmental staff clean and confirming cleaning efficacy may significantly reduce AB hospital infection rate thereby ensuring positive outcomes for the patient and the hospital.

**Systematic Review of the Literature**

The investigator conducted a systematic review of the literature to find evidence-based practice studies/research articles to support the project's PICO (See Appendix C for an example of the Literature Review). Using a thematic analysis, the researcher placed the literature findings into four categories, Environmental Factors, Contaminated Surfaces, Methodology for Assessing Cleaning Efficacy and Measuring Cleaning Efficacy with ATP.

**Environmental factors.** Environmental factors contribute to the transmission of *C. difficile*. In 2013, Weber, Anderson, Sexton, and Rutala assessed microbiologic features of *C. difficile* in its role in environmental contamination and the role of environmental contamination in patient-to-patient transmission. Weber et al. demonstrated how long *C. difficile* survives on environmental surfaces, the level of contamination of *C. difficile* in the environment, and the link of contamination from staff/patient's hands to the environment. A study by McFarland et al. (2013) reported 49% of rooms occupied by symptomatic patients with *C. difficile* were contaminated and 29% of rooms occupied by asymptomatic patients were contaminated. The level of microbial contamination from *C. difficile* in the environment/ surfaces varied from <1-2 log10 with evidence of *C. difficile* surviving on hard surfaces for up to five months (Weber et al., 2013). Weber et al. also reviewed the guidelines from professional organizations, which

recommended the following key measures to prevent *C. difficile* transmission due to contaminated surfaces: hand hygiene, improved cleaning with sporicidal, no touch methods for room disinfection, and self-disinfecting surfaces. The professional organizations also recommended improved antimicrobial stewardship, rapid identification and use of contact precautions for patients with *C. difficile* and enhanced disinfection to prevent *C. difficile* infections (Weber et al., 2013). The Minnesota Hospital Association recommends a two-step cleaning process in rooms occupied by patients on transmission-based precautions for *C. difficile* infections (MHA, 2016). The two-step cleaning process consists of cleaning and disinfecting surfaces in the patient environment. During Step 1 of the cleaning process, staff will use a hospital-approved detergent to remove soil from surfaces followed by Step 2, the disinfection process. Step 2 requires staff to use bleach or another sporicidal disinfectant on the surfaces. During Step 2, the sporicidal agent must dwell on the surfaces for a set time to kill *C. difficile* spores.

Jou et al. (2015) ran a case-control study to assess the risk of *C. difficile* transmission in the hospital environment based on the square footage of the patient's room. They identified 468 cases of *C. difficile* during the yearlong study. One hundred and three or 22% were healthcare-acquired infections. Bivariate analysis demonstrated an association between *C. difficile* infection and location in a single room (OR, 2.03; 95% CI, 1.40-2.94; $P<0.001$). Based on the data, the larger the room or square footage, the greater the risk of *C. difficile* acquisition. The authors concurred that improving the hospital disinfection process would prevent risk of *C. difficile* transmission in the hospital environment.

Chemaly et al. (2014) conducted a literature review to assess the connection of the environment and transmission of pathogens, and strategies to prevent spreading of pathogens in

the environment. In this review, the authors assessed data linking contamination in the environment to the spread of multi-drug resistant organisms (MDROs). They looked at the survival rate of MDROs in the environment, the presence of MDROs in the patient care environment, prior room occupancy risk, issues with current practice, and emerging technologies. The evidence demonstrated how pathogens are recovered from the healthcare environment. Their literature appraisal also showed gaps in current practice and the need to implement new technology to assist in the monitoring of surface contamination in the patient setting. Attention to the environment is a factor in the prevention of infections. Resources to improve knowledge and understanding of the interaction of pathogen survival, disinfection, hand hygiene, and healthcare-acquired infection risk must also be available.

Guerrero et al. (2013) performed an experimental study to evaluate the effect of an intervention including education, observation of cleaning, and direct supervision with immediate feedback on reduction of environmental *C. difficile* contamination. At baseline, 63% of the surfaces were cultured positive for *C. difficile* after housekeeping cleaned the surfaces. Despite the use of bleach, *C. difficile* was present on 90% of drawer handles post cleaning. During the observed phase, the proportion of positive cultures were significantly reduced to an overall rate of 20% (P = .002). Guerrero et al. (2013) demonstrated how active interventions optimized by direct interaction with housekeeping staff result in highly effective disinfection of patient zone environmental surfaces.

**Contaminated surfaces**. Contaminated surfaces are a direct link to the transmission of *C. difficile* in rooms previously occupied by patients on transmission-based precautions for *C. difficile*. Donskey (2013) conducted a systematic review of sixteen studies that looked at environmental disinfection strategies and common routes of healthcare-acquired infections

(HAIs). Common routes consisted of patients who were colonized or infected and shedding organisms in the environment, direct contact with contaminated surfaces or equipment, and staff hands. The literature review demonstrated that improving surface cleaning and the disinfection process significantly reduces the risk of healthcare-associated infections. Findings from Donskey's review of the literature support the investigator's DNP project; cultures were monitored frequently in eight of the nine interventions reviewed and a reduction in environmental contamination decreased significantly as indicated by the results of the culture. Methodologies such as direct observation, ATP bioluminescence assay, and fluorescent markers were tools used to monitor the efficacy of cleaning.

To demonstrate how contaminated surfaces contribute to the transmission of hospital pathogens and review strategies to address contaminated surfaces in hospital settings, Otter, Yezli, Salkeld, and French (2013) directed a literature review in which modeling transmission routes through animal models and mathematical models were used in a study to show the link between contaminated surfaces and the transmission of pathogens. The authors assessed microbiologic studies, observational epidemiological studies, intervention studies, and outbreak reports to substantiate the evidence. Their findings validated the theory that rooms previously occupied by patients with a known infection or pathogen increases the risk of acquiring that pathogen. Combined with intervention studies that demonstrate that improved environmental decontamination can mitigate risk, this review also provides significant evidence that contaminated surfaces contribute to transmission.

To establish guidelines for disinfection process of noncritical surfaces in the health care setting, Havil (2013) conducted a systematic review of the literature. The author considered steps needed to create a cleaning bundle. Havil discussed the following processes in detail: forming a

multidisciplinary team, creating policies and procedures for cleaning, selection of cleaning products, recognizing advantages and disadvantages for methods for accessing cleaning practice, understanding method of application, and conducting staff education and monitoring. Havil concluded that implementing a cleaning bundle could potentially improve the overall cleaning processes in healthcare. Cleaning grids can identify what objects to clean, what chemical to use and frequency of cleaning. In addition, Havil provided a list of advantages and disadvantages of methods for accessing cleaning practices below:

- Visual inspection is simple, but not reliable.
- Aerobic colony counts can detect pathogens on surfaces, but the results are not available for 48 hours.
- Fluorescent marker systems are inexpensive, but labor intensive since you must mark surfaces before cleaning and check after cleaning with a UV light.
- ATP bioluminescence assay systems provide quantitative measures of cleanliness quickly, but is expensive.

Havil's review of the literature demonstrated that rooms previously occupied by patients with a known infection or pathogen increases the risk of acquiring that pathogen, combined with intervention studies that demonstrate risk prevention with improved environmental decontamination.

**Methodology for assessing cleaning efficacy.** To review methods used to assess the efficacy of cleaning practice and room disinfection, Carling (2013) reviewed descriptive and qualitative studies to assess methods to validate the cleaning practice in the patient environment and healthcare surfaces. Carling evaluated the following methods: direct observation, culture swab, agar culture system, fluorescent system, and ATP bioluminescence. For each method,

Carling determined ease of use, ability to identify pathogens, accuracy, usefulness for teaching and use in programmatic monitoring. Three of the methods ranked high for ease of use: culture swab, fluorescent system, and ATP bioluminescence. Two of the methods ranked high for accuracy: culture swab and fluorescent system. Three methods were useful for teaching: direct observation, fluorescent system, and ATP bioluminescence. Carling recognized that only the fluorescent system is useful for programmatic monitoring and only a culture swab can identify pathogens. Based on the data, the fluorescent system or a culture swab is a method to evaluate cleaning practice.

Luik et al. (2013) directed a prospective study of 50 patient rooms at a 580-bed hospital for a two-month period. Five high-touch objects were marked with a fluorescent marker. The researchers plated culture swabs on blood agar and then incubated them at 37º C for 40 hours. In the same manner, the researchers collected a swab and confirmed as clean using the ATP system. The study evaluated 250 surfaces in 50 patient rooms before and after cleaning. Two hundred and fourteen (86%) were without any visible contamination prior to cleaning and the number increased to 232 (93%) after the cleaning process (visual inspection: $X^{\wedge 2}=14.4$, $P<.001$). Based on the results, Luik et al. (2013) demonstrated that fluorescent dye or ATP assay has better diagnostic compared with visual inspection alone.

Dramowski, Whitelaw, and Cotton (2016) performed an experimental study to assess the efficiency of cleaning with limited resources to ensure the cleaning process is adequate in isolation rooms at Tygerberg Children's Hospital in Africa from August 1, 2014-October 31, 2015. They evaluated the efficiency of cleaning in a pediatric isolation ward using quantitative bacterial surface cultures, ATP bioluminescence assay, and fluorescent high-touch markers. Cleaning efficiency was determined by measuring the surfaces pre-and post-cleaning. Seven

employees terminally cleaned 25 pediatric isolation rooms. Of all the cleaning episodes, the researchers observed 3.6 per employee, which generated data on seven first and eighteen subsequent cleaning episodes. The mean Aerobic colony count (ACC) declined significantly between pre-and post-cleaning evaluations (39 vs 15: P< .001). Of the 276 fluorescent marks placed on high-touched surfaces 138 or 50% were removed post cleaning mean. ATP RLU values for four surfaces were low before cleaning (72 ± 40) and decreased further post cleaning (23 ± 11) (P< .001).

Gordon, Bruce, Suh, and Roth (2014) completed an experimental study to evaluate two products for auditing the cleanliness of the hospital environment. They tested an alcohol-based fluorescent marking product and an adenosine-50-triphosphate bioluminescence product on 15 pre-selected high-touch objects in randomly selected patient rooms, following regular daily cleaning. A room was considered a "pass" if, 80% of surfaces were adequately cleaned as defined by manufacturers' guidelines. The use of adenosine-50-triphosphate bioluminescence had the highest rate with 21 of 37 patient rooms passing or (57%). However, the users preferred translucent, alcohol-based fluorescent marking because of the visual effects (Gordon et al., 2014).

To analyze the connection of the cleaning process in previously uncleansed patient care items grey zones (GZ), on healthcare-acquired transmission rates, Semret et al. (2016) conducted a randomized control trial. Two acute medical wards that were structurally different with an incidence rate of VRE 3.5/1,000 patient-days (PD), *C. difficile* 0.8/1,000 PD and MRSA 1.8/1,000 PD were observed for grey zones and cleaning frequency between September 25, 2013- October 8, 2014. Grey zone (GZ) items or non-critical items such as laundry hampers, portable blood pressure, oxygen tank, shower chair to name a few, were cleaned by a specific GZ

cleaner: wiping with a soapy rag to remove organic matter then disinfected with a quaternary ammonium-based product and left for 10 minutes.

The investigators obtained 778 swabs from both wards covering 108 surfaces. On unit A, one specimen obtained from a scale returned VRE after cleaning during the four-month intervention. On unit B, two specimens obtained from a walker and IV pole grew MRSA after cleaning during the final month of the intervention. Fifteen hundred fifty-three swabs performed after cleaning the GZ had no growth. The data in this study demonstrates how cleaning interventions of the gray zone are both clinically important and cost-effective.

**Measuring cleaning efficacy with ATP**. Hardy et al. (2013) administered an experimental research study to determine if measuring environmental cleanliness using ATP will aid in monitoring units with increased incidence of *C. difficile*. It was determined that the use of ATP alongside environmental audits to control clusters of *C. difficile* in period B had an impact on the reduction of time the ward remained on the environmental audit. In period C, the reduction was sustained when ATP was discontinued (Hardy et al., 2013). Similarly, other studies concluded that ATP could aid in measuring the cleaning efficacy of surfaces within the hospital environment.

