University of Kentucky
UKnowledge

DNP Projects

College of Nursing

2017

Implementing a Patient Hand-Hygiene Protocol to Decrease *Clostridium Difficile* Infections in the Acute Care Setting

Lydia S. Mendez
University of Kentucky, lscrow01@gmail.com

STUDENT AGREEMENT:

I represent that my DNP Project is my original work. Proper attribution has been given to all outside sources. I understand that I am solely responsible for obtaining any needed copyright permissions. I have obtained and attached hereto needed written permission statements(s) from the owner(s) of each third-party copyrighted matter to be included in my work, allowing electronic distribution (if such use is not permitted by the fair use doctrine).

I hereby grant to The University of Kentucky and its agents a royalty-free, non-exclusive and irrevocable license to archive and make accessible my work in whole or in part in all forms of media, now or hereafter known. I agree that the document mentioned above may be made available immediately for worldwide access unless a preapproved embargo applies. I also authorize that the bibliographic information of the document be accessible for harvesting and reuse by third-party discovery tools such as search engines and indexing services in order to maximize the online discoverability of the document. I retain all other ownership rights to the copyright of my work. I also retain the right to use in future works (such as articles or books) all or part of my work. I understand that I am free to register the copyright to my work.

REVIEW, APPROVAL AND ACCEPTANCE

The document mentioned above has been reviewed and accepted by the student's advisor, on behalf of the advisory committee, and by the Assistant Dean for MSN and DNP Studies, on behalf of the program; we verify that this is the final, approved version of the student's DNP Project including all changes required by the advisory committee. The undersigned agree to abide by the statements above.

Lydia S. Mendez, Student

Dr. Sheila Melander, Advisor

DNP Final Project Report

Implementing a Patient Hand-Hygiene Protocol to Decrease *Clostridium Difficile* Infections in the Acute Care Setting

Lydia S. Mendez, BSN, CNRN, RN-BC

University of Kentucky

College of Nursing

Fall 2017

Sheila Melander PhD, APRN, ACNP-BC, FAANP, FCCM, FAAN – Committee Chair

Melanie Hardin-Pierce, DNP, APRN, ACNP-BC – Committee Member

Lewis Perkins, DNP, APRN, GNP-BC, NEA-BC – Committee Member

Kristin Pickerell, DNP, RN, NE-BC, CPHQ – Committee Member/Clinical Mentor

Dedication

This work and my DNP Project is dedicated to my daughters, who have had to endure the last three years with my busy, unrelenting schedule. These girls have always been able to keep me smiling and divert my attention and anxieties in other directions. I hope that they can see this accomplishment and know that they can do anything. This is for my husband, who may not always understand everything that I have done but has supported me throughout this journey. This is for my parents, who understand me and have always reminded me to look at the light at the end of the tunnel. Their never ending support is appreciated more than I can put into words, thank you. This is for my brothers, both of whom are nurses and so easily relate to my everyday work and school life.

Acknowledgements

I would like to express my appreciation and thanks to my advisor Dr. Sheila Melander. Thank you for your incredible help as an advisor, picking me up late in the program and supporting my project idea. Your supportive words and assurance that I will get through this journey in one piece has always been needed and appreciated. I would like to thank my committee members Dr. Hardin-Pierce and Dr. Lewis Perkins for taking the time to support my idea and lend a helping hand. A big thanks to my clinical mentor Dr. Kristen Pickerell, who supported my idea from day one, provided me with a multitude of information, and helped me tweak this project into what it has become. Thank you for answering my random texts without frustration and always being cheerful.

I would like to thank some special members of the University of Kentucky and Norton Healthcare who have mentored me throughout this study: Betty Hayes (mental mentor) for always supporting me and helping me be optimistic, your kindness is like no one I've ever met; Karen Ross (nurse manager) and Becky Blakeman (assistant nurse manager) for working with my schedule and being cheerleaders for me during this journey; Dr. Amanda Wiggins (statistician) for meeting with me on multiple occasions and sharing your statistical knowledge; Dr. Michelle Pendleton for helping smooth out the bumpy data collection road and always having time available for consultation; Whitney Kurtz-Ogilvie (writing specialist) for your guidance and helping me flourish my study into words and on to paper; and last, but not least, to all of my classmates and coworkers (especially, Sunita, Christine, Dawn, and Mike); each person has contributed to my growth in this grad school journey and helped make it all worthwhile. Many thanks to Norton Healthcare for sponsoring me to achieve my DNP at the University of Kentucky.

This Doctor of Nursing Practice project and program of study was fully funded through the University of Kentucky College of Nursing and Norton Healthcare academic-practice partnership.

Table of Contents

List of Tables

List of Figures

Abstract

PURPOSE: The purpose of this study was to develop and implement a patient hand hygiene protocol (PHHP) to improve patient outcomes, specifically to decrease the rates of *clostridium difficile* infections (CDI) at Norton Hospital (NH) and Norton Audubon Hospital (NAH) in Louisville, Kentucky.

METHODS: This was a multi-center, quasi-experimental study that implemented a PHHP on three units at two hospitals in the Norton Healthcare system. The sample consisted of 159 patients in the pre-intervention period and 18 patients in the intervention period. A retrospective records review was performed to analyze specific demographic variables.

RESULTS: No differences in age and gender were found between the pre-intervention and intervention groups. The groups showed no difference in gastric antacid and antibiotic usage, prior to and during admission. A control chart illustrated CDI rates between NH and NAH for a 21-month time period. Both facilities demonstrated common cause variation with no significant trends.

CONCLUSION: CDI development is multifaceted; Risks include age, diagnoses, comorbidities, and need for antibiotics. CDI rates at NH and NAH were variable and unpredictable, indicating a need for extensive research into additional preventative measures. Engaging patients and families in hand hygiene can strengthen knowledge and attitudes about hospital acquired infection prevention.

Implementing a Patient Hand-Hygiene Protocol to Decrease *Clostridium Difficile* Infections in the Acute Care Setting

Background

Hand hygiene reduces the spread of infection, specifically hospital acquired infections (HAIs; Larson, 1999). HAIs are likely the most common type of complication for patients who are hospitalized (Patient Safety Network, 2016). According to Cao et al. (2016), nearly one-quarter of patients discharged from an acute care hospital had at least one multidrug-resistant organism (MDRO) on their hands at discharge. In 2011, there were an estimated 722,000 HAIs in U.S. acute care hospitals, with about 75,000 patients dying during hospitalization (Magill et al., 2014). Of those HAIs, 80,400 were hospital-onset *clostridium difficile* infections (CDI or C. Diff). According to Magee et al (2015), a CDI in 2011 added approximately $7,285 in additional hospital costs per patient and 55% of patients experienced a longer hospital stay of nearly five days. The CDC provides a HAI progress report that displays HAI statistics based on the national average and local data. Based on 2014 data, among the 69 hospitals in Kentucky, 14% had a standardized infection ratio (SIR) that was significantly higher than the national SIR of 0.92 (CDC, 2016, pg. 64).

