

**Hospital-Associated
Clostridium difficile Infections
Prevention & Policy Implications
in an Acute Hospital Setting**

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I. Background

A. Summary of Critical Literature

i. Hand Hygiene – The Policies Arising from Hospital-Associated Infections (HAI)

The practice of proper hand hygiene, by health care workers (HCW), is the easiest, most effective measure for preventing hospital-associated infections (HAI) (s.4). The World Health Organization (WHO) defines a HAI as being (s.2):

“(1) An infection [obtained] in hospital by a patient who was admitted for a reason other than that infection. (2) [Infection(s)] occurring in a patient in a hospital or other healthcare facility in whom the infection was not present or incubating at time of admission...[including] infections acquired in the hospital but appearing after discharge, and also occupational infections among staff of facility.”

From a historic perspective, French pharmacists in 1822 verified the eradication of “foul odors” in human corpses by using solutions containing chlorides of lime or soda (s.1). We know today that bacteria or skin flora, such as *Staphylococcus aureus* or *Proteus mirabilis*, cause the “foul odors.” Later on in 1961, the United States Public Health Service developed a Hand Hygiene training film demonstrating proper hand washing techniques for HCWs (s.1). Eventually in 1975 and 1985, the Centers for Disease Prevention and Control (CDC) wrote up guidelines on hand-washing practices for hospitals. The CDC guidelines encouraged washing with non-antimicrobial soap between patient contacts and use of antimicrobial soap before and after invasive procedures or caring for high-risk patients, e.g., the immune-compromised or the elderly (s.1). The Association for Professionals in Infection Control (APIC) developed guidelines for hand antisepsis and hand washing in 1988 and 1995, in which they recommended similar techniques to those of the CDC guidelines. Overall, these guidelines are the standards for HCW to follow and emphasized by the Infection Control Department in efforts to reduce HAIs.

Despite CDC and APIC national guidelines, the literature suggests there is room for improvement as far as hand hygiene compliance by HCW is concerned (s.6). HCW policy compliance to hand hygiene practices is unacceptably low, thus leading to a number of HAIs (s.5-11).

According to the CDC, an estimated 1.7 million cases of U.S. health care-associated infections were reported for 2002 (s.3). Of these cases, 33,269 HAIs reported for newborn in high-risk nurseries, 19,059 for “newborns in well-baby nurseries,” 417, 946 reported for “adults and children in intensive-care units (ICUs), and 1,266,851 for “adults and children outside of ICUs (s.3).” Furthermore, the CDC’s report indicates that 98,987 cases were HAI associated deaths (s.3). To understand how the microorganisms on our skin (skin flora) cause infections, we must understand their microbiology.

There are two major types of skin flora on our skin: (1) normal microorganisms that reside on our skin (resident/commensal flora) and (2) contaminants known as “transient flora” (s.12). The pathogenic potential of resident flora is low, unless introduced via medical devices (e.g., intravenous catheters). Most hospital infections result from cross transmission of transient flora (s.13). Examples of skin flora known to cause major HAI include *Staphylococcus aureus*, *Proteus mirabilis*, *Klebsiella* spp., *Acinetobacter* spp., and *Clostridium difficile*. On a healthy patient’s skin, skin flora heavily colonize the perineal area; other areas of colonization include the trunk, axillae, and upper extremities (s.1). In a hospital environment, patients can shed skin flora to bed linen, patient gowns, bedside furniture or direct contact with HCW. Studies have shown that larger number of microorganisms (a count of $> 10^4$) are transmitted due to wet hands versus dry hands (s.14).

The pathogenesis of HAIs microorganism causes patients to suffer from various ailments. Of the bacteria species mentioned earlier, *Staphylococcus aureus*, *Enterococcus* spp., *Escherichia coli*, and *Clostridium difficile* are predominant in causing HAI (s.1). These bacteria are present in large numbers (a count of 10^9 on our skin), permanent meaning ‘they are always on hand,’ and marked as being potentially pathogenic, which allows them to infect a sterile body site when introduced (s.17). These resident bacteria account for nearly 80% of HAI (s.17). Serious HAIs include the following, as defined by the WHO and the CDC:

- a.) Catheter-Associated Urinary Tract infections (UTI)
- b.) Surgical Site Infections (SSI)
- c.) Healthcare-associated pneumonia
- d.) Healthcare-associated bacterial infections
- e.) Other healthcare-associated infections as defined by the CDC:
Soft-tissue infections, bone and joint infections, cardiovascular system infections
bloodstream infections, lower respiratory tract infections, gastrointestinal system
infections, eye/ear/nose/throat/mouth infections, reproductive tract infections,
central nervous system infections, and systemic infections.

So, how are healthcare-associated infections transmitted? In their *Guidelines for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings*, the CDC outlines three principle routes of transmission: either by patients, healthcare workers, or the healthcare facility’s environment (s.26):

- a.) Contact Transmission:
Divided into two subgroups (direct and indirect), contact transmission is the most common means of transmission. A transfer of microorganisms from one infected person to another without the aid of a contaminated intermediate defines direct transmission, while transfer due to a contaminated intermediate defines indirect transmission. *S. aureus* infections are examples of both direct and indirect infection.
- b.) Droplets Transmission:
Technically a form of contact transmission, droplets transmission is defined as transmission of droplets from the respiratory tract of the infectious person to the susceptible mucosal surfaces of another. An example of a microorganism transmitted via droplets is the influenza virus.

c.) Airborne Transmission:

When either an airborne droplet nuclei or small particle containing infectious agents “remain infective over time and distance,” it is airborne; examples include *M. tuberculosis* and *C. diff* spores.

Infections are avoidable if HCWs follow proper hand washing guidelines outlined by the CDC (s.26).

So what does proper hand hygiene entail? The term hand hygiene incorporates various actions intended to reduce colonization of transient flora and achieved through proper hand washing or hand disinfection. The main objective of hand hygiene is to avoid cross-transmission by removal of dirt and loose skin flora (s.15). Hand washing requires the use of a non-medicated detergent and water when washing (s.15). Hygienic hand washing refers to the same procedure, but with an antiseptic agent added to the detergent. Hand disinfecting requires using an antiseptic solution to clean hands (either medicated soap or alcohol-based solutions) (s.1). Additionally, certain experts refer to the action of ‘de-germing’ as the use of alcohol or detergent based antiseptics (s.16). Hygienic hand rubs (e.g., alcohol gels or lotions) allow individuals to rub hands with a small quantity (2mL to 3mL) of a highly effective, fast acting antiseptic agent (s.15). Yet, these gels do not remove bacterial spores – a highly resistant/durable form of the bacteria that can survive in harsh conditions longer than its living (vegetative) form. Thus, physical hand washing is required to dilute and remove the spores. An example of such an organism is *Clostridium difficile*.

ii. Special Project – Trending for Hospital-Associated *Clostridium difficile*

1. *C. difficile* Pathogenesis

Clostridium difficile is an anaerobic Gram-positive bacillus, whose toxins (toxin A and B) infect the intestinal-tract (s.27). In a healthcare setting, the risk factors for *Clostridium difficile* Infections (CDI) – aka *C. difficile*-associated disease (CDAD) – are exposure to antimicrobials, duration of hospital stay, and advanced age (s.27). The National Nosocomial Infection Surveillance System (NNIS) defines CDI as a patient meeting either of the two following criteria (s.33):

- a) Acute diarrhea (liquid stools for > 12hrs) with/without vomiting or fever (temp. >38C) and no likely noninfectious cause.
- b) Having at least two of the following symptoms: vomiting, nausea, fever >38C, abdominal pain, headache, and 1 of 5 positive lab confirmatory tests (e.g., positive testing toxin in stool sample).