In 2015, Chan et al. ran an experimental study to evaluate the effectiveness of cleaning/disinfection process in the environment with the use of ATP bioluminescence. At baseline, 43.9% of the surfaces swabbed using ATP failed in Phase I and in Phase II, the effectiveness of cleaning increased to 88.3% in surfaces frequently touched by patients, high touched areas, confirmed by ATP swabbing. The results obtained in Phase II after the implementation of disposable color-coded wipes, showed that staff training increased the efficacy of cleaning as confirmed by ATP testing. Bed rails failed ATP testing in phase I with a

result of 58.5% to 93.4%. In phase II, ATP testing confirmed the efficacy of cleaning of all high-touched surface areas in real time (Chan et al., 2015).

To evaluate the use of ATP to monitor the cleaning process upon discharge, O'Neil, Speziale, Blue, Ballantyne, and DiSimoni (2013) conducted an experimental study. For a period of 90 days, six surfaces in the patient environment, bed rails, bed table, call light, grab bar, commode, and blood pressure cuff were tested using ATP bioluminescence to measure cleanliness of these surfaces upon discharge. To establish a baseline, the surfaces were tested prior to cleaning. The ATP measurements were measured in relative units (RLU) in relation to cleanliness. The value was interpreted as pass (<150 RLU), marginal (150-300 RLU) or fail (>300 RLU) based on the manufacturer's established thresholds. ATP testing is quick; however, due to the high turnover of patient rooms, staff would not be able to keep up with testing. ATP works well with other processes in place such as the fluorescent marker, so it is not recommended to use without other interventions (O'Neil et al., 2013).

Whitely, Safety, Derry, Glasbey, and Fahey (2015) performed an experimental study to evaluate the use of adenosine triphosphate (ATP) bio luminometers on high-touch objects in the intensive care unit (ICU) and identify the presence of microorganisms on surfaces. The researchers swabbed high-touch objects and surfaces in the ICU with two brands of ATP bio luminometers to identify the presence of microorganisms. The use of ATP bio luminometers was significantly associated with the identification of 12 of the 13 individual multi-drug resistant organism (MDRO) locations. The MDRO recovery and readings from the two ATP bio luminometers were not significantly correlated with distinct cutoffs for each ATP device, and there was no correlation between the two ATP devices. The microorganisms or MDROs identified were not limited to just the patient surroundings or high-touch objects or surface type

(Whitely et al., 2015). The inclusion of ATP testing aided in the identification of areas that were soiled for sampling purposes. The greatest density of positive MDRO locations was around and within the clinical staff workstation (Whitely et al, 2015).

Alfa et al. executed an experimental study to determine if ATP would be stable to use as a tool to confirm cleanliness. The average level of ATP detected from five logs of *C. difficile* spores was 38 RLUs; no further testing was done on *C. difficile* spores as this was used for a negative control. Purified ATP was stable over 29 days in suspension or dried on to a surface (Alpha, Olson, and Murray, 2015). In 2016, Whitely et al. conducted a semi-experiment study to recommend a sampling algorithm for use with ATP testing in cleanliness measurement and to ensure appropriate use of ATP testing on various surfaces/equipment. An algorithm was created with a 4-tier approach, standardizing the sampling area of 2 x5cm=10cm^2, two samples will be required initially, a four-tiered cleanliness rating, and the final control step for cleanliness verification requires the use of a disposable wipe, and then re-test the cleaned area. To improve decision-making, two ATP measures were combined; a CV of 04 suggests that any two measures from the identical surface could differ by a factor of 1.5. A reading of 50RLU and 100RLU could be generated from the same surface cleanliness and still represent the same result. Using the same logic, two readings above the threshold are reported as unclean (Whitely et al., 2016).

Omidbakhsh, Ahmadpour, and Kenny (2014) tested different brands of ATP bioluminescence meters for their sensitivity, linearity of measurements, and correlation of the readings to the pathogen, and the potential interference from chemicals in their reading. Solutions of pure ATP in various concentrations were used to construct a standard curve and determine linearity and sensitivity. Dilutions of broth culture of *Staphylococcus aureus* were used as the pathogen to determine if the ATP readings correlated with the actual pathogen or

colony forming units (CFU). Varieties of disinfectants were tested for their potential interference with ATP readings. According to Omidbakhsh et al. (2014), "None of the ATP meters provided a linear relationship between ATP readings and the actual concentration of the ATP throughout the whole test range. Approximately 6 logs of ATP reading RLUs is the highest difference observed in reading the same ATP concentration among different ATP meter brands" (p.4).

Amodio and Dino (2014) appraised studies to evaluate the use of ATP bioluminescence for assessing the cleanliness of hospital surfaces. They performed searches using the PubMed and Scopus databases. Keywords included ATP, bioluminescence, and surfaces. In addition, an iterative process in which reference lists of all relevant publications were consistently reviewed. Thirty-one articles were reviewed and 12 were selected and analyzed for this review. Amodio and Dino (2014) analyzed the literature and discovered that the studies used different ATP meters, methods, materials, and sensitivities, which makes it difficult to compare the results from the study. Upon reviewing all the literature related to measuring cleaning efficacy with ATP, this investigator believes ATP is a useful tool to confirm the cleaning efficacy in rooms previously occupied by patients on transmission-based precautions for *C. difficile*.

The literature review supported the investigator's project/PICO as the setting and population of the studies conducted mirrors the setting/population that the investigator used to conduct this quality improvement project. The literature assessed different methodologies for cleaning and confirming the cleaning efficacy in the patient's environment to prevent risk of infectious organisms adhering to surfaces in the patient environment. The literature review supported the rationale for the intervention the investigator implemented, based on previous works/ studies conducted. Similarly, the processes that were in place, no checklist/ visual inspection did not follow the current recommendations that were evaluated in the studies and this

supported the need for the investigator to compare the cleaning efficacy after implementing the tools used in the studies reviewed by the investigator. More importantly, the literature framed the possible outcome of this quality improvement project, an increase in staff knowledge on disinfecting contaminated surfaces, resulting in a decrease in the healthcare-acquired infection, C. *difficile*, and this was the purpose of conducting this investigation.

## Project Plan and Evaluation

### Market/Risk Analysis

A *SWOT analysis* was conducted and the strengths, weaknesses, opportunities, and threats related to this quality improvement project were identified (See Table 1). The strengths of conducting this investigation included the support of leadership, the Director of Infectious Disease and the Director of Quality, who were in full support of the project and its effort to improve quality. The Chief of Quality approved access to the hospital data. Other strengths included the availability of the ATP meter and the literature to drive evidence-based practice. Publicly reported *Clostridium difficile* infection (CDI) rates/ data are accessible to anyone who searches for the information.

The investigator identified time required for changing the culture and initial staff resistance to change as weaknesses for this project; however, this did not occur. Prior to the implementation of this evidence-based project, there was a lack of communication notifying the environmental staff when a previously occupied room by a patient on transmission-based precautions for *C. difficile* needed to be clean. There was also a knowledge deficit amongst the EVS staff regarding the process required to clean rooms previously occupied by patients on transmission-based precautions for *C. difficile*.

The opportunity for staff development that resulted from implementing this project, allowed EVS staff to be educated on evidence-based practice related to the cleaning process required to kill *C. difficile* spores in the patient environment, specifically, high-touched surfaces. Quality metrics for healthcare-acquired *C. difficile* were expected to improve because of the enhanced cleaning efficacy. A threat to implementing this investigation included the lack of staff. Due to a shortage of environmental staff, there was a potential threat of staff assigned to other areas in the hospital, resulting in a lack of attention to detail. Staff turnover was another concern. The plan was to orient new staff on the process and develop the skill set required to clean rooms previously occupied by patients on transmission-based precautions for *C. difficile*. Due to an increase in the resistance of *C. difficile* and antimicrobials and the lack of cleaning, there was a risk for increased healthcare-acquired resistant *C. difficile*.

Table 1

*SWOT Analysis*

| Strengths | Weaknesses |
|---|---|
| • Leadership support<br>• QI project will occur in investigator's work environment<br>• ATP meter is available<br>• Evidence is available to support the project<br>• CDI rates publicly reported | • Staff resistance to change<br>• Lack of communication regarding isolation precautions<br>• Knowledge deficit of the cleaning process required for *C. difficile* rooms |
| **Opportunities** | **Threats** |
| • Staff development<br>• Improve quality metrics<br>• Improve cleaning efficacy<br>• Decrease in healthcare-acquired *C. difficile* | • Lack of EVS staff (small number)<br>• Conflicting work demands<br>• Staff turnover<br>• Increase in health care-acquired resistant *C. difficile* |

**Driving, Restraining and Sustaining Forces**

The driver**s** to this project included the need to implement evidence-based practice related to the cleaning process required for rooms previously occupied by patients on transmission-based precautions for *C. difficile.* The environmental staff was educated on the 2-step cleaning process required to kill *C. difficile* on environmental surfaces from high-touched objects in order to decrease the risk of patients acquiring a healthcare-acquired infection from environmental surfaces. Associated costs to treat an HAI was another driver for this study. Restraining forces identified prior to implementing this evidence-based project included potentially poor staff engagement, one ATP meter, the lack of EVS staff, and staff not embracing cleaning tools.

Environmental staff was fully engaged in the education sessions on the 2-step cleaning process. The infection control department purchased an ATP machine and this investigator did not need to contact the Director of EVS prior to conducting the pre and posttest on the identified high touched objects in the patient's room. There were minimal staff working in EVS; however, they were not pulled from their assigned units and there were no delays in getting the rooms terminally cleaned on the day shift. Actions that reduced the restraining forces included the implementation of evidence-based pracsatice, staff education on the 2-step cleaning process, and a cleaning checklist and finally, the implementation of ATP testing. See Figure 1 for an overview of driving and restraining forces and actions to reduce restraining forces.

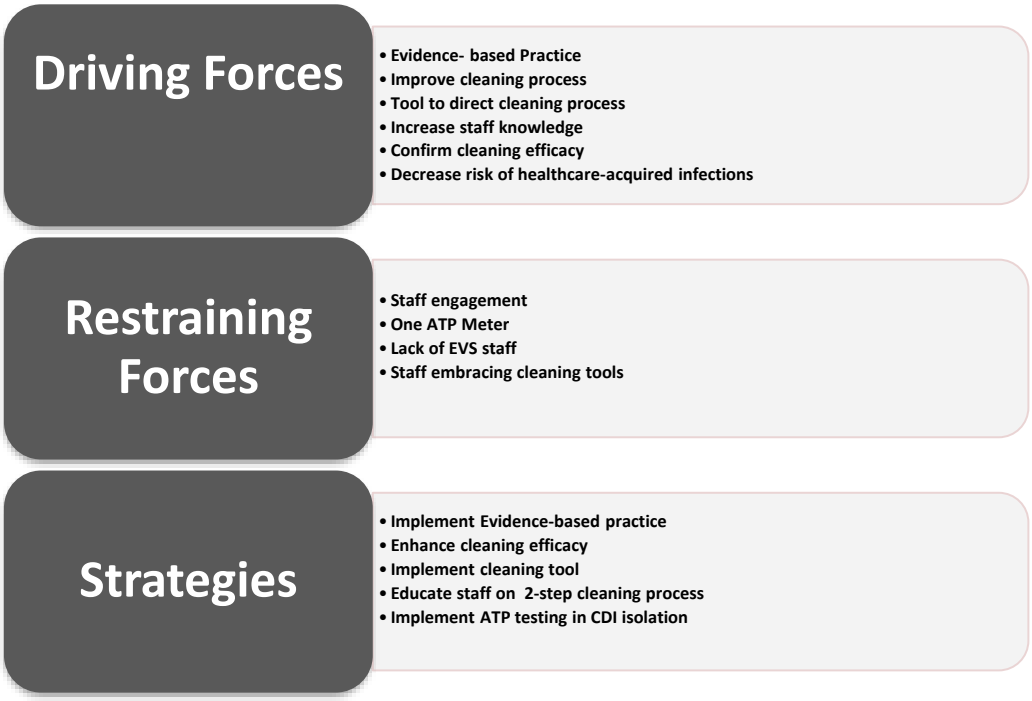


*Figure 1*. Diagram of Driving Forces, Restraining Forces, and Strategies

**Need, Resources, and Sustainability**

**Need**. More than 75% of *C. difficile* infections / cases have onset outside the acute care hospital (SHEA, 2014, p. 628). The probability of a patient being admitted to the hospital from the community with *C. difficile* infection is high. Patients who are admitted with *C. difficile* infection may increase risk for other hospitalized patients. A systematic review of the literature demonstrated how surfaces in the hospital that are not adequately clean can harbor bacteria. Hospital rooms previously occupied by patients on transmission-based precautions for *C. difficile* that are not cleaned effectively, increase the risk of *C. difficile* remaining on surfaces in those rooms. Given the number of patients requiring antibiotics and patients being admitted from the community and long-term care, the risk of acquiring *C. difficile* while in the hospital is high. Due to the prevalence of healthcare- acquired *C. difficile* infection, there was a need to implement an educational intervention for environmental services staff supplemented with a cleaning checklist

and ATP testing to confirm cleaning efficacy in hospital rooms previously occupied by patients on transmission-based precautions for *C. difficile.*