Recently there has been an increased focus on the issue of HAI prevention, due to the change in reimbursement from the Centers for Medicare and Medicaid Services (CMS) for costs associated with the care and treatment of these infections (Conway, 2013). Evidence based practice guidelines have been developed by the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) to help prevent HAIs from occurring. These guidelines focus on bundling care for patients with diarrhea and suspected CDI. Guidelines for CDI prevention include antibiotic stewardship, contact precautions, rapid fecal testing for diagnosis, environmental cleaning with bleach, and hand hygiene with soap and water (Witt & Barnes, 2013). Both the CDC and the WHO recommend instituting healthcare worker hand hygiene guidelines to reduce the spread and development of HAIs (CDC, 2002; WHO 2009). The current quality measures address infection prevention by the healthcare worker, but these measures fail to adequately address the importance of patient hand hygiene (Cao et al., 2016). There are no current practice measures in place at the four adult hospitals at Norton Healthcare that focus specifically on patient hand hygiene related to HAI prevention.

Purpose

The purpose of this study was to develop and implement a patient hand hygiene protocol (PHHP) to improve patient outcomes, specifically to decrease the rates of CDI at Norton Hospital (NH) and Norton Audubon Hospital (NAH). The study objectives were to identify the one year incidence of CDI rates among patients at NAH and NH between January 1, 2016 and December 31, 2016 and to use this as pre-intervention data to compare with the intervention period of August 7, 2017 through September 29, 2017. The pre-intervention period was also narrowed down to August 2016 through September 2016 so as to compare an equal time period to the intervention phase. The primary investigator then developed a PHHP based on current evidence based practice and implemented this protocol in the medical/surgical and oncology telemetry unit at NAH and the renal telemetry units at NH from August 7, 2017 through September 29, 2017. Prior to and after implementation of the PHHP, the questions to be addressed were:

1. How many incidences of CDI occurred during the pre-intervention period of the 2016 calendar year at both hospitals?
2. How many incidences of CDI occurred during the narrowed pre-intervention period of August and September 2016 at both hospitals and within the specific units?
3. How many incidences of CDI occurred during the intervention period within the specified units at NAH and NH?
4. How many incidences of CDI occurred during the intervention period hospital wide at NAH and NH?
5. What variables might contribute to the incidences of CDI during both the pre-intervention and intervention periods?

Methods

This was a multi-center, quasi-experimental study. The study consisted of two phases adapted from a PHHP developed by Pokrywka et al. (2014). The first phase consisted of educating nursing staff from the selected units and implementing the PHHP. The second phase consisted of a retrospective review of data, and gathering the amount of CDI occurrences prior to the implementation of the PHHP (January 1, 2016 and December 31, 2016) and during the intervention period on the chosen units at both hospitals.

Setting

The Norton Healthcare system is the largest in the Louisville, Kentucky region and includes four adult hospitals and one pediatric hospital, along with many primary and urgent care centers available for the medical needs of the residents in Louisville and the surrounding counties of Kentucky and Southern Indiana. Of the five hospitals, NH and NAH were the focus of this study. NH is a 379 private bed facility that houses adult patients, ages 18 and older. The units that the study occurred on care for patients with renal disorders and general medical and surgical patients. NAH is a 432-bed acute care facility that houses adult patients, ages 18 and older. The unit that this study occurred on cares for oncology patients and general medical and surgical patients. These units were chosen to pilot the study because they had the highest incidence of CDI at their respective hospitals in 2016.

Sample

The sample consisted of the medical records of 159 patients for the pre-intervention period and 18 patients for the intervention period. The records of all patients who met inclusion criteria between January 2016 and December 2016 (pre-intervention) and between August 7, 2017 and September 29, 2017 were included. Both pre-intervention and intervention period outcomes were compared. Inclusion criteria encompassed adult patients 18 years and older who were admitted to the specific units and tested positive for hospital-onset CDI. The CDI was considered hospital-onset if there was confirmed laboratory testing after 72 hours of admission. Exclusion criteria consisted of patients who tested positive for a CDI within the first 72 hours of admission and those with a length of stay shorter than three days. The definition of CDI that was used was: “A toxin-producing C. difficile organism detected by culture or other laboratory means performed on an unformed stool sample (must conform to the container)” (CDC, 2017, p. 20). Patient-related variables were collected in order to compare variables that may have contributed to the differences in the incidences of CDI. These included: age, sex, hospital length of stay, admitting diagnoses, comorbid conditions, antibiotics administered prior to and during admission but prior to CDI testing, gastric antacid use during hospital stay, previous history of CDI, date of CDI testing performed, location from which the patient was admitted (home, nursing home, rehab, etc.), and admission date.

Features

Unit Specifics. The two renal telemetry units at NH consist of 16 private inpatient rooms each. The oncology telemetry unit at NAH consists of private and semi-private rooms with a total of 40 inpatient beds.

Staff Education. All nursing staff (nurses and nurse assistants) on the intervention units were trained in implementation of the PHHP. Nursing staff received education about the study via face-to-face education sessions. Handouts and posters were provided as reminders, as well as educational tools in the process.

The Intervention. Since the primary mode of CDI transmission within inpatient healthcare facilities is person-to-person spread through the fecal-oral route, the starting point of the PHHP to occur was at mealtimes. The PHHP consisted of three designated times for staff to perform or offer patient hand hygiene: prior to breakfast, lunch, and dinner. Hand hygiene was defined as washing the patient’s hands with soap and water at the sink, using hand sanitizer, or cleansing with a soapy washcloth.

Monitoring Adherence. Nursing staff were assessed for adherence to the PHHP through random audits at varying meal times, using the auditing tool in Appendix A. Protocol adherence was defined as providing patients with hand hygiene prior to each meal. If patient hand hygiene was not performed, the staff member was asked to describe the barrier to patient hand hygiene (i.e. patient refusal, patient not on the unit, no soap or hand sanitizer available, etc.).

Data Collection

Approvals from the University of Kentucky Institutional Review Board (IRB) and the Norton Healthcare Office of Research and Administration (NHORA) were obtained prior to the collection of data. This study was based on a quasi-experimental design and a retrospective chart review. After the intervention period, patient charts were obtained from NHORA through the Norton Healthcare electronic patient database. Charts were identified by each hospital's standard report of patients with hospital-onset CDI that is required to be reported to the CDC National Healthcare Safety Network (NHSN). During data collection, patient records were accessed using the patient medical record number (MRN), data were abstracted based on the list below, and then transferred to an electronic spreadsheet. Please refer to Table 1 for a list of variables that were reviewed, which included demographic variables (age, gender, admitting diagnosis, comorbidities, the location from which the patient was admitted, previous history of CDI) and outcome variables (hospital length of stay [LOS], antibiotics administered prior to and during admission but prior to CDI testing, gastric antacid use).

Data Analysis

Descriptive statistics, including frequency distributions, means, and standard deviation (SD) were used to describe patients' demographic characteristics and outcome variables. A control chart was created to look at CDI rates over the 21 month period of January 2016 through September 2017 for both NH and NAH. The mean rate, SD of +/- 3, and upper and lower confidence intervals were obtained. All data analysis was conducted using Microsoft Excel 2013.

