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Associations Between Healthcare Facility Types and Healthcare-Associated Infections

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This is to certify that the doctoral dissertation by

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Walden University
2016

Abstract

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MPH, Walden University, 2012

BsCN, Ryerson University, 2002

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Healthcare-Associated Infections (HAIs) continue to be an epidemiological issue burdening patients and public health systems worldwide. The purpose of this study was to determine if specific healthcare facility types (Acute Care Hospitals, Long Term Acute Care Hospitals, and Inpatient Rehabilitation Facilities) were associated with particular categories of HAIs: Ventilator-Associated Pneumonias (VAPs), Central Line-Associated Bloodstream Infections (CLABSIs), and Catheter-Associated Urinary Tract Infections (CAUTIs). The theoretical framework for this study was the environmental determinants of infectious disease framework. A single research question focused on whether an association existed among the specified health care facility types and HAIs. Three independent categorical variables were used, including Acute Care Hospitals, Long Term Acute Care Hospitals, and Inpatient Rehabilitation Facilities, and 3 dependent variables were used, comprising of VAPs, CAUTIs, and CLABSIs. A quantitative design engaged the chi-square test of association, using a 2012 population-level report of archival data collected by the Centers for Disease Control and Prevention's National Healthcare Safety Network. Seven groups of HAIs and facility types were tested, and the results revealed that 6 groups had statistically significant differences. This study may contribute to positive social change by helping to identify whether healthcare facility types are associated with HAIs and to supply evidence to stakeholders to support standardization of best practices across all facility types, thus contributing to the reduction of HAIs in the United States.

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Dedication

This work is dedicated to Chris, my darling spouse for seeing me through these graduate studies. I would also like to dedicate this work to Dr. Safiya George-Dalmida for motivating me to pursue continuing education. To my cherished siblings – “the kids,” this degree is validation that we must continue to work hard to achieve our goals. I would also like to acknowledge my cousin Lonsdale Greene who sat with me in the wee hours of the mornings at the age of ten to review my homework and to drill me in mathematical concepts. This degree would not have been possible without Lonsdale’s tutelage and I am forever in his debt.

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Chapter 1: Introduction to the Study

Introduction

Healthcare Associated-Infections (HAIs) are associated with infectious agents including fungi, bacteria, or viruses (Office of Disease Prevention and Health Promotion, 2014). Eighty percent of all HAIs occur as a result of four specific infections: Ventilator-Associated Pneumonias (VAPs), Catheter-Associated Urinary Tract Infections (CAUTIs), Central Line-Associated Bloodstream Infections (CLABSI), and Surgical Site Infections (SSIs), (Agency for Healthcare Research and Quality [AHRQ], 2014). Furthermore, HAIs may be acquired in any facility where healthcare is provided, for instance Long Term Acute Care Hospitals (LTACHs), or Inpatient Rehab Facilities (IRFs).

The most recent data revealed about 722,000 patients contracted HAIs in healthcare care facilities in the U.S. in 2011 (Centers for Disease Control and Prevention [CDC], 2015a), subsequently about 100,000 people losing their lives each year (AHRQ, 2012). It is evaluated that 33% of all instances of HAIs are avoidable (Curtis et al., 2013). This is an issue because there are, and have been, established methods to reduce or prevent HAIs (The Society for Healthcare Epidemiology of America, 2015). As a result, health care providers are under pressure to decrease the frequency of these infections (AHRQ, 2012). This study influenced positive social change by revealing the gap in research in the various facility types of the healthcare system. While Acute Care Facilities are leading the healthcare industry in terms of research on HAIs, evidence-based research in other facility types is sparse. Patients leave Acute Care Facilities and sometimes are placed in other facility types, but then return to Acute Care Facilities (Robert Wood Johnson Foundation, 2013). A recommendation is to use a systems approach to standardize HAI prevention best practices strategies to all facility types across the healthcare system.

Chapter 1 presents a background on HAIs focusing on three types of healthcare facilities. There is a brief explanation of how HAIs are reported in a piece-meal fashion by facility types to the CDC and the National Healthcare Safety Network (NHSN). Chapter 1 also includes the problem statement, purpose of the study, research question and hypotheses, conceptual model, nature of the study, as well as the assumptions, limitations, and significance of this study.