CDI is a ‘three hit’ disease, meaning that two factors are essential: the first is the patient’s antibiotic exposure and the second, picking-up *C. difficile*. In the majority of cases, the patient does not acquire CDI from the first two ‘hits;’ the presence of at least one more factor leads to the onset of CDI. This added factor may derive from various factors such as genetics, the patient being immune-compromised, or the presence of a virulent *C. difficile* strain (s.35).

Usually spread via fecal-oral route, CDI begins by ingestion of the spores, which pass through the acidic environment of the stomach and can survive for months (s.27). Spores tend to germinate into the vegetative form when they reach the small intestine and wait for normal skin flora to be disrupted by antibiotics. Once competing flora are removed, *C. difficile* populates the large intestine and “reproduce in the intestinal crypts,” releasing toxins A and B. The release of these toxins causes severe inflammation, degradation of colonic epithelial cells, pseudomembrane formation, colitis, and watery diarrhea (s.27).

~For visualization of *C. difficile* Pathogenesis, please refer to the Image 1 in Appendix~

2. Clostridium Difficile Infections (CDI) in an Acute Hospital Setting: Rates and Susceptible Populations

CDI Hospital trends have been increasing in the past years (Appendix Image 2). Data from the CDC and various studies show a doubling between 2000-2003, with rates of CDI hospital discharges and only after short hospital stays. Recent statistics show the number of CDI discharge cases have increased to over 300,000 cases in 2005 (from 149,000 cases in 2001) with New England having the highest number of cases (s.27).

Death certificates from the United States and Canada reveal the mortality rates of CDI-patients (Appendix Image 3). In the United States, CDI increased to 23.7 per million in 2004, from an estimated 5.7 per million population in 1999. Quebec hospitals in 2004 showed an increase in 30-day attributed CDI mortality rate of 6.9% versus 1.5% in 1997 among other Canadian hospitals (s.27).

The most susceptible population includes the elderly, patients who are immunocompromised, and those requiring use of antibiotics (s.27). *C. difficile* toxins can be found in stool samples of 15-25% of patients with antibiotic associated diarrhea and more than 95% of patients with pseudomembranous colitis (s.28). This is because spores can survive the acidic environment of the stomach and resist disinfectants. Data suggest that CDIs are less common in children than in adults; rates of colonization increase as children get older: from 6% in children less than 2 years of age to 3% in children older than 2 years of age (s.27). For infants, most studies fail in showing the “epidemiological association between colonization and disease in infants less than 1 year (s.27). The reasoning behind such findings relates to the fact that infants have different skin flora than those found in older children and adults.

3. *C. difficile* Modes of Transmission in a Hospital Setting

Patients, HCW, and the healthcare environment are mediums for *C. difficile* transmission. In a healthcare setting, infected humans (symptomatic or asymptomatic) and various objects (e.g., medical devices) are the two largest reservoirs of *C. difficile* (s.27). Research supports the fact that the most likely mode of transmission of *C. difficile* and other HAIs to the patients is hand carriage from healthcare workers; hospitals where HCW use gloves show a significant decrease of CDI rates (s.27).

Transmission through patient care activity is another mode of *C. difficile* transmission. Examples include fecal-oral transmission due to poor hand hygiene or the sharing of

thermometers used to obtain rectal temperatures (s.27). Poor environmental cleaning allows *C. difficile* spores to survive in the patient's room for an extended period - up to five months and in a reported case, contaminating 49% of CDI patients' rooms (s.27). Thus, HCW can pick up spores from the environment and transmit them to the patient. Other forms of fecal-oral transmission include oral care/suctioning and the administration of medication or feeding with contaminated hands (s.27).

4. Prevention of CDI Onset

Although an enormous amount of data about *Clostridium difficile*'s etiology and its role in hospital infections exist, challenges and questions still surface regarding CDI control measures. Prevention measures must constantly undergo surveillance and improve to ensure that they remain effective against spread of infection. For example, Zafar *et al.* show that a multidisciplinary approach and comprehensive infectious control intervention that incorporates: 1) educating all HCW patients 2) isolation 3) use of concentrated hand soap 4) establishing a centralization/sterilization department 5) installing cart-washer 6) aggressive surveillance and 7) environmental cleaning may reduce CDI incidence by 60% (s.32).

Prevention of transmission of *C. difficile* infections to patients from HCW and the environment requires the adoption and practice of proper hand hygiene and environmental disinfections. For both patients and HCW, the use of soap and water is best to remove spores physically from hands: 1) Hands should be wet before the dispensing of soap, 2) hands should be rubbed for at least 15 seconds to ensure removal of the spores, 3) and finally hands should be rinsed with warm water. Alcohol gels or alcohol-based rubs should be used if hands are not visibly soiled. As mentioned before, alcohol gels and alcohol rubs will NOT kill *C. difficile* spores; alcohol is utilized to enrich growth medium for *C. difficile* recovery (s.33).

HCW handling CDI patients must take extra precautions to ensure that the organism does not spread to others or the environment. An infected patient should be isolated or placed in a cohort with other infected patients. When handling a patient, HCW should wear personal protective equipment (PPE) such as gloves and gowns before entering the room, remove PPE prior to leaving, and wash their hands. Any movement of the patients outside their room should be limited to those dubbed medically necessary (s.27). APIC guidelines recommend that contact precautions continue for two days after diarrhea stops.

High touch surface areas (e.g., patient bedrails, call button, bathroom environment, etc) must be properly disinfected. Properly disinfecting the environment will remove the spores from contaminated surfaces. CDC policy guidelines recommend use of chlorine-based disinfectants or concentrated, vaporized hydrogen peroxide to clean high touch surface areas where spores would reside (s.29). Mayfield *et al.* prove the effectiveness of using a chlorine-based disinfectant (1:10 hypochlorite solution) as an environmental disinfectant. In addition, phenol-based disinfectants (EPA approved) prove effective against spore removal (s.32). However, visible dirt and debris must be removed prior to the use of environmental disinfectants. Use of disinfectants helped reduce *C. difficile*-associated diarrhea (CDAD) incidence rates from 8.3 cases per 1,000 patient days to 3.3 cases (s.31). The least costly and best disinfectant is a simple 1:10 diluted solution of

bleach for daily use, or for a 30-day supply make a 1:5 dilution. This is a practice that Hospital A adopts when disinfecting the patient's environment.

Infection rates will decrease if HCW adhere to preventative policies and protocols for *C. difficile* and other HAI. Continuous education and bringing awareness of CDI to HCW has also proven to reduce rates of CDIs (s.32).