**Resources**. The resources needed to conduct this investigation included evidence-based literature, AB hospitals data on *C. difficile,* cleaning checklist and data collection sheet from the environmental tool kit from the Centers for Disease Control and Prevention, education training material, 2-step cleaning process, ATP testing meter, and ATP testing swabs. The EVS staff was key to this investigation. EVS staff performed cleaning in rooms previously occupied by patients on transmission-based precautions for *C. difficile.* When cleaning rooms, the EVS paid detailed attention to high-touched surfaces in the patient's environment: bed-rails, overbed tray table, call light, telephone and the bathroom sink handles. The Infection Preventionist (IP) (investigator) reviewed daily alerts to identify positive lab results for *C. difficile,* pulled daily isolation list to identify the location of patients on transmission-based precautions for *C. difficile*, and conducted pre-post ATP test on the identified high touched surfaces.

**Sustainability**. By re-enforcing the 2-step cleaning process and the cleaning checklist with the environmental staff during new employee orientation and annual training, this project can be sustainable. The IP will monitor quality controls, *C. difficile* data and the results of the ATP test, and do just in time education when required. The IP will discuss results of both *C. difficile* data and the results of the ATP test at future Infection Control Committee meetings.

**Feasibility/Risks/Unintended Consequences**

**Feasibility**. The implementation of this evidence-based project was feasible at AB hospital as the setting and make-up was the same as the hospitals identified in the literature review. The availability of the existing resources within AB hospital and the accessibility to on-line resources made this investigation feasible. *C. difficile* is a quality indicator that is monitored

closely and the data indicated a need for improvement. Cleaning the patient's room is an essential duty of the environmental staff and they should receive on-going education and training. The feasibility of implementing an educational intervention, cleaning checklist, and a 2-step cleaning process along with ATP testing at AB hospital made sense based on the hospital data on *C. difficile* and the prevalence of *C. difficile* in the community.

**Risks**. There was no risk of harm to human subjects or animals with this quality improvement (QI) project. This QI project required human subjects to be educated on a new cleaning process and a cleaning checklist. The investigator obtained informed consent from EVS staff and disclosed all details of the project to EVS staff. Participation did not affect EVS staff employment at AB hospital. The intention of this QI project was to explore best practice for cleaning rooms and serve as a learning process for the EVS staff; therefore, the staff was not at risk for losing their jobs for any positive post-clean results. The new cleaning process was based on evidence-based guidelines related to cleaning efficacy in rooms previously occupied by patients on transmission-based precautions for *C. difficile* and Adenosine Triphosphate (ATP) testing. There were minimal to no risks to the participants related to the use of the study tools.

**Unintended Consequences**. The investigator had no control of the days when patients with *C. difficile* rooms were clean or the days when patients were discharged. The investigator was not in charge of assigning environmental staff to a particular unit, nor was the investigator always certain of when staff would be on the unit. A Hawthorne effect may have also taken place, whereby the EVS altered their behavior in response to being observed/monitored (Paradis & Sutkin, 2017, p.31). This potential effect is discussed more in the Discussion section of this paper.

**Stakeholders and Project Team**

The stakeholders that benefited from this investigation included the hospital board members, executive leadership, infection control, managers, staff, patients, family members, and the community. The rate of healthcare-acquired *C. difficile* can affect each stakeholder directly or indirectly. This is "why" it was imperative that the investigator conducted this study in order to ensure implementation of evidence-based practice for preventing the risk of healthcare-acquired infections from reaching the patient environment and surfaces in the patient's room. The investigator discussed the plan for this project with the stakeholders (See Appendix D, Site Letter of Agreement). The project team included the primary investigator, Manager of Environmental Services, the Environmental staff, research nursing staff at Regis University, and the Capstone Committee Chair at Regis University.

**Cost-Benefit Analysis**

The cost to conduct this investigation was $3,011, direct cost. This cost included the cost for an ATP testing meter/medium, educational training material, and staff salaries. The benefits of conducting this investigation were worth the investment as illustrated in Appendix E, Cost-Benefit Analysis. The environmental staff was educated on a modified cleaning checklist from the Centers of Disease Control and Prevention and an evidence-based cleaning process, 2-step cleaning process. Hospital staff now check high touched-objects in rooms previously occupied by patients on transmission-based precautions to confirm the cleaning efficacy, decreasing risk of healthcare-acquired infections.

This evidence-based project has the potential to generate revenue of $10,000 over time, estimated cost from deductions made by the Centers for Medicaid and Medicare for a healthcare-acquired infection. The avoidance cost of $7,285 is an estimated cost for antibiotic therapy

needed to treat *C. difficile* infection. Money will also be saved for personal protective equipment (PPE) required for patients on transmission-based precautions for *C. difficile*. According to AB hospital purchasing department, the approximate cost for PPE is $1600/ month. This cost comprised the cost for all isolation types and not just transmission precautions for *C. difficile.* This cost included the cost of isolation gowns, gloves, and a disposable thermometer and stethoscope from AB hospital vendor. Clorox Healthcare germicidal bleach wipes are stocked in *C. difficile* isolation carts and this is an additional cost of $ 1400/ month for PPE for a total cost of $3,000/per month. The total cost benefit for this project is estimated to be $25,285.

The cost to conduct this study and or replicate it at another institution is $3,011 (See Appendix E). This cost includes staffing salaries for the Infection Preventionist, EVS Director, EVS Manager, EVS Staff, Equipment, and Education Material. This cost may increase depending on the size of the institution. For this QI project, the cost of the study was absorbed by the hospital as the institution of the 2-step cleaning process and use of a high-touch checklist is now part of the routine disinfection process for *C. difficile* infected rooms. Study materials and the ATP machine and solution were provided by the hospital. Media Equipment was available in all conference rooms at no cost to the investigator.

**Mission/Vision/Goals**

**Mission and Vision**. The investigator's mission was to implement an evidence-based project related to infection prevention that would improve the disinfection process for *C. difficile* infected rooms and improve hospital quality metrics. The investigator's vision was to have a standardized cleaning process for *C. difficile* that the environmental staff could understand and utilize; to have a decrease in the number of healthcare-acquired infections related to *C. difficile*, with the overall goal of zero infections.

**Goal**. The main goal of this project was to explore the use of evidence-based guidelines related to the cleaning efficacy in rooms previously occupied by patients on transmission-based precautions for *C. difficile* and ATP testing. This project was a quality improvement initiative and findings were not generalized outside of the safety net hospital where the research took place.

**Process/Outcome Objectives**

The outcome objectives for this project were to:

- Measure the differences between pre-post ATP test results in rooms previously occupied by patients on transmission-based precautions for *C. difficile* as well as differences between the pre-post 2- Step Cleaning Process educational session test results. In addition, the investigator wanted to track the number of just in time EVS staff remediation sessions, to evaluate the effectiveness of the educational intervention of environmental staff (EVS) understanding of the disinfection process.
- Compare hospital *C. difficile* rates pre-post intervention to assess for a change (improvement) in *C. difficile* rates.

In order to meet these time-sensitive outcome objectives the investigator followed a specific project timeline, shown in Appendix F.

**Logic Model**

The investigator used an infection prevention conceptual model to address outcomes and performance measures. The conceptual model or Logic Model illustrates the resources that were required to initiate the plans and the activities required to conduct this investigation (See Appendix G). The conceptual model also showed the possible constraints that could have

affected activities such as the frequent turnover of environmental staff and the time required to conduct the experiment.

The overall aim of this quality improvement project was to implement evidence-based practice as illustrated in the conceptual model. The outcome of this research led to AB hospital having a standardized process for cleaning *C. difficile* rooms while accomplishing short-term goals that will aid in continuous quality improvement. This process will affect AB hospital financially, by decreasing the length of stay associated with *C. difficile* infections and antibiotic use. More importantly, this evidence-based project will prevent the transmission of *C. difficile* in the hospital environment and decrease cost over time.

**Appropriate for Objectives and Research Design**

Investigating the major outcomes of this quality improvement project required the investigator to use a quantitative research design. Quasi-experimental pre-posttest studies allow an investigator to manipulate an intervention using a convenience sample, as well as to "provide beginning evidence of causality" (Schmidt & Brown, 2015, p. 181). This approach allowed this investigator objectivity when comparing EVS staff test results pre- and post-educational intervention and pre- and post-ATP testing of a *C. difficile* infected room over an extended period to determine the effect of a new 2-step cleaning process and cleaning checklist for a potential policy change.

**Population/Sampling Parameters**

This study included a convenience sample of 12 EVS staff employed by AB hospital. The primary investigator recruited the EVS staff by sending them an invite via the hospital email system to attend an educational session on the new cleaning process and use of the cleaning checklist. Participation was mandatory for the educational session as this new process is part of

EVS staff's job to clean *C. difficile* infected rooms. The inclusion criteria for the proposed plan included EVS staff responsible for cleaning patient rooms previously occupied by patients on transmission-based precautions for *C. difficile* in the Intensive care unit (ICU), Telemetry, and the Medical-surgical unit and who worked between the hours of 9:00 AM and 5:00 PM, Monday-Friday. EVS staff who cleaned rooms previously occupied by patients on transmission-based precautions for *C. difficile* after 5:01 PM and before 9:00 AM Monday-Friday or EVS staff who cleaned on the weekends, were not subject to ATP testing to confirm cleaning efficacy. Occupied rooms and rooms not identified as previously occupied by patients on transmission-based precautions for *C. difficile*, were not tested. Surfaces and objects that were not identified as high touch were excluded in this investigation. Of note, the investigator would have terminated a participant's participation only if the EVS employee resigned from their position.

The investigator swabbed and tested the following high touch surfaces: Bed rails, over bed tray table, call light, telephone, and the bathroom sink handles. The investigator tested each of these high touch surfaces with the ATP meter after patient discharge from the room and before conducting the 2-step cleaning process and after conducting the 2-step cleaning process.

Prior to implementing the study, the investigator performed a statistical power analysis for sample size estimation, based on data from a published study by Luik et al. (2013). With an alpha of .05 and power of 0.80, the projected sample size needed with this effect size was approximately N = 50 patient rooms and 250 surfaces for the simplest between/within group comparison. For this study, it was not possible to achieve a power of 0.80. The projected number of rooms for this study was 3-4 per month or 30-40 samples of high-touched objects (HTO) pre/post clean.

**Appropriateness of the Setting for EBP project**

AB hospital is a safety net hospital located in the Midwest. AB hospital has a total of 150 beds which comprises a 12-bed emergency department with seven additional beds in fast track, 10 pediatric beds, 16 telemetry I beds, 17 telemetry II beds, 14 intensive care beds, 18 mother baby unit beds, 16 medical stabilization beds and 40 psyche I/II beds. AB hospital provides services to a patient population with risk factors for *C. difficile.* Some patients received antibiotics during their stay, while others received antibiotics within the last thirty days prior to their hospital stay, increasing their risk for *C. difficile.* A review of AB hospital quality data on *C. difficile* showed the rate of healthcare-acquired *C. difficile* infection in 2017 was 3.274 per 10,000 patient days. Based on the identified risk factors, and the hospital data, AB hospital was an appropriate setting to conduct this investigation and implement evidence-based practice.