Results

Rates of CDI

A control chart was created to assess the trend of CDI rates for 21 months (January 2016 through September 2017) at NH and NAH. The control chart illustrated a common cause variation for CDI rates at NH, with no significant outliers (LCL=0; Figure 1). For NAH, there was one outlier in early 2016, and the following months show a common cause variation as well (LCL=0; Figure 2). On the three specific intervention units, there were four incidences of CDI during the intervention period of August and September 2017, compared to one incidence during the same time period in 2016. An incidental finding when reviewing patient charts was that 32.2% of these patients were deceased.

Staff Adherence

Random audits of the PHHP were performed at each mealtime on the intervention units. Overall, for the three units, staff were compliant with offering hand hygiene to the patients 71.1% of the times observed (NH: 73%, NAH: 66.7%). Breakfast was the most compliant mealtime with 86.5% adherence to the protocol (NH: 90%, NAH: 80%), lunch had 66.7% compliance (NH: 70%, NAH: 60%), and dinner 60% (NH: 60%, NAH: 60%; Figure 7). Reasons provided for non-adherence to the PHHP were: patient refusal of hand hygiene (46%), staff were too busy (30.8%), there was not enough time to provide hand-hygiene to the patient (7.7%), staff forgot to provide hand-hygiene (7.7%), and patient was not on the unit at the time meal was served (7.7%; Figure 8). Nursing staff were reeducated 100% of the time during random audits about the importance and purpose of patient hand-hygiene.

Sample Characteristics

A total of 177 patient charts were reviewed: 159 prior to the PHHP implementation for January 2016 through December 2016 (NH: 93, NAH: 66) and 18 during the intervention period (NH: 12, NAH: 6). The mean age for both groups was 64.4 years old and the majority of patients were female (52.6%). The mean length of stay for both groups was 17.1 days. The pre-intervention and intervention demographic characteristics as to age, gender, admitting diagnosis, comorbidities, location from which the patient was admitted, antibiotic use before and during admission, and previous history of CDI are presented in Tables 1 and 2. The group demographics did not differ significantly, demonstrating similarities.

Admitting diagnosis

Patients' admitting diagnoses were individually assessed and the top five diagnoses for both pre-intervention and intervention groups were identified (Figure 5). Overall, for both hospitals the most common admitting diagnoses were sepsis (8.5%), GIB (6.8%), pneumonia (6.2%), respiratory failure (6.2%), and cancer (5.2%). At NAH the most frequent admitting diagnoses for these patients were pneumonia (12.5%), sepsis (8.3%), chronic obstructive pulmonary disease (COPD; 6.9%), and congestive heart failure (CHF), encephalopathy, small bowel obstruction, and gastrointestinal bleeding (GIB) (5.6% each). At NH they were sepsis (8.6%), respiratory failure (7.6%), GIB (7.6%), cancer (6.7%), and cellulitis (4.8%).

Comorbid conditions

Patients' comorbidities were individually assessed and the top five comorbid conditions for both pre-intervention and intervention groups were identified (Figure 6). The most common comorbidities for both hospitals were hypertension (HTN) (31.6%), diabetes mellitus (DM) (25.4%), COPD (17.5%), renal disorders (14.2%), and coronary artery disease (CAD) (11.9%). At NAH the most frequent comorbid conditions were HTN (31.9%), COPD (20.8%), DM (19.4%), hyperlipidemia (HLD) (16.7%), CAD (13.9%) and urinary tract infection (UTI; 13.9%); at NH were HTN (31.4%), DM (29.5%), COPD (15.2%), renal disorders (15.2%), atrial fibrillation (12.4%), and CAD (10.5%).

From where were patients admitted

The most common living arrangement for 132 pre-intervention and intervention patients prior to admission to the hospital was home (74.6%) (Table 3). There were no significantly statistical differences between NAH and NH patients being admitted from either a nursing home (11.1% and 16.2%, respectively) or rehab (6.9% and 8.6%). NH had patients admitted from high risk areas, like shelters and outlying hospitals (2.9% each), and NAH patients were not admitted from either place.

Antibiotics, gastric antacids, and history of CDI

To assess for antibiotic overuse and stewardship, the use of antibiotics prior to admission and during admission but prior to CDI testing were analyzed. As a whole, both the pre-intervention and intervention groups did not statistically differ with regard to the percentage of antibiotics being prescribed prior to admission (18.9% and 22.2%, respectively) and during admission (86.8% and 88.9%). A look at Figures 3 and 4 illustrates the most frequently prescribed antibiotics for these patients, both prior to and during admission but prior to CDI testing.

Gastric antacids, specifically proton pump inhibitors can play a role in the development of C. Diff, so it was assessed whether the patients were receiving one during admission. The use of gastric antacids during hospitalization in both pre-intervention and intervention groups was high (80%). To assess for other possible contributions to the contraction of CDI, previous history of a CDI was analyzed. There was no difference between the pre-intervention and intervention groups with regard to whether the patient had a previous history of CDI (12% and 16.7%) (Refer to Tables 1 and 2).

Discussion

This study aimed to decrease CDI rates in the acute care setting through a PHHP and assess other variables that may contribute to the development of CDI. Comparing the intervention unit data from August/September 2016 and 2017 revealed an increase in CDI incidence. Though overall PHHP adherence rate was at 71.1%, there were outliers that were uncontrollable to the determination of CDI on the culpable units. Some of these outliers included unit transfers during hospitalization and transportation of patients through infected areas of the hospital (i.e., through other units or ancillary departments).

As evidenced by the demographic data collected, CDI development is multifaceted, with specific risk factors being both modifiable and non-modifiable. As the rates of CDI increase, it is crucial to develop a more systematic approach to CDI and overall HAI prevention. There is an algorithm in place at

Norton Healthcare to combat the spread of CDI, which includes early microbiology testing of stool at symptom onset, contact plus precautions, soap and water handwashing by staff, and environmental cleaning with bleach. At NAH, a Xenex machine was purchased to help decrease the rates of CDI. The Xenex machine uses an ultraviolet disinfection technology that is proven to kill C. Diff spores in five minutes (Xenex, n.d.). Based on the results of the CDI rates at NH and NAH, there is still more to be done to help in CDI prevention and transmission.

In a 2012 C. Diff and mortality literature review, 15 studies were identified that indicated a mortality rate of 15% or greater in patients with a CDI (Magill et al, 2014). As previously mentioned, 32.2% of the patients included in this study were deceased. The mortality rate of the study sample was higher than that of the literature review; there are a few explanations for this finding. The patients at NAH were admitted to an oncology unit which could indicate that they may have been at a higher risk of developing HAI due to being immunocompromised. Also, one of the top admitting diagnoses at both hospitals was sepsis. Sepsis alone carries a mortality rate of 15% while in the hospital and carries many of the risk factors for the development of a CDI (Rhee et al., 2017). Further evaluation of the comorbidity burden and mortality risk among patients who develop CDI is recommended.

Hand Hygiene

According to the Clinical Practice Guidelines for CDI, one of the most important infection control measures to be implemented in the hospital is an emphasis on compliance with the practice of hand hygiene (Cohen et al., 2010). Though this study was unable to show any correlation between a PHHP and decreased CDI rates, adding patient hand hygiene to the HAI prevention bundle would be significant. Systematic patient hand hygiene is an inexpensive and highly effective preventive measure against MDRO nosocomial transmission (Gagne et al., 2010). With the common cause variation of CDI at NH and NAH, including a PHHP hospital-wide may help shift the rates downward. Norton Healthcare has a strong presence of support for healthcare worker hand hygiene, through the use of readily available hand sanitizer and sinks with soap, posters reminding staff of hand hygiene, and audits to assure hand hygiene compliance among staff; adding a PHHP throughout each hospital would facilitate the importance of compliance.