B. Project Rational

i. 2009 National Patient Safety Goal (NPSG)

A majority of the policies focus on proper isolation, antibiotic regulation, continuous surveillance, and educating HCW to reduce or control *C. difficile* infections. When developing public health related policies, it is important to have supporting data to back up proposals; there is a window of opportunity to have all the data compiled, evaluated, and formulated into a policy. Agencies such as the CDC, APIC, SHEA, HICPAC, WHO, and the Joint Commission develop infection control policies founded on solid research data and evidence-based practices.

The Joint Commission's 2009 National Patient Safety Goals (NPSG) encourages improvements focused towards patient safety. Each of the sixteen goals provides solutions and guidelines supported by evidence-based research. The goal specific to my special project is Goal #7: In an acute hospital setting, the goal is to reduce the risk of health care-associated infections due to Multi-Drug Resistant Organisms (MDRO) and *C. difficile*. As part of the NPSG, I conducted a descriptive study that identifies Hospital A's units with increasing CDI rates. Thus, Hospital A's Infection Control team can implement interventions to reduce CDI-rates and meet goal requirements by January 1, 2010 (s.30).

There are thirteen specific 'Elements of Performance' for NPSG 7 (s.30):

- a) Assign responsibility for oversight and coordination
- b) Implementation work plan
- c) Pilot testing
- d) Full hospital-wide implementation
- e) Conduct periodic risk assessments
- f) Educate staff and practitioners
- g) Educate patients and families
- h) Implement surveillance program
- i) Compliance with evidence-based guidelines or best practices
- j) Provide surveillance data to key stakeholders
- k) Policies and practices aimed at reducing the risk of transmission
- l) Implementing lab-based alert system that identifies infected patients
- m) Implementing an alert system that identifies infected readmit/transfer patients

The 2009 NPSG sets an international and national tone for hospitals to follow in relation to a wide variety of care that includes ambulatory health care, behavioral care, various hospital care, disease-specific care, home care, and long-term care. Healthcare facilities develop policies that ensure compliance to the NPSG.

C. Relationships to Public Health Values – Public Health Ethics

Healthcare infection prevention initiatives are top priorities throughout the country not only due to increasing incidence of resistant organisms but also concern about helping everyone including healthcare workers, patients and family to understand their role in prevention strategies. Multidrug resistant organisms prevention including *C. difficile* and hand hygiene compliance are two of the National Patient Safety Goals for 2009. *C. difficile* has recently been in the news due to a national conference and a prevalence study conducted by APIC under the leadership of Bill Jarvis, MD. APIC has also just released their guide on eliminating *C. difficile* with Dr. Archibald and Loretta Litz-Fauerbach being contributing authors in the document. So there are many opportunities to explore and contribute to this field of knowledge.

Preventing the onset of CDI is an ethical issue when identifying risk factors of disease and prevention. Public health ethics are the principles and values that guide actions created to promote health and prevent disease or injury in the population (s.37). In a hospital setting for example, HCW have a responsibility to prevent transmitting *C. difficile* when caring for patients; thus, HCW must practice good hand hygiene and wear PPE (e.g., gowns and gloves) whenever they are in contact with CDI patients.

From the patient's perspective, they trust HCW to a degree of professionalism, expecting that HCW will address the infection and not worsen it due to poor care. This "trusting of HCW" falls under "professional ethics," which is role oriented – requiring HCW to "act in virtuous" ways as they undertake the responsibility for patient care (s.37).

Controlling hospital incidence of *C. difficile* can also be seen as a social justice issue. HCW will benefit patients no matter their socioeconomic status.

D. Internship and Special Project Objectives

- a) Internship Objective: To understand the process behind developing and implementing hospital-wide Infection Prevention & Control Policies from an epidemiological perspective:
 1. Gain basic knowledge about infection prevention and control and hospital epidemiology.
 2. Research and understand evidence-based data from the APIC, CDC, HICPAC, Joint Commission, and SHEA

- b) Special Project Objectives: To understand the critical components for preventing hospital-associated *C. difficile* infections and to assist in evaluating current state of practice in accordance with National Patient Safety Goal #7.03.01
 1. To analyze Acute Hospital A's database of CDI for trends using Epi-Info (version 3.5.1) and Microsoft® Excel.

2. Examining the correlation between Hospital-Associated *C. difficile* and hospital units.
3. Explain findings in relation to hospital infection prevention and control policies and practices.

II. Methodology

A. Population Characteristics

Hospital A's patient data set – from January 2004 - December 2008 – that I evaluated consisted of 752 new CDI-patients. All 752 patients acquired CDI from the hospital, meaning the infection was hospital-associated. Hospital A defines hospital-associated CDI as any inpatient who has stayed for at least 7 days and returns a stool sample that tests positive for *C. difficile* toxins.

The data only provided hospital admission date (Admittance), the hospital service provided (HS), the hospital unit (HU), and the date the patient tested positive for *C. difficile* toxin (Date Positive). The data did not provide the patient's age, gender, or race for two reasons: 1) to keep the data unidentifiable and 2) to not violate IRB/HIPPA regulations for patient confidentiality. Therefore, I could not run statistics for these three variables so a descriptive study was used to trend CDI-patient cases (in relation to HU and HS).

B. Specific Methods Used and Justification for Selected Method

As stated, I conducted a **descriptive study** of the 752 new CDI-patients. In relation to a similar 2009 CDC study, the two **variables** I chose to trend were the incidence rates and hospital units (e.g., pediatrics, intensive care unit, etc) (s.34). I also did CDI-case counts for hospital services (e.g., internal medicine, surgery, oncology, etc). After defining the necessary variables, the following **questions** were asked:

- 1) What is the total New CDI-patient case count for each HU and each HS over a five-year period (2004-2008)?
- 2) How do CDI-patient incidence rates (per 1,000 patient days) vary with HU from 2004 to 2008?
- 3) Are there any new insights based on the CDI-patient incidence rates and other aspects of the descriptive study?
- 4) How do the answers to the previous questions relate to the NPSG #7 for *C. difficile* and hospital policy?

From the 752 CDI-patients, HS and HU were tallied and graphed for both a five-year overall trend and year-by-year trends (Question 1). Based on data from the first question, I looked for an increase of CDI-patient cases, per HU (Question 2). The last two study questions are answered in the "Discussion Section."

Counts were collected using the CDC's Epi Info™ program (version 3.5.1) and the total patient days, per HU, was used as the denominator to calculate incidence rates. The patient data set was stored and analyzed using hospital computers in order to prevent violation of IRB/HIPPA regulations for patient confidentiality. Once analysis was completed and finalized for trends, graphs were created using Microsoft® Excel.

C. Issues with applications/manner of addressing the issue

Descriptive studies are limited to the type of information they provide. In my case, a descriptive study design only helped in determining the incidence rates of HU so that future initiatives to reduce those increasing rates can be implemented. However, descriptive studies identify areas for further research since the study design can only provide general information. To establish concrete causation of CDI, other risk factors must be considered (e.g., antimicrobial exposure) and demographic factors must be controlled for in the analysis.