**EBP Design Methodology**

The investigator used a quasi-experimental pretest-posttest research design. The independent variable was staff education on the cleaning process and the use of a cleaning checklist. The dependent variable was the staff understanding/knowledge of the cleaning process and use of the cleaning checklist as measured by the pass rates for ATP testing, pass rates on pre-posttest assessment for the educational intervention, and the number of just in time remediation sessions (re-clean). Another dependent variable included the change in *C. difficile* rates for calendar years 2017 and 2018. Assessment of AB hospital data on *C. difficile* before implementing the intervention, established a baseline for comparing data post intervention to see if there was a change in *C. difficile* rates.

**Protection of Human Rights**

Before conducting this investigation, the investigator took a CITI course (Certificate # 21148257) to ensure participants safety (See Appendix H). The investigator obtained approval from the Regis University Institutional Review Board (IRB) to implement this DNP project. The IRB committee thoroughly reviewed the investigator's study proposal to ensure protection of human rights (See Appendix I). The investigator had to disclose all aspects of the investigation to the EVS staff as outlined in the informed consent form. Participation was mandatory for the educational session and using the new cleaning process and receiving remediation for any positive ATP results. Participation was voluntary for completing the pre-posttest for the educational intervention. The participants were given the choice not to answer any question or to not take the tests. Participants were given the choice to opt out/ choose not to have their data included in the research study. All data collected and reported internally or externally (with consent) was de-identified and reported as aggregate data. There were no EVS staff that were under the age of eighteen.

There were no risks of harm to human subjects or animals with this quality improvement project. There was a possibility of environmental staff (EVS) experiencing mild psychological distress from learning a new cleaning process and completing the cleaning checklist. In order to minimize subject burden, the investigator educated EVS on the new cleaning process prior to implementation, allowing EVS to ask questions about the process to relieve them of potential fears they may have had. The investigator also provided positive reinforcement to the EVS staff during the implementation of the new cleaning process and as needed.

**Instrumentation Reliability/Validity and Intended Statistics**

**Instrumentation Reliability/Validity**. The investigator modified a **cleaning checklist** from the CDC (See Appendix J). The CDC did not require permission to utilize their tool since they provide it to health facilities as another resource for infection control. The checklist included only the high touch objects that were tested for this investigation, bed rails, overbed tray table, telephone, call light and bathroom sink handles. EVS staff used the cleaning checklist to ensure the identified high touch objects were cleaned meticulously. A **2-step cleaning process** for *C. difficile* was also implemented (See Appendix K). The investigator created the 2-step cleaning process based on the recommendations/guidelines from the Minnesota Hospital Association (MHA, 2016). The 2-step cleaning process provided staff with a process to clean a room previously occupied by patients on transmission-based precautions for *C. difficile*. The 2-step cleaning process required the EVS staff to clean the surfaces first (remove the soil) followed by step two, disinfect the surfaces (kill pathogens).

The investigator utilized an **ATP meter** to test the surfaces for cleaning efficacy for a period of five months, October 2018- March 2019. ATP stands for adenosine triphosphate. It is an energy-carrying molecule found in the cells of all living things. Living organisms can only produce ATP. Its presence is a direct indication of all kinds of biological matter (microorganisms, biofilm and other biological residues that are invisible to the naked eye (Britannica, 2018). The ATP meter was used to conduct a test on the high touch objects to confirm cleaning efficacy (See Appendix L). The ATP meter generated results in real time, within 15 seconds. Based on recent studies as discussed in the literature review section of this document, the ATP testing meter was determined to be a reliable tool to confirm cleaning efficacy (Hardy, 2013; Gordon, Bruce, Suh, & Roth, 2014). In addition, Luik, et al. (2013)

demonstrated that when using ATP testing to assess cleaning efficacy, they were able to show that 86% of 250 surfaces were without any visible contamination prior to cleaning and the number increased to two hundred and thirty-two (93%) after the cleaning process (visual inspection: X^2=14.4, P<.001).

The investigator used a **modified data collection tool** from the CDC to collect the data and track the results of the ATP test (See Appendix M). The data collection tool included the unit, room number, date the room was cleaned, and all the objects that were tested: bed rails, overbed tray table, telephone, call light and bathroom sink handles. The data collection tool also tracked the number of EVS remediation sessions (or just in time education), by documenting rooms that needed to be "re-cleaned". EVS automatically would receive remediation for any rooms that failed the ATP test and needed to be cleaned again. An "O" identified surfaces that failed the ATP test and an "X" identified surfaces that passed the ATP test.

A **pre-posttest** assessment consisting of 10 True/False and multiple-choice questions was given to EVS staff to assess their knowledge of the cleaning process required for rooms previously occupied by patients on transmission-based precautions for *C. difficile* pre-educational session (See Appendix N). The investigator administered the same test as a posttest at the conclusion of the implementation of the 2-step cleaning process and use of the checklist. The investigator created the pre-posttest, based on the 2-step cleaning process recommendations/guidelines from the Minnesota Hospital Association (MHA, 2016). The Medical Director of Infectious Disease assessed content validity of the pre-posttest. The tests were checked against the answer key, one point was awarded for correct answers, and no points was awarded for partial or incorrect answers.

**Intended statistics**. Descriptive (frequencies and percentages) and inferential statistics were used with a level of significance set at < 0.05. A quantitative method was used to measure the ATP testing data using a numerator and denominator, numerator-number of rooms positive for *C. difficile* after being disinfected and the denominator-number of *C. difficile* rooms cleaned. In addition, the investigator had planned to use the Chi-Square Test. The Chi-Square statistic is commonly used for testing relationships between categorical variables. The data dictated what other data analysis was conducted based on assistance and feedback from the research faculty at Regis University.

**Data Collection and Treatment Procedure/Protocol**

The protocol for this project required **the investigator** to adhere to the following steps:

- Obtained IRB approval -09/24/18
- Met with the EVS staff to inform them of this investigation and go over the informed consent form (See Appendix O). The EVS staff agreed to participate in the research study (i.e. consented to use their data for the research study and dissemination external to the hospital) -10/04/18
- Obtained signatures from EVS staff and provided a copy of the consent form to EVS staff- 10/04/18
- Notified the EVS staff of the mandatory training on the cleaning checklist and the two-step cleaning process via the secured hospital intranet e-mail account - 10/05/18
- Administered a pre-test on the cleaning process to the EVS staff prior to implementing the cleaning checklist and the 2-step cleaning process 10/08/2018

- Provided EVS staff with a 30-minute session to educate EVS staff on the cleaning checklist and the 2-step cleaning process 10/08/18- 10/10/18
- Reviewed AB hospital data on *C. difficile* to establish baseline rate before implementing the process- 10/15/18
- Implemented the 2-step cleaning process followed by ATP testing in the ICU, Medical- Surgical unit, and Telemetry- 10/15/18
- Pulled daily isolation list to identify patients on transmission-based precautions for C. *difficile* - 10/15/18- 03/01/19
- Pulled discharge log to see what patient rooms were discharging – 10/15/18- 02/28/19
- When a *C. difficile* room was cleared for discharge, went to the room to obtain pre-cleaning swabs from the following high touch objects in the patient's room: bed rails, over bed tray table, telephone, call light and bathroom sink handles and performed an ATP test -10/15/18- 03/01/19
- Notified EVS staff to clean the room after obtaining pre-cleaning swabs 10/15/18- 03/01/19 and EVS staff notified the investigator after the rooms were cleaned- 10/15/18- 03/01/19
- Collected the cleaning checklist from EVS staff- 10/15/18- 03/01/19
- Obtained post-cleaning swabs from the following high touch objects in the patient's room: bed rails, over bed tray table, telephone, call light and bathroom sink handles and performed an ATP test- 10/15/18- 03/01/19
    - When the results of the ATP passed, no further cleaning was required- 10/15/18- 03/01/19

    - If the results of the ATP failed, just in time education would be provided to EVS staff and the room re-cleaned- 10/15/18- 03/01/19
    - Retested the surfaces if/when required, using the ATP meter to ensure cleaning efficacy 10/15/18- 03/01/19
- The results were tracked and recorded on a modified data collection tool from the Centers from Disease Control and Prevention, (2015)- 10/15/18- 03/01/19
- The ATP test results were shared with the EVS staff in real time -10/15/18- 03/01/19
- Administered a post-test on the cleaning process to the EVS staff at the end of this study to assess their understanding of the cleaning checklist and the 2-step cleaning process -03/08/19

The investigator maintained the confidentiality of the participants when collecting their information/data. EVS staff was asked to sign an attendance roster after attending the 30-minute education session to confirm they had received the education on the cleaning checklist and the 2-step cleaning process. The attendance roster was kept separately from de-identified study data that was collected during the study and was destroyed after the study. The ATP results recorded on the data collection tool were collected and stored in a password-protected file on the investigator's computer. The EVS staff's name was not associated with the ATP test results; only the unit and the room numbers were located on the data collection tool. EVS staff used two random numbers selected by them, (i.e., 29) to identify the EVS staff pre- and posttest results. The investigator was the only one collecting the cleaning checklist forms after each cleaning event. The EVS staff was de-identified; only the unit and the room numbers were located on each of the cleaning checklist forms. Checklists and pre-posttest results were kept locked in a file

cabinet inside the investigator's secured locked office and were destroyed at the end of the study. The primary investigator will store study data on a password secure computer for up to 3 years following the study. Consents are secured in the primary investigator's office and will be discarded in 3 years per IRB protocol.

## Project Findings and Results

The investigator collected data over a 5-month period, from October 2018 to March 2019 using a convenience sample of 12 environmental staff working between the hours of 9 am and 5 pm during the weekdays. There were 18 incidences where rooms were tested on the Telemetry and the Medical-Surgical Unit, with 126 samples collected and tested using the ATP meter. The Intensive Care Unit (ICU) was identified as a unit to be monitored for this study; however, there were no rooms that met the criteria during the time of this study. The results of the data helped the investigator to assess the effectiveness of the study's intervention and answer the investigator's PICO questions.

### Objective I: Evaluation of Effectiveness of Educational Intervention on EVS Understanding (Knowledge) of Disinfection Process

Pre-post tests for the educational session, results of pre-post ATP tests and tracking of just in time educational sessions were used to measure the effectiveness of the educational intervention and EVS understanding of the disinfection process.

**Pre-posttest educational intervention results**. All 12 EVS staff attended the educational session and completed the pre-posttest, representing a 100% participation rate. Questions on the pre-posttest were discussed during the educational sessions. The test was not timed; however, environmental staff completed it in under 15 minutes. Participants did not receive results of the pre-posttests. The results of the pre-test showed that 20% of participants

answered six questions correct, 20% of participants answered seven questions correct, 10% of participants answered eight questions correct, 20% of participants answered nine questions correct, and 30% of participants answered 10 questions correct. The results of the pre-test were uploaded on an Excel data spreadsheet and coded as a "1" to identify the variable in SPSS. The posttest test results showed that 40% of participants answered nine questions correct and 60% of participants answered 10 questions correct. The posttest results were uploaded in Excel and coded as a "2" to identify the variable in SPSS.

The reliability of the pre-posttest was assessed by the Cronbach's Alpha test. Cronbach's Alpha (or coefficient alpha) indicates how much the items on a scale are measuring the same underlying dimension, thus a measure of internal consistency (Polit, 2010, p.399). The results of the Cronbach's Alpha test (*-.581, n2*) showed a negative covariance among the pre-posttest. As shown in Table 2, the same result was obtained after this test was repeated to ensure accuracy of coding. The negative value was most likely related to a small sample of EVS staff that took the pre-posttests.