Notably, the most common reason for non-adherence to the PHHP was due to patient refusal (46%). This indicates a need for enhanced patient education on the importance and purpose of hand hygiene. According to CMS, patients and their families are essential partners in the effort to improve the quality and safety of health care (n.d.). Some methods of educating patients on hand hygiene can be providing informational brochures, signage, education boards and informational screen-savers on computers in the patient rooms (Pokrywka et al., 2014, pg. 148). Also, more extensive staff education would also be beneficial in increasing the adherence rate of a PHHP. A self-learning module on CDI and the importance of hand hygiene was developed for healthcare workers and patients in a similar study by Pokrywka et al. (2014).

Limitations and Implications for Future Research

Several limitations were identified in the design of this study. Though data were collected from two establishments, the study was limited to the specific Louisville, KY region. Many of the admitting diagnoses and comorbidities seen were indicative of the region. A larger multi-center, multi-regional comparison will help increase generalizability.

Due to charts being reviewed retrospectively, much of the nursing documentation related to stool characteristics seemed to be inaccurate or missing. This made it difficult to decipher when patient symptoms began as compared to when they were tested for CDI, which is crucial in determining CDI as hospital-onset versus community-onset. It would be recommended to include in staff education the importance of documenting correct occurrences and characteristics of the patient's stool in relation to CDI detection.

Another limitation of this study was the length and reach of the intervention. The eight week intervention period and having three intervention units was due to graduation feasibility. Auditing of protocol adherence was performed solely by the primary investigator, it is possible that such a high staff compliance rate was noted due to the Hawthorne effect. To see an impact on CDI rates, this study is recommended to be implemented for at least one year and hospital-wide. There will be a need for an increased number of researchers to assist in staff education and protocol adherence audits.

Further research should include showing direct hospital costs of CDI, both pre and post intervention implementation. Patients with a CDI are found to have increased total patient costs, hospital length of stay, and risk of readmission (Magee et al., 2015, pg. 1151). Medicare reports that each hospital will lose up to one million dollars in Medicare payments for a year based on hospital CDI rates (Rau, 2016).

Future research can also look at the issue of patient satisfaction. A PHHP is one way in which the patient can visually see the importance of hand hygiene because nursing staff are offering it throughout the day. This may lead to an increase in scores on the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) if the patient experience is enhanced through the implementation of this intervention.

Conclusion

The goal of this study was to implement a PHHP to decrease the rates of CDI at two Norton Healthcare hospitals. This type of study is critical in preventing HAI and decreasing population mortality rates. In the last 21 months at NH and NAH, CDI rates have been variable and unpredictable, indicating a need for extensive research into additional preventative measures. Engaging patients and families in hand hygiene can strengthen their knowledge and attitudes about HAI prevention and change the social expectations for hand hygiene behavior. In a healthcare society where quality of care is vital to reimbursement, HAI prevention is effective on clinical and financial outcomes, as well as the patient experience.

References

Cao, J., Min, L., Lansing, B, Foxman, B., Mody, L. (2016), Multidrug-resistant organisms on patients' hands: A missed opportunity. *Journal of American Medical Association: Internal Medicine, 176*(5), 705-706. doi:10.1001/jamainternmed.2016.0142

Centers for Disease Control and Prevention. (2002). *Guideline for hand hygiene in health-care settings* (Morbidity and Mortality Weekly Report, 51, RR-16).

Centers for Disease Control and Prevention. (2016). *National and state healthcare associated infection: Progress report.* Retrieved from http://www.cdc.gov/HAI/pdfs/progress-report/hai-progress-report.pdf

Centers for Disease Control and Prevention. (2017). *Multidrug-resistant organism &* clostridium difficile *infection (MDRO/CDI) module.* Retrieved from https://www.cdc.gov/nhsn/pdfs/pscmanual/12pscmdro_cdadcurrent.pdf

Cohen, S., Gerding, D., Johnson, S., Kelly, C., Loo, V., McDonald, L., ... Wilcox, M. (2010). Clinical practice guidelines for *Clostridium difficile* infection in adults: 2010 Update by the Society for Healthcare Epidemiology of America (SHEA) and the Infectious Disease Society of America (ISDA). *Infection Control and Hospital Epidemiology, 31*(5), 431-455. doi: 10.1086/651706

Conway, P. (2013). Statement from *Centers for Medicare & Medicaid Services on U.S. Efforts to reduce healthcare-associated infections*. Retrieved from http://www.hhs.gov/asl/testify/2013/09/t20130924.html

Fox, C., Wavra, T., Drake, D. A., Mulligan., D., Bennett, Y. P., Nelson, C., . . . Bader, M. K. (2015). Use of a patient hand hygiene protocol to reduce hospital-acquired infections and improve nurses' hand washing. *American Journal of Critical Care, 24*(3), 216-224. http://dx.doi.org/10.4037/ajcc2015898

Gagne, D., Bedard, G., & Maziade, P. J. (2010). Systematic patients' hand disinfection: Impact on methicillin-resistant Staphylococcus aureus infection rates in a community hospital. *Journal of Hospital Infection, 75*(4), 269-272. doi: 10.1016/j.jhin.2010.02.028

Larson E. (1999) Skin hygiene and infection prevention: More of the same or different approaches? *Clinical Infectious Diseases, 29*, 1287–94.

Magee, G., Strauss, M., Thomas, S., Brown, H., Baumer, D., & Broderick, K. (2015). Impact of *clostridium difficile*-associated diarrhea on acute care length of stay, hospital costs, and readmission: A multicenter retrospective study of inpatients, 2009-2011. *American Journal of Infection Control*, *43*(11), 1148-1153. doi: http://dx.doi.org/10.1016/j.ajic.2015.06.004

Magill, S. S., Edwards, J. R., Bamberg, W., Beldavs, Z. G., Dumyati, G., Kainer, M. A., . . . Fridkin, S. K. (2014). Multistate point-prevalence survey of health care-associated infections. *The New England Journal of Medicine*, *37*(13), 1198-1208. doi: 10.1056/NEJMoa1306801

Mitchell, B. G., & Gardner, A. (2012). Mortality and *clostridium difficile* infection: a review. *Antimicrobial Resistance and Infection Control, 1*(20). http://doi.org/10.1186/2047-2994-1-20

Patient Safety Network. (2016). *Health care-associated infections.* Retrieved from https://psnet.ahrq.gov/primers/primer/7

Pokrywka, M., Feigel, J., Douglas, B., Grossberger, S., Hensler, A., & Weber, D. (2014). A bundle strategy including patient hand hygiene to decrease *clostridium difficile* infections. *Med-Surg Nursing, 23*(3). 145-148.