D. Stakeholder involvement

The stakeholders involved/invested into the project include Acute Hospital A, the Infection Prevention and Control Department of Acute Hospital A, and other healthcare workers (e.g., physicians, nurses, technicians, etc). The patients themselves are indirectly invested, for infection control practices are stressed to ensure patient safety as well as the safety of those who come in contact with them.

III. Results and Interpretation

Over the five-year data set, the 752 CDI-patient cases were counted from 21 hospital units and ranked in decreasing order. The CDI incidence rate, for the HU, was expressed as the number of CDI-patients (752), divided by the total number of patient days (for the five years), then multiplied by 1,000. The average incidence rate, for 2003-2008, was 0.88 CDI-patient cases per 1,000 patient days (Figure 1).

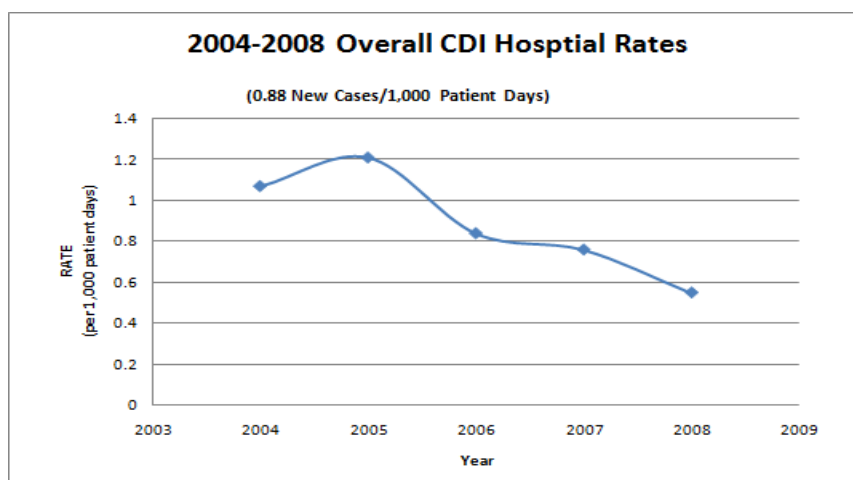


Figure 1: Hospital-wide CDI-rates have decreased

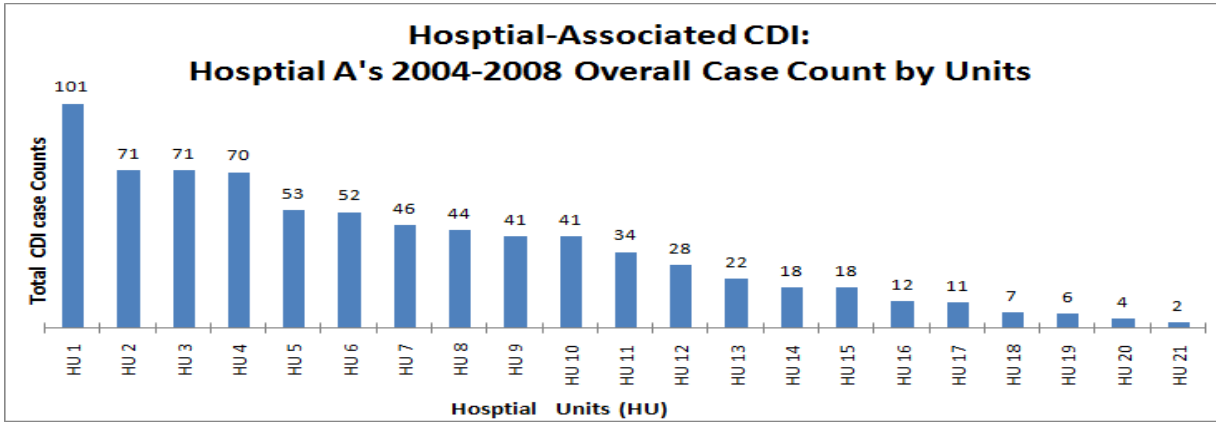


Figure 2: The location of the patient when tested positive for *C. difficile* Toxin. The numbers represent the total cases, for each HU, over a five year period.

Over the five-year data, 752 CDI-patient, in Hospital A, utilized a combination of 39 different HS. These services are not unit specific, thus a particular services can be provided on multiple units.

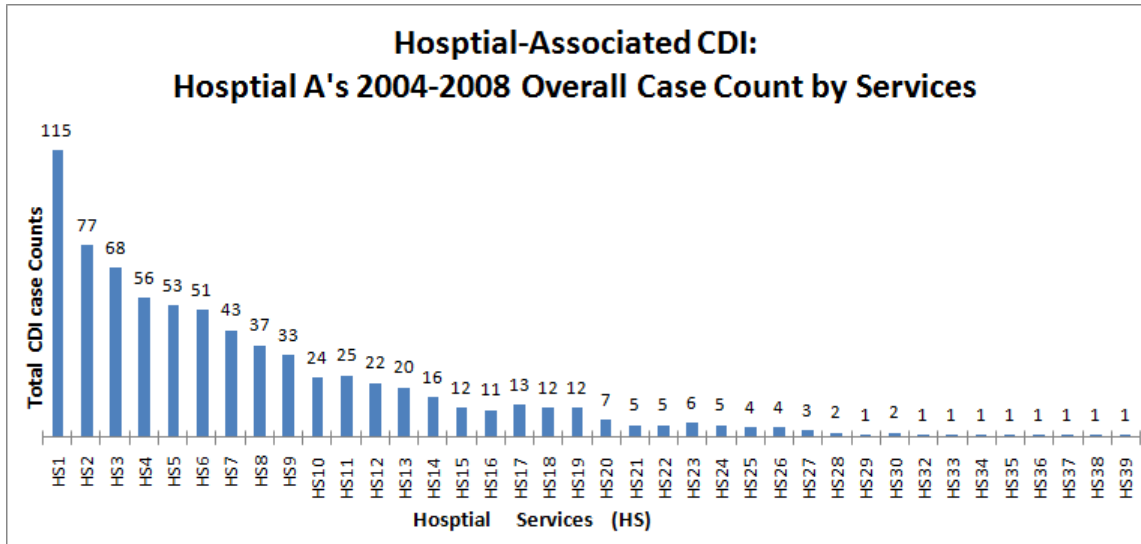


Figure 3: Total count of initial HS provided on admission. Case count by services was used to confirm patient count and not associated with CDI onset.

Of the 21 HU, 57% (12 HU) show a decrease of incidence rates over the 5 year-period while 43% (9 HU) show an increase (Figures 4-12). The average rates of all nine units is reported as “new cases per 1000 patient days (PD)”: 1.29 (HU2), 1.45 (HU3), 1.15 (HU5), 1.06 (HU6), 0.73 (HU8), 1.73 (HU9), 0.64 (HU11), 1.24 (HU18), 0.52 (HU19).