Table 2

*Reliability Test for Education Pre-Posttest*

*Results*

| Cronbach's Alpha[a] | N of Items |
|---|---|
| -.581 | 2 |

a. The value is negative due to a negative average covariance among items

A two-paired sample t-test was used to analyze the pre-posttest scores for the educational intervention, *N= 12*. The two-tailed test shows the differences between the pre-posttest results in both directions. The aggregate mean for the pretest was 8.17 with a standard deviation of 1.467 and the mean for the posttest was 9.50 with a standard deviation of .522 (See Table 3). Based on

the results of the paired sample t- test in Table 4, there was a statistical significance, (*t= -2.680, p= .021),* supporting the use of the educational intervention to improve staff understanding of the new cleaning process.

Table 3

*Education Intervention Pre-Posttest Results*

**Paired Samples Statistics**

| | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Pair 1 | pretest | 8.17 | 12 | 1.467 | .423 |
| | posttest | 9.50 | 12 | .522 | .151 |

Table 4

*Education Intervention Pre-Posttest T-Test Results*

**Paired Samples Test**

| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference Lower | Upper | | | |
| Pair 1 | pretest - posttest | -1.333 | 1.723 | .497 | -2.428 | -.238 | -2.680 | 11 | .021 |

**ATP testing.** The ATP meter was used to analyze seven high touched objects in rooms previously occupied by patients on transmission-based precautions for *C. difficile.* The investigator was the only person who conducted the ATP test. The units were coded for SPSS, with the Telemetry unit coded as “50” and the Medical- Surgical unit coded as “51”. Pre-ATP test results were coded as “10” and Post- ATP test results were coded as “11”. The investigator used a modified data collection tool from the Centers from Disease Control and Prevention, (2015) to collect and track the values related to the independent variable and the dependent

variables. An “O” identified surfaces that failed the ATP test and an “X” denoted surfaces that passed the ATP test. There was a box to check off if the room required repeat cleaning.

After the patient was discharged, the investigator collected pre-cleaning test swabs and performed ATP testing on the following surfaces: bed rails, over bed tray table, telephone, call light and the bathroom sink handles. The ATP meter has a light inside that detects the presence of contamination on an object. The Relative Light Unit (RLU) is expressed numerically to indicate surface contamination. The investigator also recorded the numerical results of the ATP test results. If the RLU was between 0-45, that means the surface passed the ATP test. An RLU >45 means the surface failed ATP and is contaminated. All of the swabs (n=126) passed the ATP test; 63 swabs collected pre-cleaning RLU were < 45 and 63 swabs collected post-cleaning RLU were <45 (See Table 5).

Table 5

ATP *Pre/Posttest Statistical Results*

**Paired Samples Statistics**

| | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Pair 1 | Pre-ATP | 8.02 | 63 | 4.619 | .582 |
| | Post-ATP | 2.06 | 63 | 1.874 | .236 |

The mean for the pre-ATP test was *8.02* with a standard deviation of *4*.619 and the mean for the post ATP test was *2.06* with a standard deviation of *1.874*. The two-tailed test in Table 6 below, shows the differences between the pre-post ATP results in both directions (*t=12.520, p=.000*). These results demonstrate that the new cleaning process may have contributed to improved cleaning efficacy after the EVS used the 2-step cleaning process.

Table 6

*ATP Pre-Posttest T-Test Results*

**Paired Samples Test**

| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference Lower | Upper | | | |
| Pair 1 | Pre – ATP Post-ATP | 5.952 | 3.774 | .475 | 5.002 | 6.903 | 12.520 | 62 | .000 |
| | | | | | | | | | |

As shown in Table 7, the investigator assessed internal consistency of the ATP test by preforming a Cronbach's Alpha. The Cronbach's Alpha was (*.598, N2*) indicating a poor ATP test reliability in this study that was most likely due to the low sample size of high touched objects/surfaces. The stronger the reliability, the stronger the correlation between obtained scores and true scores (Polit, 2010, p. 355).

Table 7

*Reliability for ATP Pre-Posttest Results*

| Cronbach's Alpha | N of Items |
|---|---|
| .598 | 2 |

**Just in time education**. Rooms that did not pass ATP were subject to just in time education on the 2-step cleaning process with the EVS staff who cleaned the room, followed by re-cleaning of the room and ATP testing. Just in time education was not required for the EVS

staff as all of the rooms passed ATP testing during the duration of this study. Based on no need for just in time education, EVS demonstrated understanding of the disinfection process required for high touch objects in rooms previously occupied by patients on transmission-based precautions.

**Objective II: Comparison of AB Hospital *C. difficile* Rates Pre-post Intervention to assess for a Change (Improvement) in *C. difficile* Rates**

AB hospital *C. difficile* rates were compared pre-post intervention to assess for a change (improvement) in infection rates. Data was pulled from the National Health Safety Network (NHSN) and is shown below in Table 8. The incidence rates are calculated by dividing the number of infections by the number of patient days multiplied by 10,000. The incidence rate for healthcare-acquired *C. difficile* for calendar year 2017 was 3.27. The incidence rate for *C. difficile* was 2.56 for calendar year 2018. The investigator also reviewed the incidence rate of *C. difficile* for the period of the study with the previous year, to better assess for improvement in the rate of *C. difficile* infection. In October 2017- March 2018 there were a total of 9 lab- identified (Lab-ID) cases of *C. difficile* and 3 of 9 were classified as a healthcare-acquired infection (HAI), patient days were 7,967, which resulted in an incident rate of 3.76. Compared to the current period October 2018- March 2019, there were 11 lab -identified cases of *C. difficile* and 2 of 11 were classified as a healthcare-acquired infection, patient days during this time period was 10,724, resulting in an incident rate of 1.86. There was a difference in the mean, (1.9) for the incidence rate. Based on the comparison of data for C. difficile rates from 2017/2018 to 2018/2019, this demonstrates a slight change/ (improvement) in C. difficile rates after the implementation of the educational intervention, 2-step cleaning process, and ATP testing.

Table 8

*C. difficile Infection Rates*

| **Year/Months** | **Lab-Identified *C. difficile*** | **Healthcare-Acquired *C. difficile*** | **Patient Days** | **Incidence Rate** |
|---|---|---|---|---|
| **1/17- 12/17** | **17** | **6** | **18,322** | **3.27** |
| **1/18-12/18** | **22** | **5** | **23,347** | **2.56** |
| **10/17-3/18** | **9** | **3** | **7967** | **3.76** |
| **10/18- 3/19** | **11** | **2** | **10,724** | **1.86** |

**Discussion**

The primary investigator explored whether an educational intervention with environmental staff (EVS) on a new cleaning process would make a difference in cleaning efficacy of *C. difficile* infected rooms. While the results did show a statistical significance in the pre-posttest educational intervention and with pre-post ATP tests, the investigator is unclear if there was a Hawthorne effect. Environmental Service staff may have altered their behavior wherein they became more productive or conscientious in cleaning the rooms in order to attain passing ATP results. Even though the ATP test results were never in the "failed" range, the tests did give valuable information in this study by verifying if a room was properly cleaned and disinfected.

## Limitations, Recommendations, Implications for Change

### Limitations

Limitations of this study included a small sample size of participants and the reduced numbers of rooms and surfaces tested. There was an average of one to two patients a month who presented with signs and symptoms of *C. difficile.* The environmental staff did not consistently use the cleaning checklist as a guide to clean the high-touch objects in the room. The study did not evaluate the cleaning efficacy of shared equipment such as the glucometer, stethoscope, and the Dynamapp machine.

### Recommendations

The investigator recommends the use of an educational intervention and the ATP meter to confirm cleaning efficacy in rooms previously occupied by patients on transmission-based precautions for all isolation types. The investigator recommends a follow-up study to assess cleaning efficacy of shared patient-care equipment frequently used on patients on transmission-based precautions, stethoscope, glucometer, and Dynamapp machine. Future studies should also assess the cleaning efficacy in the nursing station for the risk of environmental contamination from hospital staff non-compliance with infection control guidelines. Lastly, studies with larger numbers of participants are needed to assess the internal consistency of the pre-post EVS educational intervention test.

### Implications for Change

The results of this study supported the implementation of evidence-based practice guidelines to increase staff knowledge and improve quality metrics. While this study did not generate new phenomenon, it does provide patients at AB hospital with a safe clean environment, decreasing their risk of acquiring *C. difficile.* The results of the study may impact

re-admission rates for patients who return to the hospital with signs and symptoms suggestive of *C. difficile.* The results of this study have the potential to generate revenue for AB hospital over-time, from dollars spent on Personal protective equipment (PPE), and extended patient days for patients requiring treatment for *C. difficile.* The results of this project will be sustained by providing staff with positive reinforcement, ongoing education, and training. This study can be replicated at small community hospitals for a cost of $3,011; this cost is minimal when compared to the benefits a hospital can receive overtime. Other implications include expanding the study to include other possible risk factors that may increase the risk of *C. difficile* transmission in the hospital environment.

## Summary

This quality improvement project was specific to a small safety net hospital and explored the use of evidence-based guidelines related to cleaning efficacy in rooms previously occupied by patients on transmission-based precautions for *C. difficile* and Adenosine Triphosphate (ATP) testing. The investigator investigated if an educational intervention and follow-up ATP testing would increase the EVS knowledge of the cleaning process and improve hospital quality metrics for *C. difficile* infections. By using a quasi-experimental pre-posttest design, the investigator was able to address the PICO study questions for this project. While the data does show statistical significance, it is not clear, if the results were attributed to staff awareness of ATP testing which caused their behavior to change, or if the educational intervention on the 2-step cleaning process resulted in the staff improving the overall process.