Background

In the 21st century, HAIs are more prevalent than ever before (Sydnor & Perl, 2011). As more complex medical and surgical care is offered in non-acute settings, the definitions of healthcare settings are becoming more challenging since it is commonplace for patients to move unrestrictedly through the healthcare system, for instance from acute-care facilities to rehabilitation, or long-term acute care facilities (Sydnor & Perl, 2011). In 2008, in response to growing patient morbidity and mortality in the healthcare system, the Centers for Medicare and Medicaid Services (CMS) implemented a proactive strategy to withhold financial reimbursements for HAIs like CAUTIs and CLABSIs (Anderson, Pyatt, Weber, & Rutala, 2013; North Carolina Department of Health and Human Services, 2013). Thirty-two states have complied with mandates to report data on HAIs to the NHSN (CDC, 2015d), and facilities have been using individual, institution-specific surveillance to prevent, manage, and curtail HAIs (Sydnor & Perl, 2011). Healthcare facilities comply by reporting (a) rates of HAIs, (b) colonization and infection with specific organisms, and (c) care measures to public health authorities for the data to be publicly available. The goals of these interventions are to increase public awareness, improve the quality of healthcare, as well as patient safety (Sydnor & Perl, 2011). This study differs from other research as it addressed the existing gap in the current literature about the relationship between HAIs and facility types. This study influenced positive social change by revealing the gap in research in the various facility types of the healthcare systems, and may provide evidence to public health policy makers to use systems approaches to standardize HAI prevention best practices to all facility types across the U.S. healthcare system.

Problem Statement

Nosocomial infections, also known as HAIs, are contagions illnesses patients obtain in healthcare establishments as they are being treated for another ailment (Custodio, Jaimovich, Windle, Domachowske & Tolan, 2014). HAIs may be acquired in any facility where healthcare services are provided, for instance LTACHs or IRFs. HAIs are a major source of concern in all types of health care facilities, costing the healthcare industry billions of dollars each year (AHRQ, 2014). There are multiple risk factors for contracting a HAI such as, (a) number of days spent in health care settings, (b) improper aseptic technique, and (c) improper antibiotic therapy (Custodio et al., 2014). According to the World Health Organization (2016), some determinants of HAIs are more specific to healthcare facilities with limited resources, which may include poor infrastructure, understaffing, overcrowding, or inadequate knowledge of the application of personal protective equipment. This study was distinctive as it addressed an existing gap as to why HAIs continue to occur, possibly determined by the type of facility where patients are housed; thus, making an original contribution to a gap in the literature.

Purpose of the Study

The purpose of this study was to determine if facility type is associated with HAIs. This quantitative study had an overall purpose and intention to explore whether the types of healthcare facilities in the United States bear a relationship to the three major types of HAIs. There are three independent categorical variables, including Acute Care Hospitals, LTACHs, and IRFs and three dependent variables, including VAPs, CAUTIs, and CLABSIs.

Research Question and Hypotheses

A single research question, along with nine hypotheses guided this study:

RQ 1: Is there any difference in number of HAI infections (VAPs, CAUTIs, and CLABSIs) among healthcare facility types (Acute Care Hospitals, LTACHs, and IRFs).

$H_0 1$: There is no difference in number of VAP infections between Acute Care Hospitals and LTACHs.

- Dependent Variable: number of VAP infections
- Independent Variable: Healthcare Facility type (Acute Care Hospitals, LTACHs, and IRFs).
- Statistical Analysis: Chi-square Analysis

$H_0$2: There is no difference in number of VAP infections between Acute Care hospitals and IRFs

- Dependent Variable: number of VAP infections
- Independent Variable: Healthcare Facility type (Acute care hospitals and IRFs)
- Statistical Analysis: Chi-square Analysis

$H_0$3: There is no difference in number of VAPs between IRFs and LTACHs.

- Dependent Variable: number of VAP infections
- Independent Variable: Healthcare Facility type (IRFs and LTACHs)
- Statistical Analysis: Chi-square Analysis

$H_0$4: There is no difference in number of CAUTI between Acute care hospitals and LTACHs.

- Dependent Variable: number of CAUTI
- Independent Variable: Healthcare Facility-type (Acute care hospitals and LTACHs)
- Statistical Analysis: Chi-square Analysis

$H_0$5: There is no difference in number of CAUTI infections between Acute Care hospitals and IRFs.