2004-2008 Incidence Rates for HU 2

(1.29 New Cases/1,000 Patient Days)

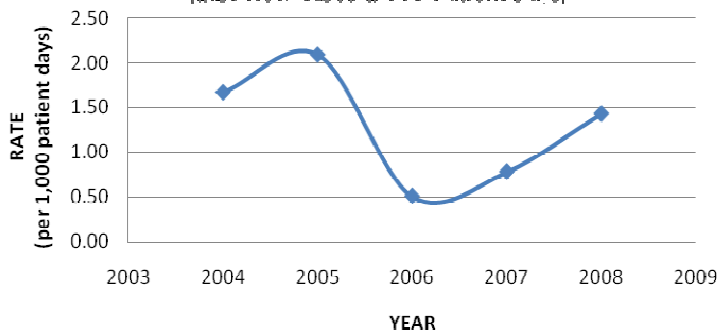


Figure 4: Annual HU2 incidence rates

2004-2008 Incidence Rates for HU 3

(1.45 New Cases/1,000 Patient Days)

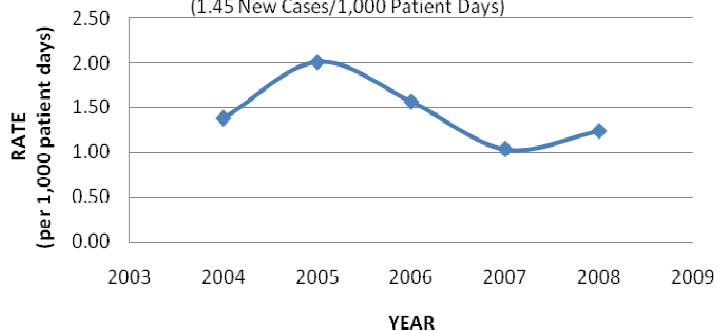


Figure 5: Annual HU3 incidence rates

In 2005, HU2 incidence increased to its highest rate of 2.09 cases per 1000 PD from its 2004 rate of 1.67 cases per 1000 PD (Figure 4). HU2 decreased to its lowest rate of 0.51 cases per 1000 PD in 2006; then at the end of 2008 it increased to 1.43 cases per 1000 PD. In Figure 5, HU3 follows a similar trending pattern as HU2, with only a slight rate increase from 2007 (1.04 cases per 1000 PD) to 2008 (1.24 cases per 1000 PD).

HU5 rate follows a similar S-curve trend as HU2 and HU3, while more than doubling its lowest point in 2006 (0.75 cases per 1000 PD) to 2008 (1.64 cases per 1000 PD). HU 6, shows a W-shaped curve, with its lowest rate of 0.53 cases per 1000 PD (2007) compared to last year's rate of 1.16 cases per 1000 PD – more than doubled (Figure 7).

2004-2008 Incidence Rates for HU 5

(1.15 New Cases/1,000 Patient Days)

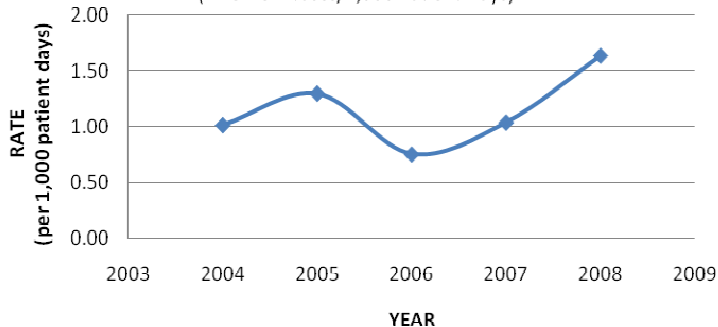


Figure 6: Annual HU5 incidence rates

2004-2008 Incidence Rates for HU 6

(1.06 New Cases/1,000 Patient Days)

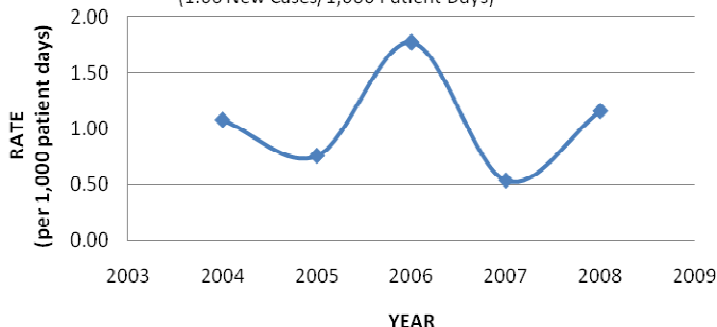


Figure 7: Annual HU6 incidence rates

2004-2008 Incidence Rates for HU 8

(0.74 New Cases/1,000 Patient Days)

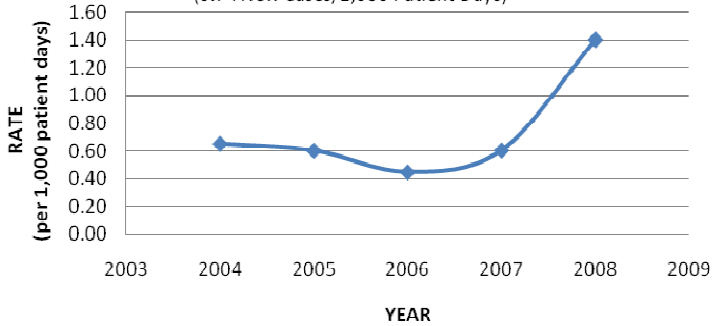


Figure 8: Annual HU8 incidence rates

2004-2008 Incidence Rates for HU 9

(1.73 New Cases/1,000 Patient Days)

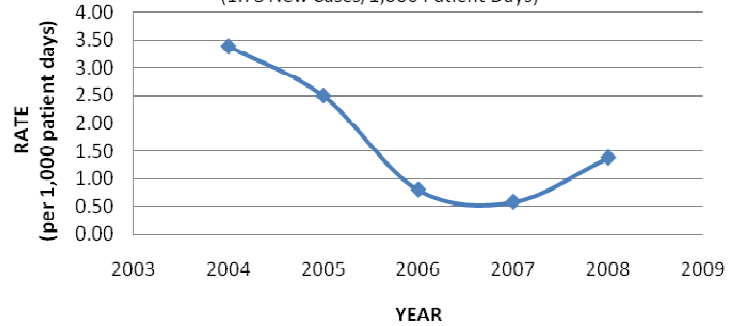


Figure 9: Annual HU9 incidence rates

HU8 shows a steady decline in incidence, then in 2008 it leaps to its highest rate of 1.4 cases per 1000 PD (Figure 8). HU9, on the other hand, experiences a large rate decline from 3.39 cases per 1000 PD (2004) to 0.58 cases per 1000 PD (2007), then reaches 1.38 cases per 1000 PD (2008).