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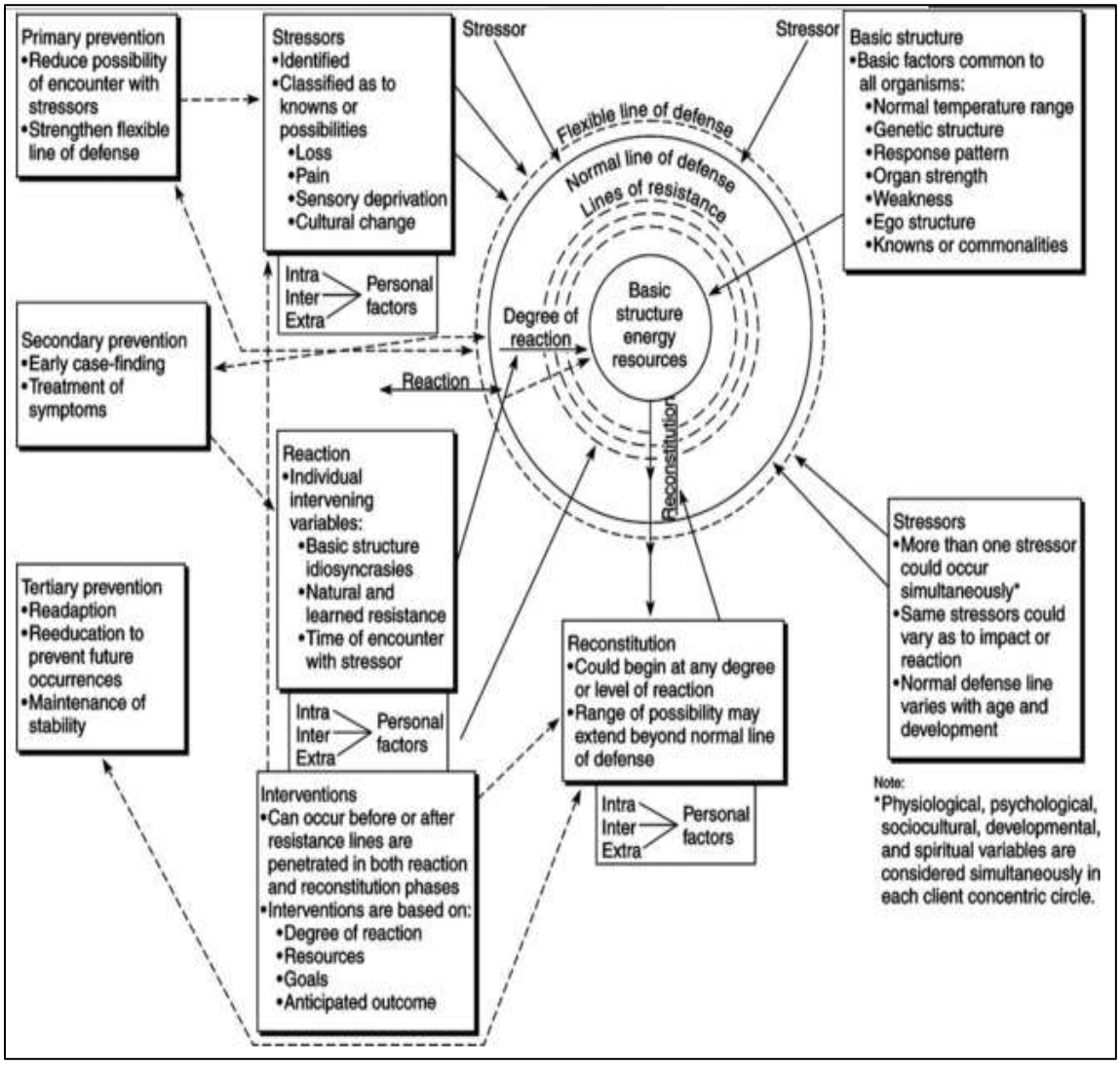
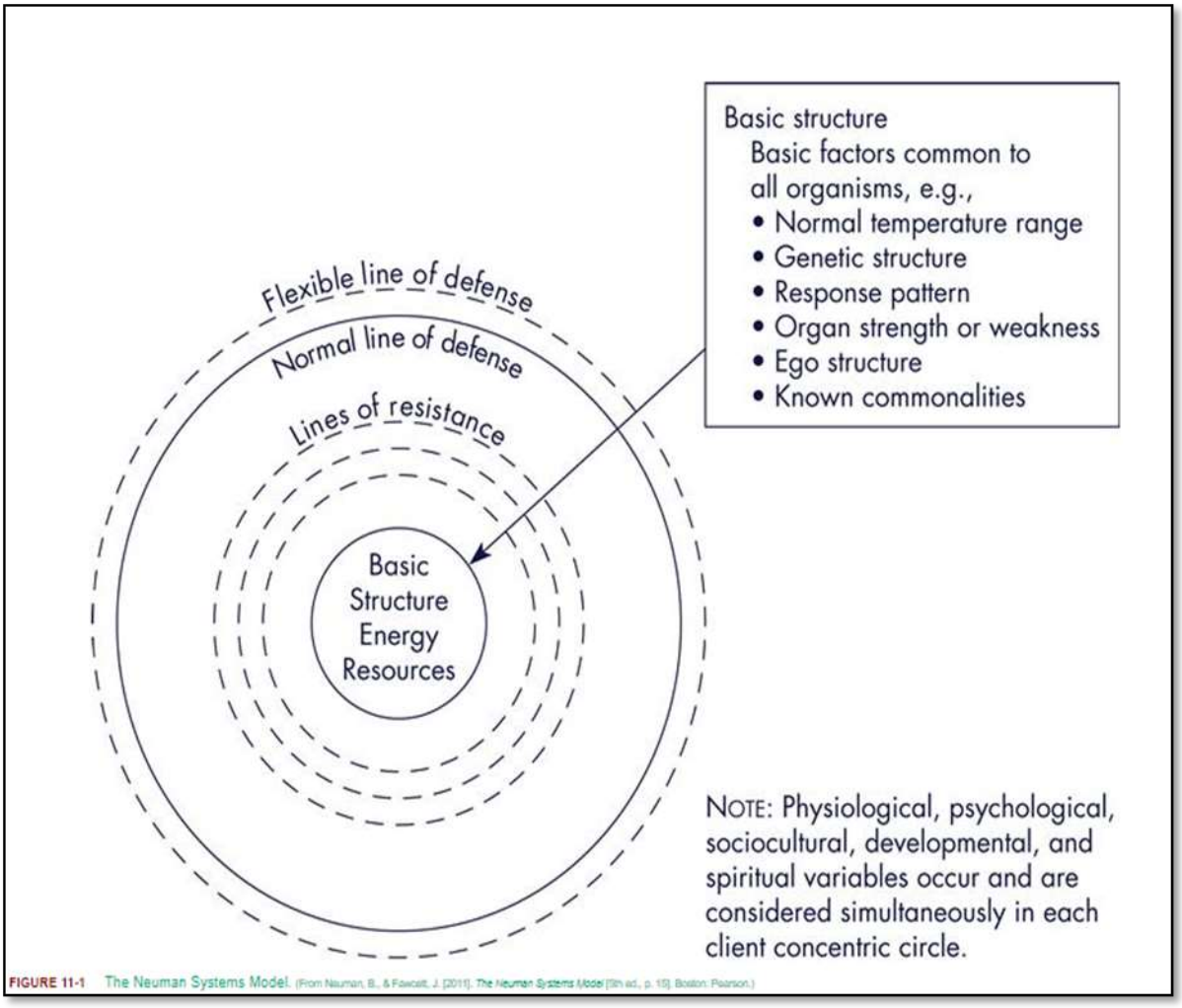
# Appendix A

## Betty Neuman's System Theory




(McEwen & Wills, 2014)




(McEwen & Wills, 2014)

Appendix B

Avedis Donabedian Quality Model

**TABLE 5-1** Donabedian's Matrix for the Classification of Quality Measures

| | Structure | Process | Outcome |
|---|---|---|---|
| Accessibility | | | |
| Technical management | | | |
| Management of interpersonal relationships | | | |
| Continuity | | | |

*Source*: Donabedian, A. 1980. The definition of quality and approaches to its assessment. In *Explorations in Quality Assessment and Monitoring* (Vol. 1, pp. 95-99). Ann Arbor, MI: Health Administration Press.

(Cohen & Shang, 2015)

# Appendix C

## Example of Literature Review

| | |
|---|---|
| **Article/Journal** | The adenosine triphosphate method as a quality control tool to assess 'cleanliness' of frequently touched hospital surfaces.<br>*The Journal of hospital infection*, ISSN: 1532-2939, Vol: 91, Issue: 2, Page: 166-70 |
| **Author/Year** | Knape, L., Hambraeus, A., Lytsy, B. (2015). |
| **Database/Keywords** | Google Scholar/ Hospital cleaning, ATP, Visual Inspection |
| **Research Design** | Prospective intervention study |
| **Level of Evidence (Melnyk & Fineout-Overholt, 2005)** | Level 2- One or more randomized controlled trials |
| **Study Aim/Purpose** | To assess the cleanliness of high touched surfaces in the patient environment/ To confirm those surfaces frequently touched in the patient environment are clean using a quality control tool as opposed to visual inspection alone. |
| **Population/Sample size Criteria/Power** | Intensive Care unit and a Medical Ward at a Regional Hospital in Sweden/ 16 rooms/ 20 test surfaces in the Medical ward was tested daily and 10 surfaces in the ICU was tested daily and, in both areas, 100^2 cm of the same surfaces was tested. |
| **Methods/Study Appraisal Synthesis Methods** | A prospective intervention study was carried out in three phases, observational phase, intervention phase and follow-up phase. The observational phase was conducted over a one-month period from December 2012- January 2013. During the observational phase, 10 frequently touched surfaces in the patient environment was assessed both visually and using ATP to collect baseline data. The intervention phase was conducted over a two-week period, from January 8- January 18, 2013. During this time, staff was educated on healthcare-associated infections, the importance of cleaning surfaces to prevent cross-contamination within the environment and how to clean according to the guidelines. A cleaning protocol was developed that consisted of daily cleaning which focused on the ten high- touch surfaces using an alcohol-based disinfectant, 70% Isopropanol and a disposable microfiber cloth for single use. The follow-up phase was conducted from January 28- February 18, 2013. During the follow-up phase, the cleaning protocol was used with daily feedback of the relative light unit (RLU) value of each surface written on the whiteboard, so staff can know if the surfaces were cleaned appropriately in real-time. / Visual assessment and ATP testing were conducted immediately and no later than an hour after the surfaces were cleaned. Surfaces were identified as clean visibly when it was free from contamination and organic material. With respect to ATP, 500 RLU were used as an upper limit for clean. |
| **Study tool/instrument validity/reliability** | A mixed model was fitted with logarithimized ATP as a dependent variable to test the efficacy of cleaning on ATP levels and visual assessments was conducted using general estimating equation (GEE), time, surface type and ward. / Logistic Regression Model was used for both visual assessment and ATP levels. |
| **Primary Outcome Measures/Results** | A total of 668 visual assessments and ATP were conducted and the RLU decreased after staff was educated on the cleaning protocol. The mixed model showed a significant decrease in ATP levels after the intervention ($P < 0.001$). Relative light unit values were lower in the ICU. Cleanliness as judged by visual assessments improved. In the logistic regression analysis, there was a significant association between visual assessments and ATP levels. |
| **Conclusions/Implications** | Staff education and the implementation of the cleaning protocol along with visual assessment and ATP measurement improved overall cleaning and however cannot ensure cleaning in larger spaces of the hospital. |
| **Strengths/Limitations** | Strengths- The same person conducted both the visual assessment and ATP measurements in both areas.<br>Limitations - The duration of the study was not long enough. |
| **Funding Source** | Svenska AB, Saljkontoe, Sweden |
| **Comments** | Instruments and measures are described objectively, and the literature review can be linked directly and indirectly to the research question. I will use this article for my project as it correlates both visual assessment and ATP measurement as an important process needed to ensure the efficacy of cleaning in the patient environment. |

Adapted from Houser, J. & Oman, K. S. (Eds.). (2011) Evidence table format for a systematic review.

Appendix D

Site Letter of Agreement

**Letter of Agreement**

***July 23, 2018***

To Regis University Institutional Review Board (IRB):

I am familiar with Rochelle Bello's research project entitled **"Enhancing Environmental Staff Cleaning Process and ATP."**

I understand [redacted] Hospital's involvement to be allowing the education of staff from Environmental Services (EVS) to be educated on the 2-step cleaning process supplemented with a cleaning checklist and Adenosine Triphosphate (ATP) testing of high touch objects in rooms previously occupied by patients on transmission-based precautions for C. difficile. The hospital data on C. difficile will also be reviewed for data collection and compliance monitoring.

I understand that this research will be carried out following sound ethical principles and that participant involvement in this research project is mandatory as the institution of the 2-step cleaning process and high-touch checklist will be part of the routine cleaning process for *C. difficile* infected rooms. An information sheet about the project will be reviewed with all EVS staff prior to implementation of the new cleaning process and provides confidentiality of research data, as described in the proposal.

Therefore, as a representative of [redacted] Hospital, I agree that Rochelle Bello's research project may be conducted at our agency/institution.

[redacted] Hospital does not have its own IRB and will accept oversight from the IRB at Regis University.