- Dependent Variable: number of CAUTI
- Independent Variable: Healthcare Facility type (Acute care hospitals and IRFs)
- Statistical Analysis: Chi-square Analysis

$H_0$6: There is no difference in number of CAUTI infections between IRFs and LTACHs.

- Dependent Variable: number of CAUTI

- Independent Variable: Healthcare Facility type (IRFs and LTACHs)
- Statistical Analysis: Chi-square Analysis

$H_0$7: There is no difference in number of CLABSI between Acute care hospitals and LTACHs.

- Dependent Variable: number of CLABSI infections
- Independent Variable: Healthcare Facility type (Acute care hospitals and LTACHs)
- Statistical Analysis: Chi-square Analysis

$H_0$8: There is no difference in number of CLABSI between Acute care hospitals and Inpatient Rehabilitation Facilities.

- Dependent Variable: number of CLABSI infections
- Independent Variable: Healthcare Facility type (Acute care hospitals and IRFs)
- Statistical Analysis: Chi-square Analysis

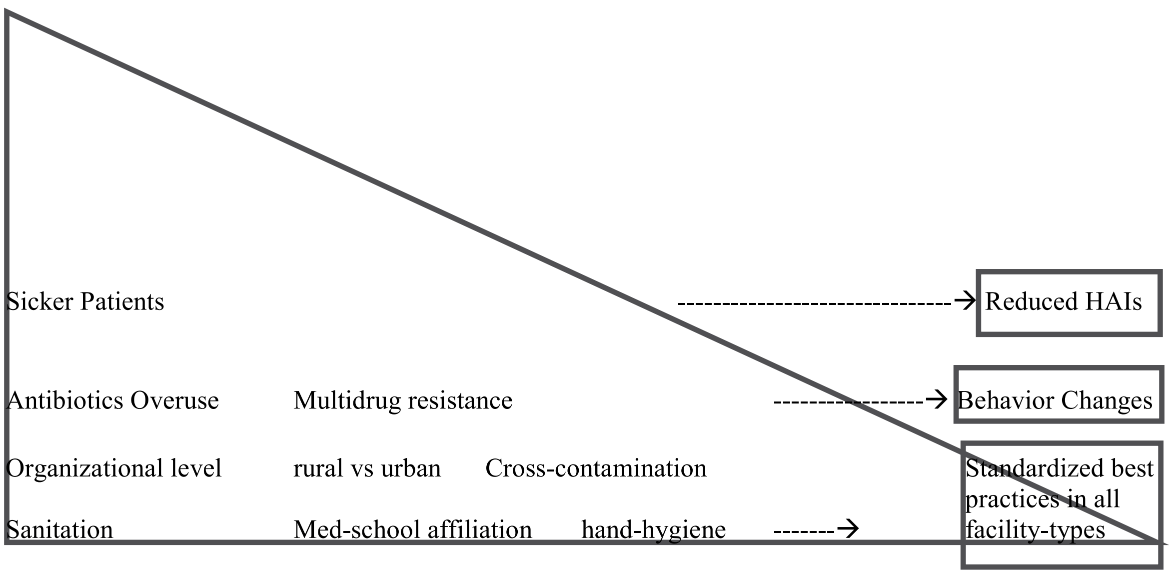
$H_0$9: There is no difference in number of CLABSI between IRFs and LTACHs.

- Dependent Variable: number of CLABSI
- Independent Variable: Healthcare Facility type (IRFs and LTACHs)
- Statistical Analysis: Chi-square Analysis

Conceptual Framework

Figure 1 reveals the social determinants of HAIs and this conceptual model was adapted from the environmental determinants of infectious disease (EnvID) framework. The EnvID uses a systems theory approach to incorporate and analyze different information from numerous disciplines (Eisenberg et al., 2007). The EnvID incorporates three interconnected features of the environment to disease relationship, including (a) changes in the environmental, (b) the transmission dynamics of infectious diseases, and (c) the outcome between changes in the environment and the transmission cycle of disease pathogens (Eisenberg et al., 2007). The EnvID framework incorporates a multifaceted array of social and ecological factors that may influence disease such as climate change, road projects, or deforestation (Eisenberg et al., 2007). The concepts for this study were entered into the EnvID framework in order to answer the question of how the hypotheses of this model relate to this study.