2004-2008 Incidence Rates for HU 11

(0.64 New Cases/1,000 Patient Days)

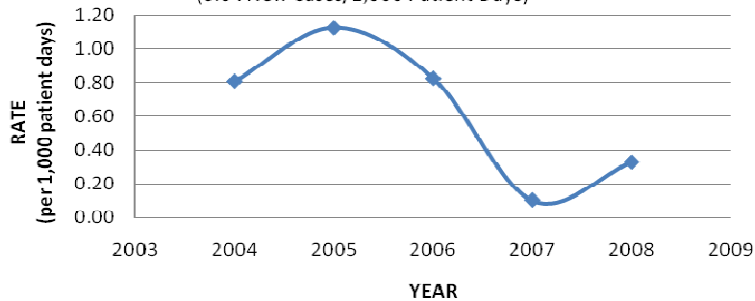


Figure 10: Annual HU11 incidence rates

HU 11 shows similar S-curve trending as HU2, 3, and 5 with its lowest rate in 2007 (0.1 cases per 1000 PD) to a rate increase at the end 2008 (0.33 cases per 1000 PD).

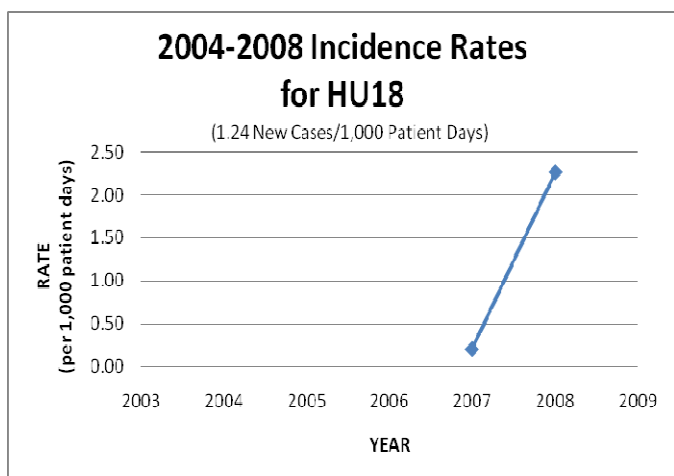


Figure 11: Annual HU18 incidence rates

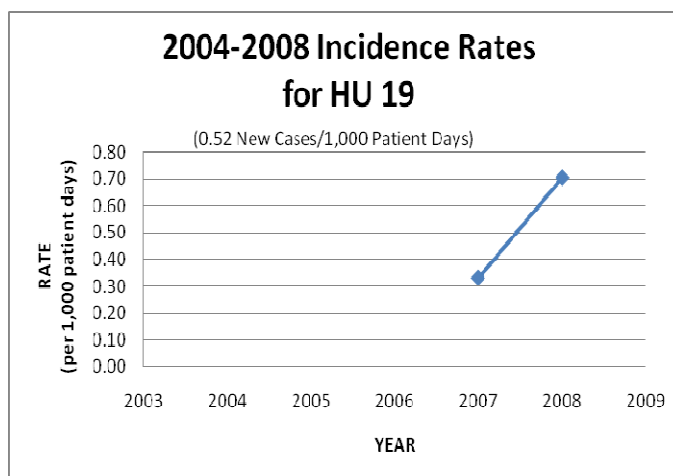


Figure 12: Annual HU19 incidence rates

Both HU18 and HU19 begin to yield incidence rates in 2007 since they are newer units. HU18's rate at the end of 2007 is 0.21 cases per 1000 PD and ends 2008 with a rate of 2.27 cases per 1000 PD (Figure 11). Similarly, HU19's rate at the end of 2007 is 0.33 cases per 1000 PD and ends 2008 with a rate of 0.7 cases per 1000 PD (Figure 12).

Overall, the analysis and results met Special Project Objectives 1 and 2, while the findings are discussed in the next section (Objective 3). Over the internship experience, the knowledge gained about infection prevention and control and hospital epidemiology (Internship Objective 1) justified my project's methodology and study approach. While reading related research on infection control and attending webinars, I was able to 1) validate my reasoning behind the project's analysis; and 2) use the findings to manage, develop, and distribute *C. difficile* patient-education brochures hospital wide (Internship Objective 2).

IV. Discussion

Overall, Hospital A's CDI-rates have decreased from a high of 1.2 New cases/1,000 PD to a low of 0.55 New cases/1,000 PD. The increasing CDI rates of the nine identified units *may be* associated with a combination of multiple factors and not attributed to one main reason; improper hand hygiene, inadequate cleaning of the patient's room, antibiotic usage, or patient's length of stay. Remember, CDI is a "three hit" disease. It should be noted that HU 2, 3, 5, 6, 11, and 18 were "Medical/Surgical" units, HU 9 and 19 were "Intensive Care" units, and HU 8 was the "Pediatric" unit (both medical and surgical). These units house the most susceptible patients (e.g, the elderly and immune-compromised), thus *may be* an explanation of why rates were high in these 9 units relative to the other 12 units.

Beginning 2005, Hospital A's infection control personnel identified an increase of CDI cases in a critical care unit (s.36). To reduce incidence, a hospital-wide *C. difficile* intervention was implemented for the single unit. The intervention entailed assessing procedures and practices, utilizing bleach cleaners to disinfect patient rooms, educating staff and patients about the pathogenesis of *C. difficile*, stressing proper hand hygiene practices, and constant surveillance. As a result, rates began to decline; this *may be* a possible explanation for the decrease (beginning in 2005) within HU 2, 3, 5, 8, 9 and 11 as well as the for the overall hospital rate.

Re-implementation of *C. difficile* interventions occurred whenever CDI-rates began to increase, possibly explains HU6's rate decrease from 1.77 cases per 1000 PD (2006) to 0.53 cases per 1000 PD (2007).

A rate for hospital services could not be calculated or associated with the onset of CDI. Since hospital services are provided on multiple floors, a particular service is not specific to a unit. Therefore, the service counts (Figure 2) were ONLY used to confirm the number of new CDI cases and were not associated with CDI onset.

Finally, the nine identified HU have experienced an increase in new cases per 1000 PD since 2007. Therefore, hospital policy requires re-implementing the *C. difficile* intervention to these specific units in an effort to reduce the risk of health care-associated infections by *C. difficile* (National Patient Safety Goal #7.03.01).

A. Project Strengths

The project conducted had three major strengths. First, I had access to a vast amount of infection control resources to support my methodology and confirm my results. For example, the Hospital A's Infection Control Department has a library filled with infection control policies, guidelines, and research from the CDC, APIC, and the Joint Commission.

Second, Hospital A's infection control director and hospital epidemiologists are influential voices within the realm of infection control. Their constant mentoring and evaluation of my study design and methodology ensured that I provide evidence based information when reporting my results.

Third, I was able to utilize a data set directly from the hospital. The data set included a large patient population (n=752) and identify only specific units with increasing CDI rates. From the data results, the *C.difficile* intervention could be focused on those specific units.

B. Project Limitations

The project conducted had three major limitations. First, due to lack of gender, race, and age in the data set, I could not report all patient characteristics. Therefore, I could not correlate my findings to other CDI demographic studies.

Second, the study requires more concrete evidence to determine causality of CDI. Determining incidence rate per unit is not sufficient enough to determine CDI causality – it can only identify which units had the highest rates. As mentioned previously, CDI is a “three hit disease,” requiring at least three factors to justify causality. However, identifying the third factor requires a case-by-case patient study, which means accessing hospital patient records. Doing such research without IRB consent would violate regulations; therefore, these variables and other identifiable information were removed.