Sincerely,

*Alfredo Mena Lora MD, FACP*

*Medical Director*

# Appendix E

## Cost-Benefits Analysis and Cost to Replicate Study

### A. Cost Benefit Analysis

| **Cost Description** | **Estimated Cost for The Project** |
|---|---|
| **Costs of newly proposed project** | |
| ATP testing meter/mediums | $2175.00 |
| Education training material | $70.00 |
| Staff salaries | $766.50 |
| **Total costs of proposed project** | **$3011.50** |
| | |
| **Benefits** | |
| Surfaces tested for cleaning efficacy | $500.00 |
| Staff trained on cleaning process | $500.00 |
| Decreased risk of healthcare acquired infections | $3,500 |
| | |
| Revenue | $10,000 |
| Cost Avoidance | $7,285 |
| Other savings (Cost for PPE) | $3,000 |
| **Total benefits** | **$25,285** |

### B. Cost to Replicate Study

| **Cost Analysis** | | | | | | |
|---|---|---|---|---|---|---|
| Staff Salaries | Hourly Rate | Staff Total | Number of hours / day | Daily salary | Daily Total Salary | Total Expense Day 1 |
| Infection Preventionist | $55.00 | 1 | 2 | $110.00 | $110.00 | $766.50 |
| EVS Director | $35.00 | 1 | 2 | $70.00 | $70.00 | |
| EVS Manager | $30.00 | 2 | 1 | $60.00 | $60.00 | |
| EVS Staff | $13.50 | 13 | 3 | $526.50 | $526.50 | |
| Total | | | | | $766.50 | |
| ATP Equipment | Price | Units | Estimated | Actual | | |
| ATP Testing Meter | $1,850.00 | 1 | | $1,850.00 | | $2,175.00 |
| ATP Test Medium | $65.00 | 100x5 | | $325.00 | | |
| Total | | | | $2,175.00 | | |
| Education Material | Price | Units | Estimated | Actual | | |
| Copy Paper | $35.00 | 2 (1000 sheets) | | $70.00 | | $70.00 |
| Total | | | | $70.00 | | |
| Project Total Cost | | | | | | $3,011.50 |

# Appendix F

## Project Timeline

- **05/2017:** Identify Problem/ Process for Improvement
- **06/2017:** Explore PICO
- **07/17- 08/2017:** Research Nursing Theories
- **08/17:** PICO Identified
- **09/17-12/17:** Literature review
- **01/2018:** Theme Selection for Project
- **02/2018:** Course on Human Research
- **03/2018:** SWOT Analysis
- **04/2018:** Cost Benefits Analysis
- **05/2018:** Start rough draft for project
- **06/2018:** Proposal Write-up
- **07/2018:** Site approval letter signed
- **07/2018:** Prepare Power Point Presentation for Defense
- **08/2018:** Defend proposal
- **08/2018:** Submit to Regis IRB
- **09/2018:** IRB Approval
- **10/2018:** Project begin/ Identify participants
- **10/2018:** Informed Consent Signed
- **10/2018:** Staff Education
- **10/18- 03/19:** Implement Project Intervention
- **03/2019**: Complete data collection
- **03/2019:** Analyze data
- **03/2019**: Write up final project
- **04/2019**: Defend project

# Appendix G

## Logic Model

| RESOURCES | ACTIVITIES | CONSTRAINTS | OUTPUTS | SHORT & LONG-TERM OUTCOMES | IMPACT |
|---|---|---|---|---|---|
| *In order to accomplish our set of activities we will need the following:* | *In order to address our problem or asset we will accomplish the following activities:* | *We expect the following constraints may affect activities:* | *We expect that once accomplished these activities will produce the following evidence of service delivery:* | *We expect that if accomplished these activities will lead to the following changes in 1-3 then 4-6 years:* | *We expect that if accomplished these activities will lead to the following changes in 7-10 years:* |
| Leadership support on process and activities<br><br>EVS support on the process<br><br>ATP machine/testing solution<br><br>EVS educational tools/ 2-step cleaning process/ cleaning checklist<br><br>Template for tracking the data<br><br>National Benchmark | Review current cleaning process for c. diff rooms and revise if needed<br><br>Educate EVS staff on the 2-step cleaning process for c. diff rooms/ cleaning checklist<br><br>Obtain swab for ATP testing for presence of c. diff<br><br>Record ATP results in a spreadsheet<br><br>Interpret the data<br><br>Share results with EVS staff and leadership<br><br>Know the national benchmark for c. diff, 0.92 and SAH current c. diff rate 0.5 | Frequent turnover of EVS staff<br><br>Timeframe<br><br>Staff resistance to<br><br>change | Standardize process for cleaning c. diff rooms<br><br>Staff will know the process for cleaning c. diff rooms<br><br>ATP results will confirm the cleaning efficacy in c. diff rooms<br><br>Track /monitor results for effectiveness<br><br>Show trends/ patterns and opportunities for improvements<br><br>Provide feed-back on the process<br><br>C.diff rates below the national benchmark of 0.92 | Decrease in c. diff rates by 25% in 3 months<br><br>Performance improvement in 6 months<br><br>Prevent healthcare-acquired c. diff or other infections from hospital surfaces in 1 year<br><br>Staff will know the cleaning process for c. diff rooms; the process will be used consistently by all EVS workers in 3 months<br><br>Cleaning process for c. diff will be standard practice used by EVS staff in 1 year<br><br>ATP will be a standard tool used to validate cleaning efficacy in c. diff room in 1 year<br><br>Results will show the cleaning efficacy in c. diff in 1 month<br><br>Results will show the cleaning efficacy in c. diff rooms annually<br><br>Allow the team to modify process based on data in 1 month<br>Staff will see the areas that needs to be improved upon immediately<br><br>Results will allow EVS staff to see how their cleaning efforts, decrease risk of healthcare-acquired infections<br><br>Process in place to ensure C. diff rates below the national benchmark of 0.92 | Financial impact- decrease in length of stay associated with c. diff infections and antibiotic use.<br><br>Quality assurance standardize cleaning processes in place to prevent the transmission of infectious organisms in the hospital environment<br><br>Provide immediate feed-back on the cleanliness of hospital surfaces<br><br>Ensures the patient environment is free of infectious organisms<br><br>Allows processes to be corrected proactively<br><br>Creates owners of processes and acknowledge staff for doing an effective job<br><br>SAH c. diff rates publicly reported are below the national bench mark of 0.92 |

Source: National Benchmark for c. difficile retrieved from: 2014 HAI Progress Report: www.cdc.gov/hai/progress-report/, REPORT IS BASED ON 2014 DATA, PUBLISHED IN 2016

Appendix H

Primary Investigator Certificate

Certificate on Human Research

# Appendix I

## IRB Approval Letter

| | |
|---|---|
| DATE: | September 24, 2018 |
| TO: | Rochelle Bello |
| FROM: | Regis University Human Subjects IRB |
| PROJECT TITLE: | [1310760-2] Enhancing Environmental Staff Cleaning Process and Adenosine Triphosphate (ATP) Bioluminometers Test to Improve Cleaning Efficacy |
| SUBMISSION TYPE: | Amendment/Modification |
| ACTION: | APPROVED |
| EFFECTIVE DATE: | September 24, 2018 |
| EXPIRATION DATE: | September 23, 2019 |
| REVIEW TYPE: | Expedited Review |

Thank you for your submission of Amendment/Modification materials for this project. The Regis University Human Subjects IRB has APPROVED your submission as an Expedited Review based on applicable federal regulations. This approval is based on an appropriate risk/benefit ratio and a project design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

The investigator has done an exemplary job with the required revisions - thank you! This project meets Expedited Category 7 and is approved with no further changes.

If you need to make any changes to your study, or need to submit a Closure Report marking the end of the study, you may use instructions available by clicking on the "Forms and Templates" button in IRBNet and following the "IRBNet Instructions: Subsequent Packages (Versions)" download. Students may also contact their Faculty Advisor and anybody can reach out to irb@regis.edu for assistance.

Please note that any revision to previously approved materials must be approved by this committee prior to initiation using the appropriate revision forms for this procedure.

Unanticipated problems, serious and unexpected adverse events, and non-compliance issues or complaints must be promptly reported to irb@regis.edu and contacting the IRB Chair and/or Vice-Chair.

This project has been determined to be a Minimal Risk project. Based on the risks, this project requires continuing review by this committee on an annual basis. Please use the appropriate forms for this procedure. Your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date of September 23, 2019.

Please note that all research records must be retained for a minimum of three years after the completion of the project.

If you have any questions, please contact the Institutional Review Board at irb@regis.edu. Please include your project title and reference number in all correspondence with this committee.



This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Regis University Human Subjects IRB's records.

Appendix J

Educational Sheet for Environmental Staff: CDC Environmental Checklist for Monitoring Terminal Cleaning

CDC Environmental Checklist for Monitoring Terminal Cleaning

| | |
|---|---|
| **Date:** | |
| **Unit:** | |
| **Room Number:** | |

**Evaluate the following priority sites for each patient room:**

| **High-touch Room Surfaces[3]** | **Cleaned** | **Not Cleaned** | **Not Present in Room** |
|---|---|---|---|
| Bed rails | | | |
| Telephone | | | |
| Bathroom sink handles | | | |
| Overbed tray table | | | |
| Call light | | | |

**Mark the monitoring method used:**

☐ Direct observation ☐ Fluorescent gel
☐ Swab cultures ☐ ATP system ☐ Agar slide cultures

Selection of detergents and disinfectants should be according to institutional policies and procedures
Sites most frequently contaminated and touched by patients and/or healthcare workers

Source: Centers for Disease Control and Prevention, 2018. Evaluating Environmental Cleaning toolkit. Retrieved from: https://www.cdc.gov/hai/toolkits/evaluating-environmental-cleaning.html. (Modified version)

Appendix K

Educational Sheet for Environmental Staff: 2-Step Cleaning Process for *C. difficile*

Definitions:

*Clostridium difficile* (*C. difficile*) is bacteria that causes inflammation of the colon, known as colitis. *Clostridium difficile* is shed in feces. Any surface, device, or material (e.g., toilets, bed rails, and electronic rectal thermometers) that becomes contaminated with feces may serve as a reservoir for the *Clostridium difficile* spores. *Clostridium difficile* spores are transferred to patients mainly via the hands of healthcare personnel who have touched a contaminated surface or item. *Clostridium difficile* can live for long periods on surfaces (CDC, 2018).

High Touch Objects- High-touch objects are those that have frequent contact with hands (i.e. telephone, bedrails, call light)
Cleaning- The removal of visible dust, soil, debris, blood, or other potentially infectious material

Disinfection- A process that kills most forms of microorganisms on inanimate surfaces

Detergent- Contains surfactants that clean and remove "soil" from surfaces

Disinfectant- Hospital approved chemicals that kill bacteria and fungus

Process Overview: All rooms previously occupied by patients on transmission-based precautions for C. difficile will be terminally cleaned upon discharge, utilizing a 2-step cleaning process (see attached tool).
Terminal cleaning is an important process in removing germs from the patient's environment.

- Use the right tools
- Use the right chemical
- Use the right amount of chemical for the right amount of time
- Use dedicated cleaning equipment

High-touch surfaces in rooms previously occupied by patients on transmission-based precautions for C. difficile requires careful attention when cleaning and disinfecting these objects.

Two- Step Cleaning Process: The two-step cleaning process consist of cleaning and disinfecting surfaces in the patient environment.

***Step 1*- Cleaning Process:** During the cleaning process, staff will use a hospital approved detergent to remove soil from all surfaces

***Step 2*- Disinfection process:** Requires staff to use bleach or other sporicidal disinfectant on all surfaces in the patient's room. During the second step, the sporicidal agent must dwell on the surfaces for a set time to effectively kill *C. difficile* spores.