Conceptual Model



Distal ---→ **Proximal**

Note. Idea adapted from Eisenberg, J., Desai, M., Levy, K., Bates, S., Liang, S., Naumoff, K., Scott, J. (2007). Environmental determinants of infectious disease: A framework for tracking causal links and guiding public health research. *Environmental Health Perspectives, 115*(8), 1216-1223. doi:10.1289/ehp.9806

Figure 1. Social Determinants of HAIs

Nature of the Study

The research method for this study was a quantitative, auxiliary information examination. The quantitative method has gained wide approval by helping researchers to know how common or widespread something is (Creswell, 2009). Quantitative exploration may be utilized to test theories or speculations, to decrease an issue into a smaller measure of variables, and to accommodate the examination of the connections between the variables and potentially set up an association (Wimba, 2009). A quantitative correlational research study, using archival data from a 2012 NHSN report, was used to determine whether a relationship exists between HAIs and types of health care facilities. This study design was cross-sectional in the form of an analytical approach to investigate the association between healthcare facilities and HAIs. A non-parametric correlational statistical test was used to determine whether an association exists between healthcare facilities and HAIs.

Definitions and Key Terms

Terms unique to this study are described in this section, to include terms with numerous definitions, and terms specific to the medical or nursing world:

CDC location. Patients are housed in a similar location to receive care for medical or surgical issues. According to the CDC, location is determined using the 80% rule. If 80% of the patient population are of a certain ilk, then the area is named based on the type of location (CDC, 2015b).

Device-associated infection. An infection that meets the requirements of a HAI and is associated with a particular device like an indwelling catheter (CDC, 2015b). If the device was placed longer than 2 days and a HAI occurs, or if a HAI occurred the day of/the day after the device was removed, the infection is considered associated to the device. For patients who were admitted to a hospital with a device, the first day the device was accessed is considered day one (CDC, 2015b).

Healthcare-associated infection. The term HAI is reserved for infections that meet certain NHSN criterion, and occur on/after the third day of admission to an inpatient unit where day one is considered the day of admission (CDC, 2015b).

In-patients. A patient who is admitted to a facility for treatment that requires at least one overnight stay (CDC, 2015b).

Sedation vacation. Sedation is held for a determined amount of time to assess the wakefulness of patients on mechanical ventilation (Khan et al., 2014).

Sentinel event. A sentinel event is an unplanned occurrence that involves the risk or actual psychological or serious physiological injury (Agency for Healthcare Research and Quality, 2014).

Teaching hospital. The NHSN list teaching hospitals into three categories: (a) major teaching hospitals are facilities that host medical and postgraduate medical training; (b) graduate programs host students at the postgraduate level, and (c) while undergraduate teaching hospitals hosts medical students only (CDC, 2015b).

Dependent Variables

HAIs, or nosocomial infections, are characterized as infections that were not present when a patient was admitted to a healthcare facility (World Health Organization, 2016), and occurred on/after the third day of admission to an inpatient unit where day 1 is considered the day of admission (CDC, 2015b). HAIs are some of the most preventable causes of death in the United States (HealthyPeople.gov, 2014). HAI is measured at the nominal (categorical) level, where number of VAPs, CAUTIs, and CLABSIs were obtained. HAIs were extracted from the NHSN archival sources, meaning the data was gathered at a previous time.

Ventilator-associated Pneumonia (VAP). A ventilator is a life-saving piece of equipment used to introduce oxygen into a patient's airway (CDC, 2010). Infections occur in the airway when pathogens enter the patient's respiratory system, and the patient shows signs of a new or worsening infiltrate, elevated white blood cell count, fever, and changes in the characteristics of their sputum 48 to 72 hours after endotracheal intubation (Kalanuria, Zai & Mirski, 2014). VAP is the most well-known disease in Intensive Care Units, and is the essential driver for patients to be placed on antitoxins in Intensive Care Units (Borgatta & Rello, 2014). VAP rates range from 1.2 to 8.5 cases per 1,000 mechanically ventilated (mv) days, and occurs in 9% to 27% of all mv patients (Kalanuria et al., 2014). Although the mortality for VAP is less than 10%, the estimated associated cost is $40,000 per patient, extended time for patients to remain on mechanical ventilation, and longer stays in Intensive Care Units and hospitals (Borgatta & Rello, 2014).