Quality Improvement Organizations. (n.d.). *Engaging patients & families in hand hygiene.* Retrieved from http://medicare.qualishealth.org/projects/healthcare-associated-infection/selected-resources/hand-hygiene

Rau, J. (2016). Medicare penalizes hospitals in crackdown on antibiotic-resistant infections. Retrieved from http://www.npr.org/sections/health-shots/2016/12/22/506489368/medicare-penalizes-hospitals-in-crackdown-on-antibiotic-resistant-infections

Rhee, C., Dantes, R., Epstein, L., Murphy, D., Seymour, C., Iwashyna, T., … Klompas, M. (2017). Incidence and trends of sepsis in US hospitals using clinical vs. claims data, 2009-2014. *JAMA, 318*(13). 1241-1249. doi: 10.1001/jama.2017.13836

Scott, R. D. (2009). *The direct medical costs of healthcare-associated infections in U.S. hospitals and the benefits of prevention.* (CDC Publication No. CS200891-A) Atlanta, GA.

U.S. Food and Drug Administration. (2012). FDA Drug Safety Communication: Clostridium difficile associated diarrhea can be associated with stomach acid drugs known as proton pump inhibitors (PPIs). Retrieved from https://www.fda.gov/Drugs/DrugSafety/ucm290510.htm

Witt, D. & Barnes, S. (2013). *Clostridium difficile*: A multifaceted approach to prevention. *Prevention Strategist.* (Spring 2013). 53-59.

World Health Organization. (2009*). A guide to the implementation of the WHO multimodal hand hygiene improvement strategy*. Geneva, Switzerland: WHO Press.

Xenex. (n.d.) How UV disinfection works. Retrieved from https://www.xenex.com/how-uv-disinfection-works

Table 1. *Demographic variables for 2016 (January – December)*

Demographic variables for 2016 (January-December)			
	Norton Hospital	*Norton Audubon*	*Both*
Patients with positive CDI testing	93	60	159
Characteristic	*n(%)*	*n(%)*	*n(%)*
***Age**, years*			
Mean (SD)	59.9 (16.2)	69 (13.4)	63.7 (15.7)
Gender			
Female	43 (46.2%)	40 (60.6%)	83 (52.2%)
Male	50 (53.8%)	26 (39.4%)	76 (47.8%)
***Length of Stay (LOS)**, days*			
Mean (SD)	17.6 (8.4)	15.5 (15)	16.7 (12.7)
Admitted from:			
Home	64 (68.8%)	54 (81.8%)	118 (74.2%)
Nursing Home	14 (15.1%)	8 (12.1%)	22 (13.8%)
Rehab	9 (9.7%)	4 (6.1%)	13 (8.2%)
Shelter	3 (3.2%)	0	3 (1.9%)
Hospital	3 (3.2%)	0	3 (1.9)
Prescribed antibiotics prior to admission			
Yes	20 (21.5%)	10 (15.2%)	30 (18.9%)
No	73 (78.5%)	56 (84.8%)	129 (81.1%)
Prescribed antibiotics during admission, but prior to CDI testing			
Yes	78 (83.9%)	60 (90.9 %)	138 (86.8%)
No	15 (16.1%)	6 (9.1%)	21 (13.2%)
Gastric antacid during admission			
Yes	75 (80.6%)	58 (87.9%)	133 (83.6%)
No	18 (19.4%)	8 (12.1%)	26 (16.4%)
Previous history of CDI			
Yes	7 (7.5%)	12 (18.2%)	19 (12%)
No	86 (92.5%)	54 (81.8%)	140 (88%)

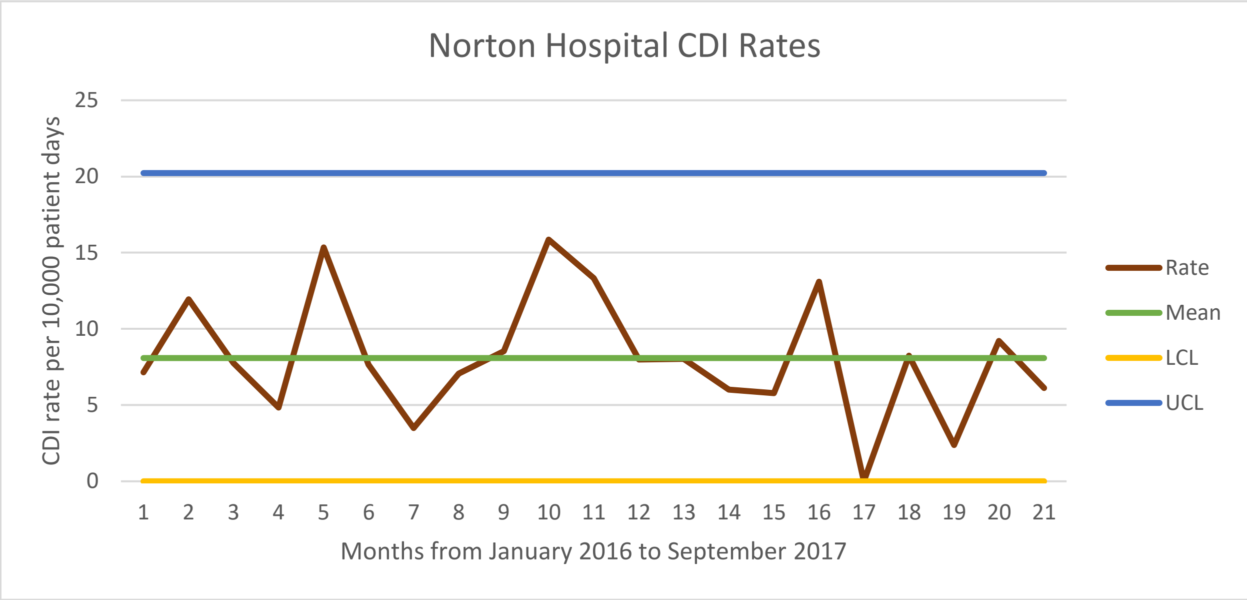
Table 2. *Demographic variables for 2017 (August - September)*

Demographic variables for 2017 (August-September)			
	Norton Hospital	*Norton Audubon*	*Both*
Patients with positive CDI testing	12	6	18
Characteristic	*n(%)*	*n(%)*	*n(%)*
***Age**, years*			
Mean (SD)	69.9 (15.2)	72.2 (13.5)	70.7 (14.3)
Gender			
Female	7 (58.3%)	3 (50%)	10 (55.6%)
Male	5 (41.7%)	3 (50%)	8 (44.4%)
***Length of Stay (LOS)**, days*			
Mean (SD)	21 (20.0)	21 (7.8)	20.2 (16.7)
Admitted from:			
Home	9 (75%)	5 (83.3%)	14 (77.8%)
Nursing Home	3 (25%)	0	3 (16.7%)
Rehab	0	1 (16.7%)	1 (5.5%)
Prescribed antibiotics prior to admission			
Yes	3 (25%)	1 (16.7%)	4 (22.2%)
No	9 (75%)	5 (83.3%)	14 (77.8%)
Prescribed antibiotics during admission, but prior to CDI testing			
Yes	11 (91.7%)	5 (83.3 %)	16 (88.9%)
No	1 (8.3%)	1 (16.7%)	2 (11.7%)
Gastric antacid during admission			
Yes	10 (83.3%)	5 (83.3%)	15 (83.3%)
No	2 (16.7%)	1 (16.7%)	3 (16.7%)
Previous history of CDI			
Yes	2 (16.7%)	1 (16.7%)	3 (16.7%)
No	10 (83.3%)	5 (83.3%)	15 (83.3%)