Third, this was a descriptive study employing univariate analyses. Thus, although one can observe that implementation of *C. difficile* interventions was followed by declining CDI-rates; a stronger study design, an experimental study, is needed to evaluate whether there is a causal relationship. For such an experiment, the patient's length-of-stay and their antibiotic history should be included.

C. Generalizability

In relation to generalizability, the results shared are applicable to Hospital A and used as a starting-point to identify susceptible units. Other hospitals may use a descriptive study, such as this one, to calculate rates for *C. difficile* and/or other MDROs.

V. Implications

A. Project's Relation to the Internship and Contribution to the Public Health Field

Within the setting of healthcare facilities, *Clostridium difficile* is a major problem. Patients may suffer from diarrhea and other ailments if hospital policies are not set to reduce *C. difficile* from the patient's environment, enforce proper hand hygiene practices when handling patients, educating staff, and maintaining surveillance. Thus, HCW must comply with infection control and prevention policies to ensure patient's safety and reduce rates of HAI.

As part of the National Patient Safety Goal #7, the Joint Commission has mandated healthcare facilities to implement evidence-based practices to prevent hospital associated CDI by January 1, 2010 (s.30). With the descriptive data results from my project, Hospital A's infection control department will direct efforts to meet the NPSG by following the goal's 13 Elements of Performance.

In relation to public health and hospital care, any intervention requires first assigning responsibility to an individual or department (e.g., infection control) to coordinate a work plan. Only after the work plan undergoes pilot testing can it be implemented hospital-wide. Periodic risk assessments are conducted and findings reported to key stakeholders. Findings are used as evidence-based data to support policies aimed at reducing the risk of disease transmission and educating staff, practitioners, patients and families. Implementation of a surveillance program ensures periodic assessments and compliance with both guidelines and best practices. In conjunction with a surveillance program, utilizing lab-based alert systems help identify infected patients (new, readmits, or transfer patients).

B. MPH competencies strengthened

The special project satisfies three of the ten MPH Core Competencies:

- 1) Competency #1 – **Monitoring health status to identify and solve community health problems.** Due to the severity of CDI and other HAI, hospital surveillance programs are set in place to monitor, identify, and reduce the onset of a hospital-wide disease

pandemic. One of the NPSG 7's criteria requires healthcare facilities to monitor MDROs and *C. difficile*.

- 2) Competency #9 – **Conducting research for new insights and innovative solutions to health problems.** My special project required utilizing an epidemiological research approach to evaluate incidence rates for CDI-patients. The project finding provides Hospital A's Infection Control Department with insight to units with increasing CDI rates.
- 3) Competency #10 – **Communicating effectively with public health constituencies in oral and written forms.** In conjunction with Competency #9, project findings were discussed with Hospital A's Infection Control Director and hospital epidemiologist before presenting information in a written format.

C. Concentration Competencies Strengthened

The special project satisfies three of the seven Management and Policy Concentration Competencies:

- 1) Competency #3 – **Identifying, retrieving, summarizing, managing, and communicating public health information.** In relation to CDI, the aim of my project was to identify hospital units with increasing patient incidence rates. Of the 21 hospital units, 9 were identified as having increasing incidence rates of new CDI-patient cases. The information was organized and communicated to Hospital A's Infection Control Department so it can intervene and require identified units to comply with CDI policy. In general, hospitals must comply with national infection control policies and reduce CDI rates as part of the NPSG #7.
- 2) Competency #6 – **Monitor and evaluate programs for their effectiveness and quality.** In conjunction with Competency #3, Hospital A will evaluate whether established CDI interventions are effective. Depending on the unit, could increasing rates be attributed to lack of hand hygiene compliance or are there issues with the unit's antimicrobial stewardship? Environmental cleaning practices could also be assessed, to reduce the number of *C. difficile* spores.
- 3) Competency #7 – **The application of principles and methods of policy development and analysis of key public health issues.** An initial step to policy development requires evidence-based information to justify it. The NPSG were defined by evidence-based data and research; they emphasize patient safety as an aim for all healthcare facilities.

D. Lessons learned/Recommendations for Future Projects

The most important lesson I learned was the connection between hospital epidemiological data and policy development. Well-formulated hospital policies rely on evidence-based data! Sure, I "learned" that epidemiological research provides data for future

policy development, but it was not until my internship that I REALIZED the connection. Policy students should understand this first when they decide to develop future public health policies.

As far as future studies are concerned, a multiple regression study can be conducted to determine whether a causal relationship exists between other independent and dependent variables. For example, it would be interesting to study the relationship between particular hospital procedures (as the third “hit” of *C. difficile*’s “three-hit” system) and the rate of infections. Such a study would consider three variables: 1) a patient’s antimicrobial usage and 2) location of where susceptible patients can pick up *C. difficile* 3) the hospital procedure the patient underwent and 4) the patient’s length of stay. Another important study would be to conduct a randomized controlled trial to evaluate the effectiveness of the *C. difficile* intervention program implemented by the hospital, whereby hospital units can be randomized into experimental and control groups.