Catheter associated urinary tract infections (CAUTIs). CAUTIs are one of the most common HAIs reported to the NHSN (CDC, 2015c). Appropriate use of urinary catheters includes the prevention of urinary retention, accurately measuring urine output, especially in critically ill patients, assisting in wound healing of incontinent patients who are bedbound, and as a comfort measure for those receiving palliative care (Healthcare Infection Control Practices Advisory Committee, 2009). Urinary catheters are inserted into the bladder and account for about 75% of CAUTIs acquired in hospitals (CDC, 2015c). About a quarter of all inpatients are given a urinary catheter; the largest risk for CAUTIs is extended use of the urinary catheter (CDC, 2015c). CAUTIs affect approximately 1.7 million American patients per year (Tillekeratne et al., 2013). A metaanalysis reported CAUTI rates of 3.4 cases for every 1,000 days a catheter remains in a patient's bladder in American Medical-Surgical Intensive Care Units (Tillekeratne et al., 2013).

Catheter related blood stream infections (CRBSI)/central line-associated bloodstream infection (CLABSI). The vocabulary used to describe various types of catheters is unclear because some researchers and practitioners reference various characteristics of catheters informally (CDC, 2011a). Catheters are labeled based on the area of the body they occupy (CDC, 2011a). Similarly, the vernacular used to define intravascular catheter-associated infections is confusing, since CRBSI and CLABSI are commonly used interchangeably, even though the meanings are not the same. The term CRBSI is used as a clinical definition to diagnose and treat patients, and requires precise laboratory test to identify whether the catheter is actually the cause of the infection (CDC, 2011a). CRBSI is not usually used for surveillance purposes. It is difficult to determine if a blood stream infection (BSI) is a CRBSI since the indwelling catheters in patients cannot always be removed, some laboratories do not perform quantitative blood cultures, and labeling of the catheters by healthcare personnel must be accurate (CDC, 2011a). The term CLABSI is a more simple term used by the NHSN. CLABSI is a primary BSI that occurs within 48 hours of an infection and is unrelated to an infection from another source (CDC, 2011b). Nearly 70% of CLABSIs are preventable, and it has been long established that prolonged use of central lines are associated with higher infection rates (Jones, Stewart & Roszell, 2015).

Independent Variables

Healthcare facilities or health facilities are institutions that provide healthcare services and include hospitals, outpatient care centers, clinics, and specialized care centers (MedlinePlus, 2015). There are various subcategories of healthcare facilities, for instance, Critical Care Units, Step-Down Units, and Inpatient Wards. The three most common types of Healthcare Facilities (Acute Care Hospitals, LTACHs, and IRFs) were extracted from the NHSN's 2012 archival report and represented the dependent variable in this study.

Acute care hospitals. There is limited amount of evidence-based literature on the definitions for Acute Care Hospitals. Acute care services at the individual or population level are time sensitive, and often performed rapidly to promote health, prevention, curation, rehabilitation, or palliation (Hirshon et al., 2012). According to the Connecticut Department of Health (n.d.), Acute Care Hospitals are short-term hospitals that boast medical staff, and supporting personnel to diagnose, care and treat patients for serious conditions.

Long-term acute care hospitals (LTACHs). LTACHs originated in the 1990s to attempt to expedite the discharge of patients with complex healthcare needs from Intensive Care Units and to decrease Medicare costs (Weinstein & Munoz-Price, 2009). The patient populations in this type of healthcare facility have numerous comorbidities, including (a) patients are hospitalized for 25 days on average, (b) are exposed to multiple drug resistant organisms, and (c) often have high rates of HAIs (Weinstein & Munoz-Price, 2009).

Inpatient rehabilitation hospitals (IRFs). IRFs serve a single part of a patients' care after being discharged from acute care service, and are governed by the rules of the CMS (CMS, 2013). IRFs use a multidisciplinary team to focus on individualized care to restore the skills, function, mobility, and independence of patients. Patients are expected to exercise a minimum of three hours per day and stay in the IRFs an average of 13 days (American Medical Rehabilitation Providers Association, 2015). However, in the course of the patient's rehabilitation stay, they may be exposed to HAIs during treatment sessions since they may share exercise equipment, and socialize with others (Widner, Nobles, Faulk, Vos & Ramsey, 2014).

Assumptions

This study was based on data reported by the NHSN by contributing healthcare facilities in the United States, who reported voluntarily and/or as a result of state mandates, federal reporting programs, and quality prevention initiatives. It was assumed all facilities reported data on HAIs truthfully and timely, and was representative of their population.