Table 3. *Demographic variables for all patients*

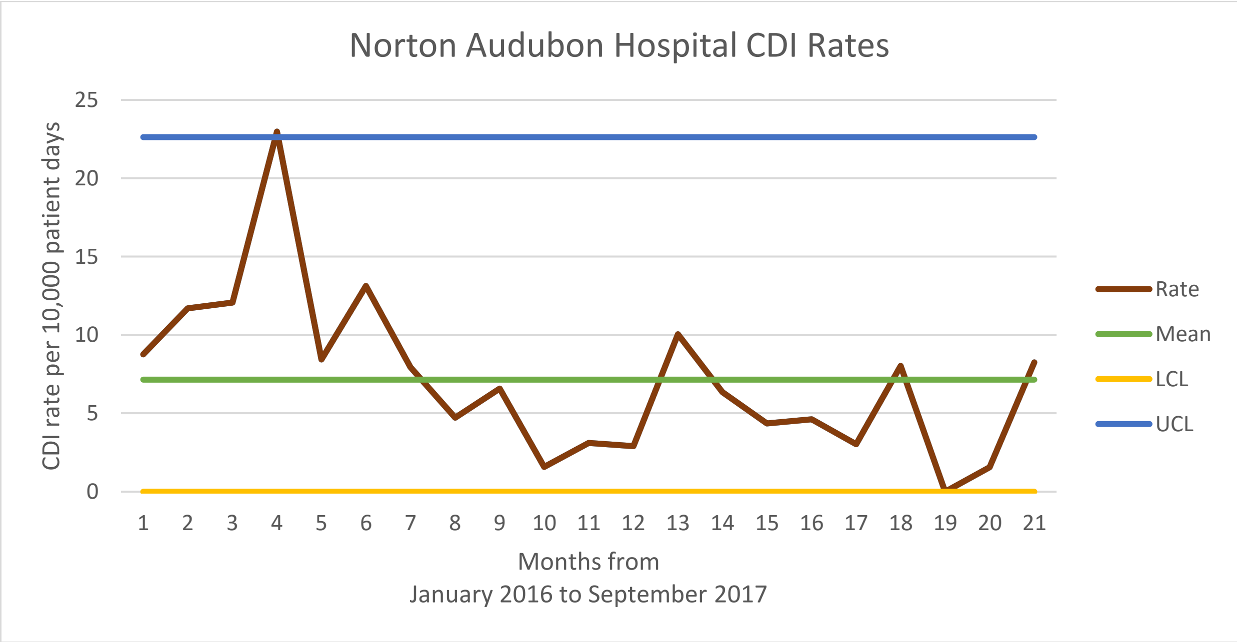
Demographic variables for all patients			
	Norton Hospital	*Norton Audubon*	*Both*
Patients with positive CDI testing	105	72	177
Characteristic	*n(%)*	*n(%)*	*n(%)*
***Age**, years*			
Mean (SD)	61.1 (16.4)	69.2 (13.4)	64.4 (15.7)
Gender			
Female	50 (47.6%)	43 (59.7%)	93 (52.6%)
Male	55 (52.4%)	29 (40.3%)	84 (47.5%)
***Length of Stay (LOS)**, days*			
Mean (SD)	18 (15.6)	15.8 (8.3)	17.1 (13.1)
Admitted from:			
Home	73 (69.5%)	59 (81.9%)	132 (74.6%)
Nursing Home	17 (16.2%)	8 (11.1%)	25 (14.1%)
Rehab	9 (8.6%)	5 (6.9%)	14 (7.9%)
Shelter	3 (2.9%)	0	3 (1.7%)
Hospital	3 (2.9%)	0	3 (1.7%)
Prescribed antibiotics prior to admission			
Yes	23 (21.9%)	11 (15.3%)	34 (19.2%)
No	82 (78.1%)	61 (84.7%)	143 (80.8%)
Prescribed antibiotics during admission, but prior to CDI testing			
Yes	89 (84.8%)	65 (90.3 %)	154 (87%)
No	16 (15.2%)	7 (9.7%)	23 (13%)
Gastric antacid during admission			
Yes	85 (81%)	63 (87.5%)	148 (83.6%)
No	20 (19%)	9 (12.5%)	29 (16.4%)
Previous history of CDI			
Yes	9 (8.6%)	13 (18.1%)	22 (12.4%)
No	96 (91.4%)	59 (81.9%)	155 (87.6%)

Figure 1. *Norton Hospital* clostridium difficile *infection (CDI) rates from January 2016 through September 2017.*



Note. This figure illustrates common cause variation for CDI rates throughout the 21-month period at Norton Hospital. The lower confidence level is zero.

Figure 2. *Norton Audubon Hospital CDI rates from January 2016 through September 2017.*



Note. This figure illustrates that there was one outlier in early 2016 and then the following months show a common cause variation with no further outliers. The lower confidence level is zero.

Figure 3. *Most frequently prescribed antibiotics prior to admission.*

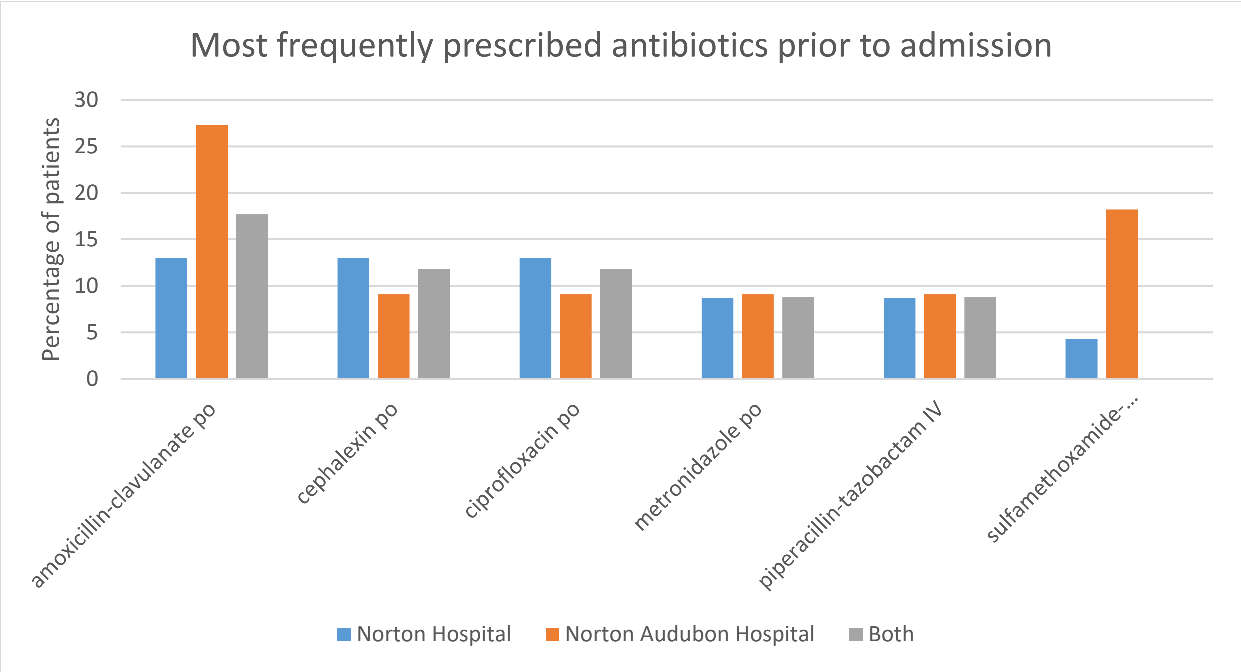


Figure 4. *Most frequently prescribed antibiotics during admission, but prior to testing*