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VII. APPENDIX

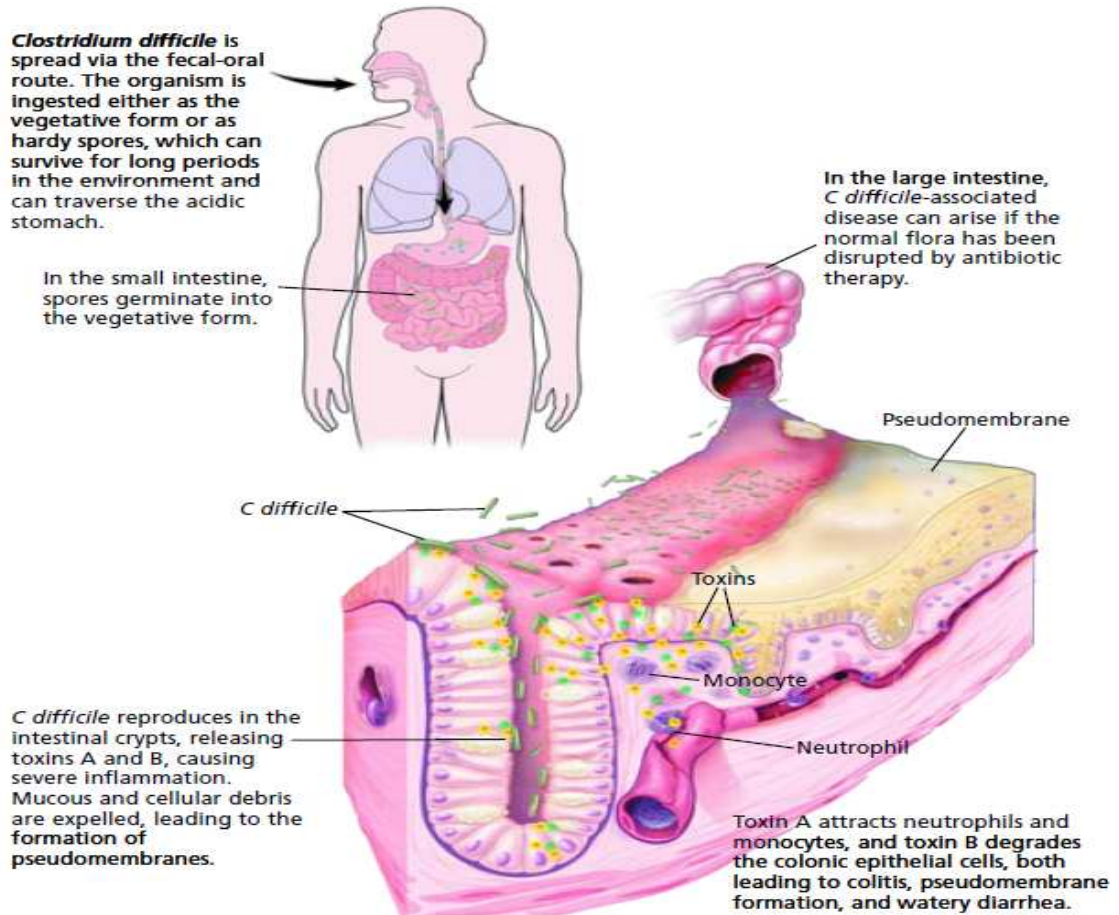


Image 1: Pathogenic pathway of *Clostridium difficile*.

Source: CDC. http://cdc.gov/ncidod/dhqp/pdf/infDis/Cdiff_CCJM02_06.pdf

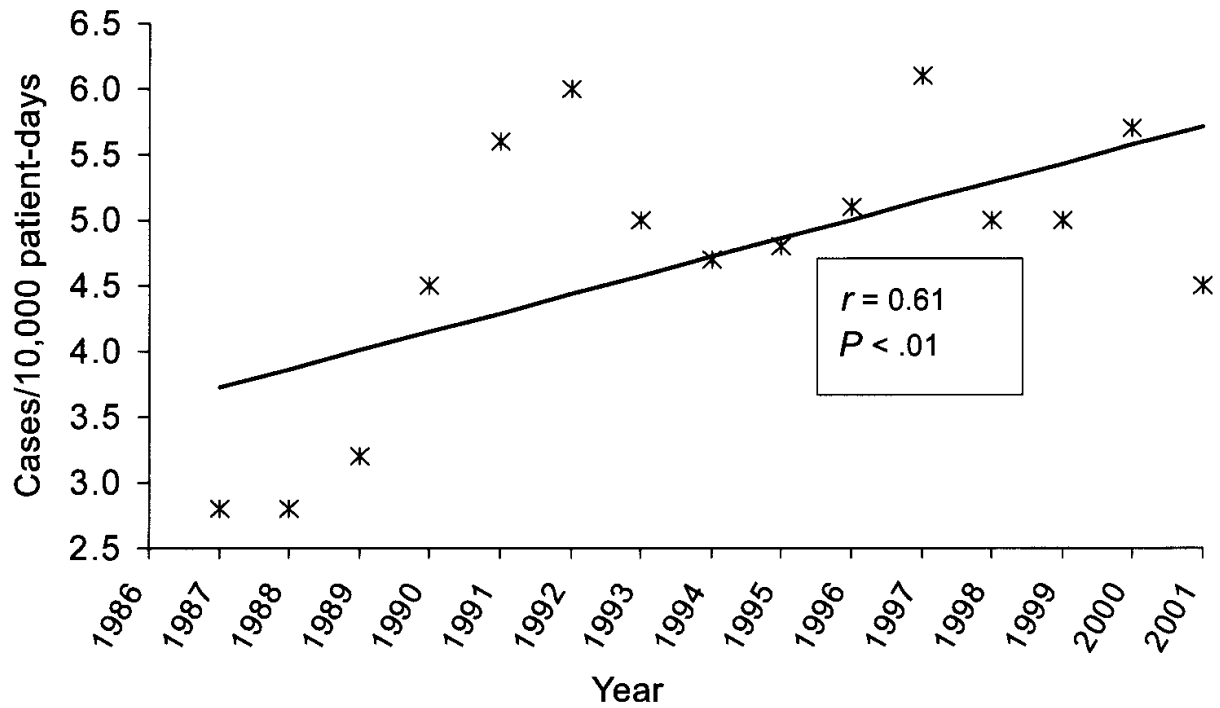


Image 2 Annual CDI rates for hospitals with over 500 beds, by intensive care unit surveillance component (National Nosocomial Infections Surveillance System, 1987–2001).
Source: Archibald et al. JID 2004.

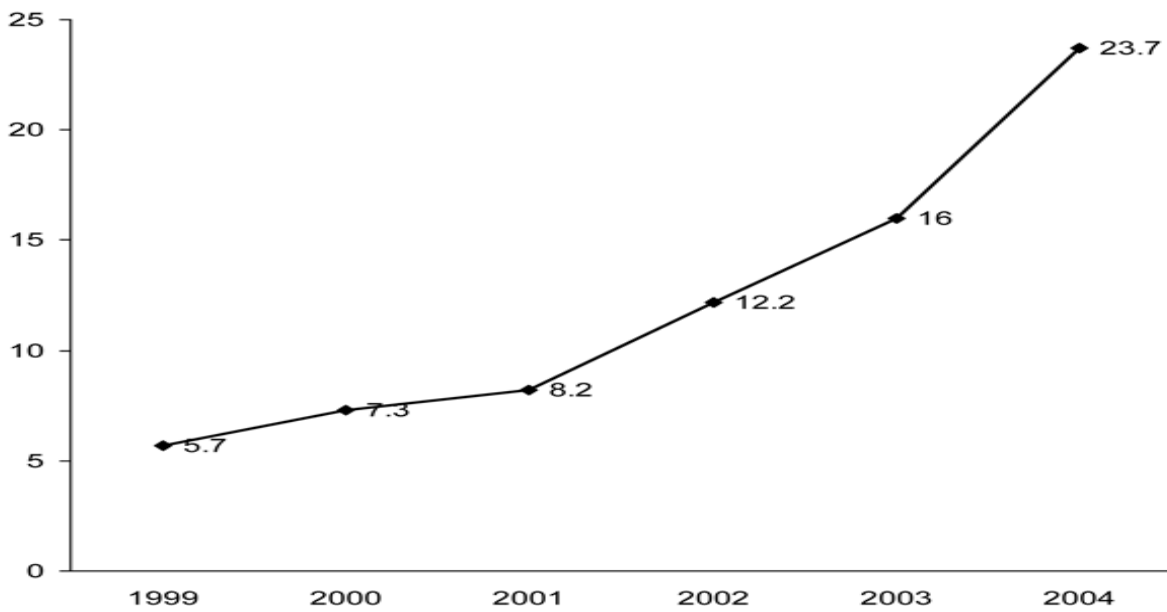


Image 3: Yearly *Clostridium difficile*-related mortality rates per million population, United States, 1999–2004.
Source: McDonald et al. CDI in Patients Discharged from US Short-stay Hospitals; CDC, 2006