References:

1. *Clostridium difficile Infection.* Retrieved from: https://www.cdc.gov/HAI/organisms/cdiff/Cdiff_infect.html

2. Minnesota Hospital Association (2016). Cleaning Protocol for Environmental Services. Retrieved from https://www.mnhospitals.org/Portals/0/Documents/ptsafety/CDICleaning/3.%20Environmental%20Services%20Cleaning%20Protocol%20Educational%20Presentation.pdf

## 2- Step Cleaning Process for *C. difficile*

| STEP | KEY POINTS | YES | NO |
|---|---|---|---|
| 1. Don PPE | • Put on personal protective equipment (gown, gloves, face shield if splashing is likely) | | |
| 2. Remove/ Discard Toiletries | • Remove and discard all toiletries inside the room (tissue, soap, any products left inside the room) | | |
| 3. Clean | • Start cleaning from the cleanest area in the room to the dirtiest area in the room (the bathroom should always be cleaned last) | | |
| 4. Clean | • Using a hospital approved detergent, clean all surfaces in the room with attention to high touched objects in the room:<br>- Bedrails<br>- Overbed tray table<br>- Call buttons/ call light<br>- Telephone<br>- Sink handles<br>• Wipe all surfaces with friction to remove the soil from all objects/ equipment inside the room<br>• After cleaning all items in the room, proceed to the next step, the Disinfection Process | | |
| 5. Disinfect | • Using a hospital approved bleach-based disinfectant (Sani cloth Bleach wipes), disinfect all surfaces in the room with attention to high touched objects in the room:<br>- Bedrails<br>- Overbed tray table<br>- Call buttons/ call light<br>- Telephone<br>- Sink handles | | |
| 6. Disinfect | • Saturate all surfaces with enough chemical to keep surfaces wet for the required contact time | | |
| 7. Disinfect | • Allow the chemical to sit on the surfaces for the required contact time (follow manufactures guidelines) | | |

| | | | |
|---|---|---|---|
| | • Sani Cloth Bleach wipes should remain on the surface for 3-minutes to effectively kill C. difficile spores<br>• After 3-minutes have passed, wipe the surfaces using friction to remove organisms | | |
| 8. Disinfect | • After the disinfection process is completed, remove mop head and place in bag to be cleaned (do not use mop again, dedicated to single use in c. diff rooms) | | |
| 9. Remove PPE | • Remove PPE and perform hand hygiene | | |

# Appendix L

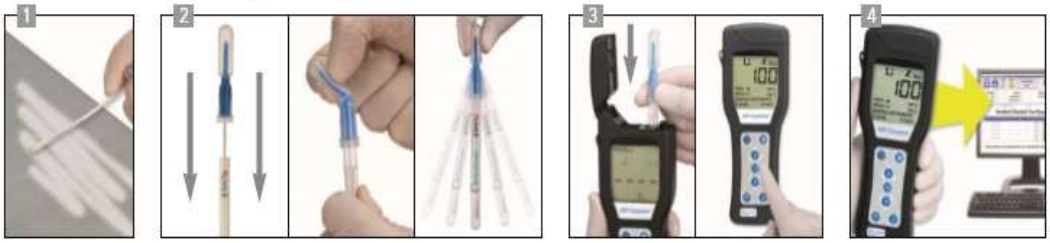
## ATP Testing Meter

### Test™ Swab

#### Directions for Use

Testing should be done after cleaning, prior to high-level disinfection or sterilization.[1]

1. Take the Test® Swab out of the tube and swab area of interest.
2. Replace the Test® Swab. Hold the swab tube firmly and use the thumb and forefinger to break the Snap Valve by bending the bulb forward and backward. Squeeze the bulb twice, expelling all liquid down the swab shaft. Bath the swab bud in liquid by gently shaking for 5-10 seconds.
3. Insert the Test® Swab tube into the Ruhof ATP Complete® hand held device, close and press the OK button. In 15 seconds the ATP Complete® device will display the amount of contamination detected.
4. The Ruhof ATP Complete® hand held device can then be synced to your computer and the reading downloaded to the Ruhof ATP Complete® software program provided. The downloaded data can then be used to produce detailed reports that provide testing history on the effectiveness of cleaning procedures.




#### Recommended Pass/Fail Criteria

| Application | Recommended Pass/Fail Criteria | |
|---|---|---|
| | Pass (RLU) | Fail (RLU) |
| **Scopes and Surgical Instruments** | **0-100** | **101 and over** |
| **Sterile Processing - General** *(all non critical surfaces in procedure rooms, restrooms, waiting rooms, etc.; for testing counters, bedrails, blood pressure cuffs, toilets, faucets, hand rails, beds, computers, I.V. poles, etc.)* | **0-45** | **46 and over** |
| **Hand Hygiene** | **0-100** | **101 and over** |

If you have a test failure please contact the manufacturer of the device being tested for advice on the best cleaning practice and products available that will help produce better outcomes.

**Other Uses for the ATP Complete Contamination Monitoring System:**

The ATP Complete® Contamination Monitoring System, used in conjunction with Ruhof's Test® InstruSponge™, is the only product that can provide an accurate numerical reading of the level of contaminants present inside the channel of scopes and cannulated instruments after cleaning. Please contact Ruhof for more information.

*[1] Please note: Testing after HLD is an option for periodic testing of HLD processor maintenance. This would be up to the facility to determine procedure and frequency.*

Source: Ruhof ATP Complete (2017). Retrieved from https://www.ruhof.com/products/ruhof-atp-complete-handheld-device

# Appendix M

## CDC: Data Collection Tool

**ATP Tool to Confirm Cleaning Efficacy**

Record results of evaluation for each surface on the check list for every room monitored. Use the following symbols for marking:

O = NOT CLEAN, X = CLEAN, LEAVE BLANK = NOT EVALUABLE NOTE - USE CAP LETTERS "X" AND "O"

The percentage of individual surfaces cleaned will be automatically calculated in Sheet 2 (Aggregate Score Sheet).

Please report aggregate scores calculated for each category highlighted in Sheet 2 (Aggregate Score Sheet).

| | | | | | High Touch I | | | | High Touch II | | Surfaces Cleaned for Each Room | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit | Rm No. | Date Room Cleaned | *C.diff* Isolation | RT Bed Rail | LT Bed Rail | Tray table | RT Sink Handle | LT Sink Handle | Call box / button | Telephone | # Surfaces Cleaned | # Surfaces Evaluated | % of Surfaces Cleaned |
| Tele-Pre | | | | | | | | | | | | | |
| Tele-Post | | | | | | | | | | | | | |
| Re-clean | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | |

Source: Centers for Disease Control and Prevention, 2018. Evaluating Environmental Cleaning toolkit. Retrieved from: https://www.cdc.gov/hai/toolkits/evaluating-environmental-cleaning.html
(Modified version)

## Appendix N

## Pre-Posttest

1. Rooms previously occupied by patients on transmission-based precautions for *C. difficile* will be terminally cleaned upon discharge, utilizing a 2-step cleaning process

    a. True
    b. False

2. High-touch objects are those that have frequent contact with hands and include:

    a. Bed rails
    b. Overbed tray table
    c. Floor
    d. Both A & B
    e. None of the above

3. Step one of the two-step cleaning process involves the removal of visible dust, soil, debris, blood, or other potentially infectious materials of soil from surfaces

    a. True
    b. False

4. A Disinfectant is used to

    a. kill bacteria and fungus
    b. remove soil from surfaces
    c. clean surfaces
    d. None of the above

5. Detergent is used to

    a. remove soil from surfaces
    b. kill bacteria
    c. kill fungus
    d. None of the above

6. Step two of the two-step cleaning process involves the disinfection process, a process that kills most forms of microorganisms on inanimate surfaces

    a. True
    b. False

7. The two-step cleaning process consist of cleaning and disinfecting surfaces in the patient environment

    a. True
    b. False

8. All surfaces should be wiped with friction to remove the soil from all objects/ equipment inside the room

    a. True
    b. False

9. A bleach-based disinfectant is the only chemical that can kill *C. difficile* spores

    a. True
    b. False

10. *Clostridium difficile* can live for long periods on surfaces

    a. True
    b. False

# Appendix O

## Informed Consent to Participate in Research

## Enhancing Environmental Staff Cleaning Process and Adenosine Triphosphate (ATP) Bioluminometers Test to Improve Cleaning Efficacy

You are asked to participate in a research study conducted by Rochelle Bello, MSN, RN and Dr. Kathleen Whalen, from the Department of Nursing Faculty at Regis University. This project is being conducted as part of the DNP Capstone course. Your participation in this study is entirely voluntary. Please read the information below and ask questions about anything you do not understand, before deciding whether or not to participate. If you decide to participate, you will be asked to sign this form and it will serve as a record of your agreement to participate. You will be given a copy of this form to keep.

**OPTIONAL:** You have been asked to participate in this study because you are currently responsible for cleaning patient rooms previously occupied by patients on transmission-based precautions (isolation) as part of your role as an environmental service worker.

**PURPOSE OF THE STUDY**

The purpose of this quality improvement (QI) project is to explore best practices related to cleaning efficacy of C. difficile infected rooms.

**PROCEDURES**

If you volunteer to participate in this study, you will be asked to do the following things: Take a pre-posttest to assess your understanding of the cleaning process required to clean rooms previously occupied by patients on isolation for c. difficile. You will be educated on a cleaning checklist and the 2-step cleaning process that will be the new process required to clean rooms previously occupied by patients on isolation for c. difficile. The following high- touched objects will be tested with an ATP machine by the investigator to confirm if the surfaces are clean and free of c. difficile: bed rails, over bed tray table, telephone, call light and bathroom sink handles. If the room fails to pass ATP testing, you will receive just in time education on the 2-step cleaning process and asked to repeat the cleaning process until the ATP results are acceptable/ pass. The results of the ATP will be collected, analyzed, and shared with the IC Committee meeting, and individuals reviewing the outcome of this investigation.

I will not be collecting data/information that will link you to the ATP results or the checklists. All participants and collection and reporting of data will be de-identified, individual names are not included on the pre/posttest, the ATP data collection tool or on the cleaning checklist. Study data from the ATP tests will be stored on the investigator's password protected computer. The cleaning checklists will be kept locked up and confidential in the investigator's office. Your identity will not be revealed in any publication resulting from this study.

**POTENTIAL RISKS AND DISCOMFORTS**

There are no anticipated risks to you from your participation in this study. We believe that the risk from participation is no greater than that encountered in everyday life. However, in case you do experience any mild distress from the experiment, a debriefing process will be provided at the end of the experimental session.

**POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY**

You will benefit by learning about research in the fields of Infection Prevention and will benefit

by learning more about the topic of Enhancing Cleaning Efficacy in C. difficile rooms. There is a benefit to the field of Infection Prevention research by expanding our knowledge about this topic. The investigator hopes to learn how the implementation of a two-step cleaning process can enhance the cleaning efficacy in c. difficile rooms with a decrease in healthcare acquired c. difficile infections.

**PAYMENT FOR PARTICIPATION**

EVS staff will participate as volunteers and will not receive compensation.

**CONFIDENTIALITY**

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. A coding procedure will be used so that the researcher will use a numerical code for your data that can't be identified with you, and your name will not be recorded with the data. The researcher and the researcher's faculty advisor will have access to the raw data, and results of data will be presented in aggregate form. After completion of the study, the consent forms and data will be stored for three years in a locked filing cabinet in the investigator's office.

This study is being conducted by a student as part of a course requirement. Therefore, records that identify you and the consent form signed by you may be looked at by others. They are:

- Regis IRB that protects research subjects like you
- Officials at Regis University who are in charge of making sure that we follow the rules of research
- Any faculty members who are co-investigators on this project may also contact you about your participation in the project

**PARTICIPATION AND WITHDRAWAL**

You can choose whether or not to be in this study and however, the two-step cleaning process and checklist will be the process for cleaning all rooms previously occupied by patients on isolation for c. difficile, this is not an option. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind or loss of benefits to which you are otherwise entitled. You may also refuse to answer any questions you do not want to answer. If you sign the consent form but then do not complete the project, please write "withdrawn" on your original consent form, next to your signature, to indicate that you have chosen not to participate further.

The investigator may withdraw you from this research if circumstances arise which warrant doing so. Participant's participation will be terminated by the investigator only if they resign from their position as an EVS worker.

**IDENTIFICATION OF INVESTIGATORS**

If you have any questions or concerns about this research, please contact: Rochelle Bello, MSN,RN, Principle Investigator at rbello@regis.edu or 773-484-4192 or my Faculty Sponsor, DNP Capstone Chair, Dr. Kathleen Whalen, at kwhalen@regis.edu or 303-458-3599

**RIGHTS OF RESEARCH SUBJECTS**

If you have any questions about your rights as a research subject, you may contact the Regis University Institutional Review Board (IRB) which is concerned with the protection of volunteers in research projects. You may contact them by any of the methods below:

Mail: Regis University
Center for Scholarship and Research, B-12

3333 Regis Boulevard
Denver, CO 80221

Phone: (303) 458-4188

Email: IRB at IRB@regis.edu.

You will be given the opportunity to discuss any questions about your rights as a research subject with a member of the IRB. The IRB is an independent committee composed of members of the University community, as well as lay members of the community not connected with Regis. The IRB has reviewed and approved this study.

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I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

_____
Printed Name of Subject

_____ _____
Signature of Subject Date

_____ _____
Signature of Investigator Date