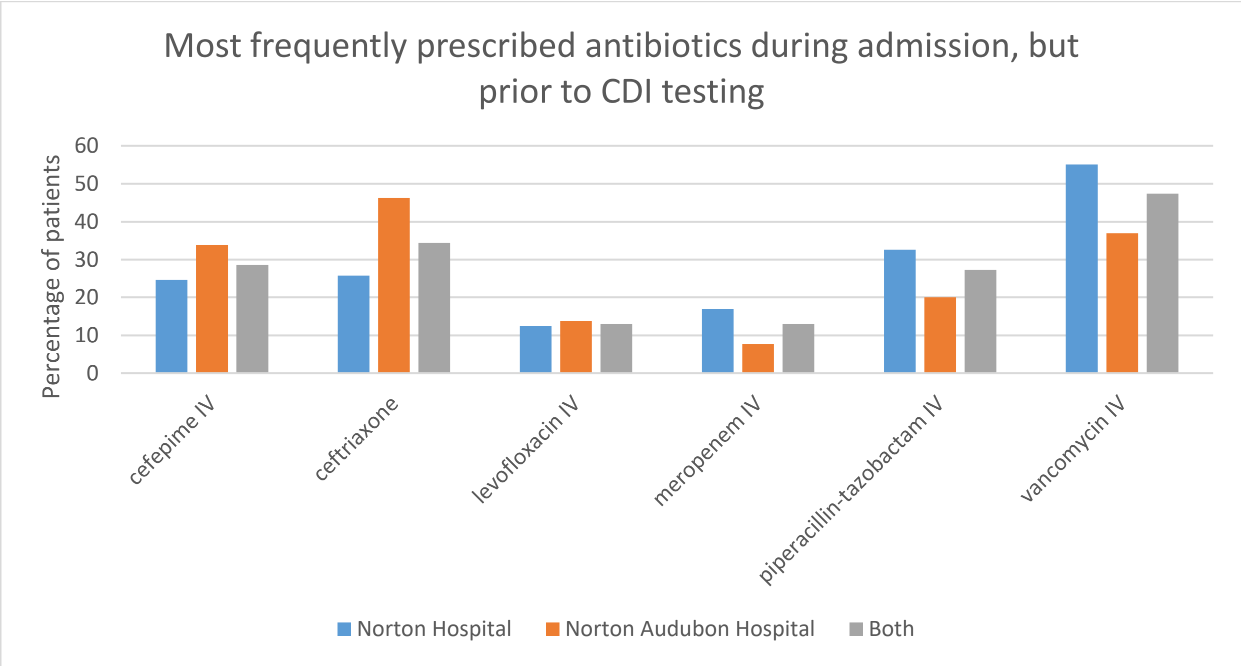


Figure 5. *Most common admitting diagnosis*

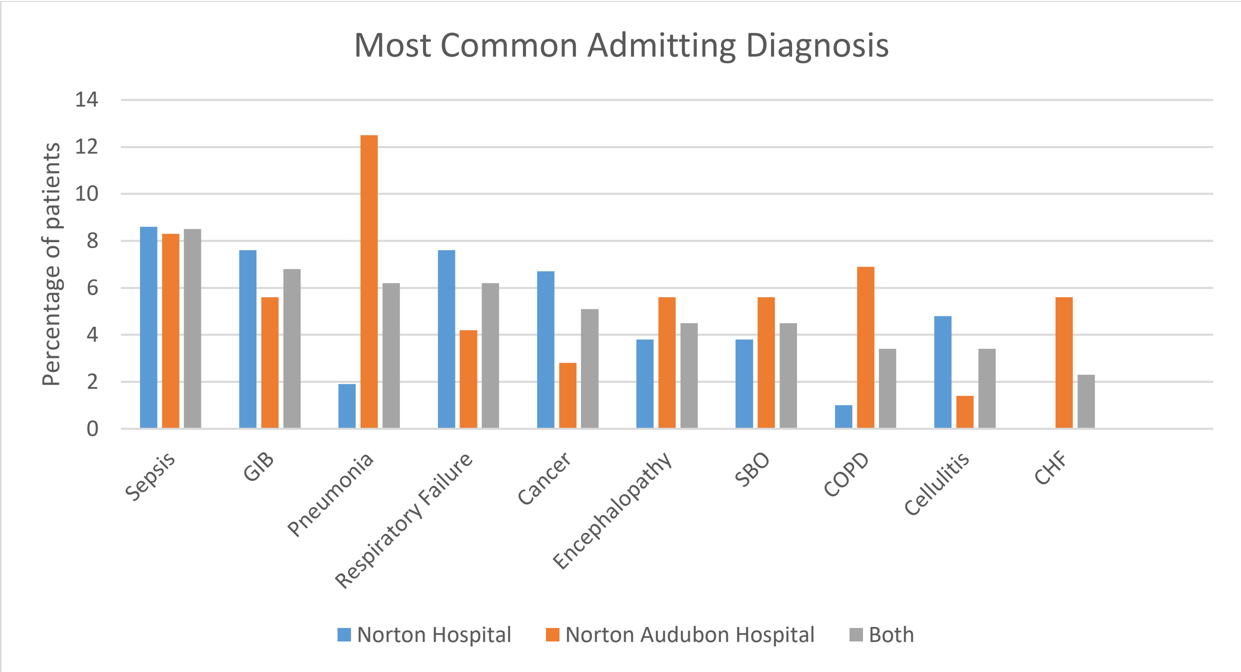


Figure 6. *Most common comorbid conditions*.

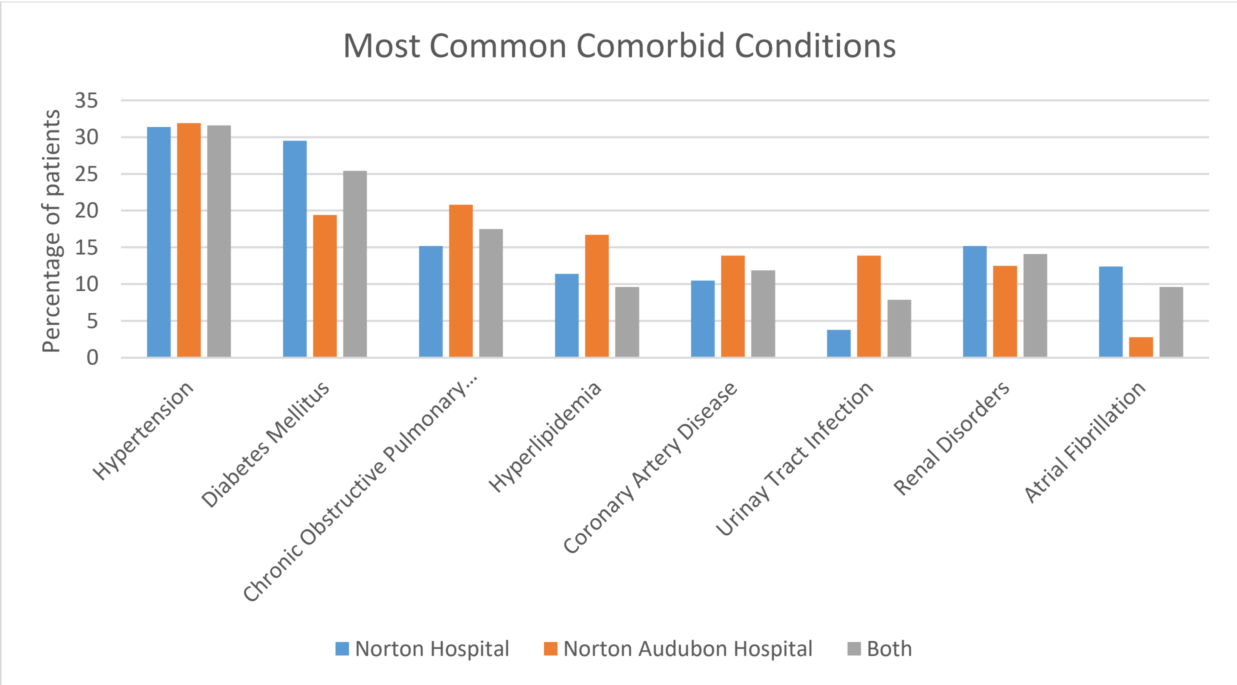


Figure7. *Staff adherence to the PHHP.*

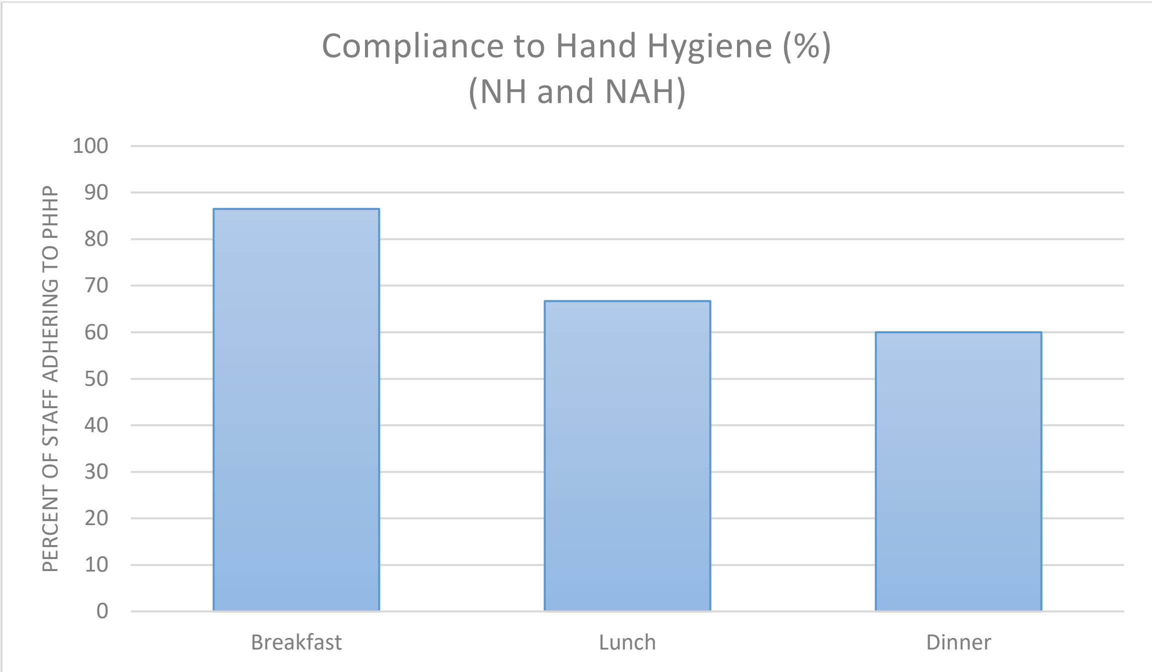
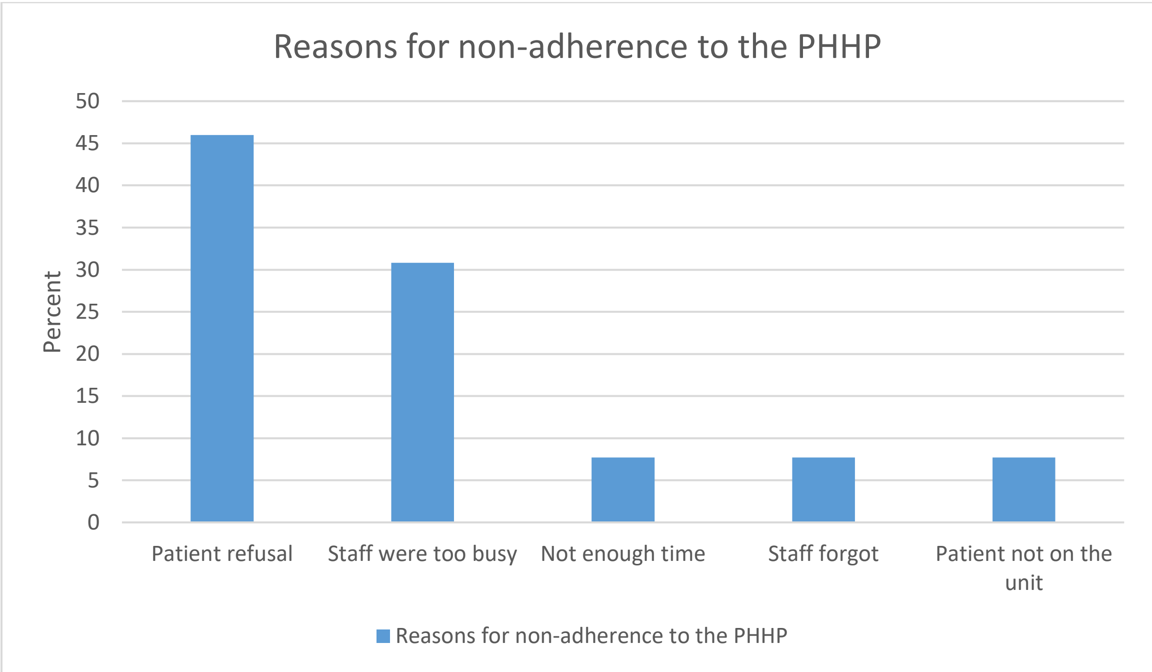


Figure 8. *Reasons for non-adherence to the PHHP*



Appendix A

Audit Tool

Mealtime observed	
Patient hand hygiene performed?	
If not, what barrier was present?	
Was staff reeducated?	