Scope and Delimitations

Several types of hospitals contributed data on HAIs to the NHSN, for instance, children's, military, oncology and psychiatric hospitals (Dudeck et al., 2013). Yet, only three types of facilities were chosen, including (a) Acute Care Hospitals, (b) LTACHs, and (c) IRFs. These three facility types were chosen based on the categories of type of location reported to the NHSN in 2012. Types of location vary from Burn Units to Adult Ward in LTACHs. However, the scope of this study was limited to the type or category of the healthcare facility, and not a specific kind of facility or a specific type of unit. In 2012, the amount of 4,444 facilities located across 53 regions of the U.S., including states, territories and the District of Columbia enrolled a minimum of one month of device-associated data based on patients who were being monitored in healthcare facilities (Dudeck et al., 2013). The result of this study was generalizable to the U.S. population since the sample is nationally representative.

Limitations

This study used secondary data previously collected for a different reason. Limitations to the use of secondary data include limited data quality. The data for this study was from a NHSN 2012 report, which is summary data because actual data was unavailable. Thirteen different types of hospitals contributed to this archival data source, but only three facility types were selected. Dudeck et al (2013) explained certain characteristics of the type of hospital that may affect the rates of HAIs, for instance, the amounts of patient beds available, rural versus urban hospitals, or whether a hospital was affiliated with a medical school. This study did not break down the amount of beds available in the chosen facility types, nor did this study breakdown whether the selected type of facility was geographically located in an urban or rural area, nor did this study delineate whether the facility type was affiliated with a medical school. Furthermore, no prior studies could be found that queried the relationship between facility types and the three chosen types of HAIs, as listed in the aforementioned CDC 2012 report. Several researchers have reported singular studies on interventions used in their particular setting to reduce HAIs, but no researcher could be found that compared HAIs to the many facility types. Moreover, this study design was cross-sectional in the form of an analytical approach; therefore, causation could not be confirmed (Aponte, 2010). These limitations could be improved in the future with greater access to the NHSN database, instead of using summary data. Additionally, chi-squared tests of independence were used to evaluate the research question and the available data for seven hypotheses. Since seven individual chi-square tests were conducted, this increased the chance of type 1 errors (Peres-Neto, 1999). However, Bonferroni adjustment was used on the results received from the chi-square tests. To calculate the Bonferroni adjustment, the significance level (.05) was divided by the number of tests (.05/7=.007), which means if any *p*-values were larger than .007, the results were not statistically significant (Laerd Statistics, 2013). As realized in Table 9, the *p*-values for six hypotheses were .001 or less; meaning, these results were likely significant.

Significance of the Study

The CMS (2014) does not reimburse hospitals for conditions that were absent on admission, including CLABSIs and CAUTIs (Office of Disease Prevention and Health

Promotion, 2014). Furthermore, The Joint Commission's National Patient Safety Goal aims to reduce the risk of HAIs, and specifically considers death or serious disability sustained as a result of a HAI to be a sentinel event (Office of Disease Prevention and Health Promotion, 2014). Information discovered from this study found an association between healthcare facilities and HAIs; thus, allowing for practical measures that could be taken to target certain facility types. This study influenced positive social change by revealing the gap in the research in the various facility types of the healthcare system. While Acute Care Facilities are leading the healthcare industry in terms of research on HAIs, evidence-based research in other facility types is sparse. Nonetheless, patients leave Acute Care Facilities, are housed in several other facility types, and often return to Acute Care Facilities. A recommendation is to use a systems approach to standardize HAI prevention best practices to all facility types across the healthcare system.

Summary and Conclusions

HAIs are commonplace, although the rates for most HAIs are decreasing, thousands of people continue to die prematurely each year from these conditions (AHRQ, 2012). Eliminating HAIs is a top priority for the U.S. Government, and many healthcare facilities. Thirty-two states were mandated to report HAI data to the NHSN (CDC, 2015d). As a result of these requirements, facilities have been using individualized, institution-specific surveillance to prevent, manage and curtail HAIs (Sydnor & Perl, 2011). Since no single system exists to monitor all HAIs in the various facility types in the U.S., it is difficult to state the reliability of all the institution-specific surveillance; therefore, the U.S. continues to have a piecemeal system to address HAIs in all facility types. This is especially troubling because there are, and have been for quite some time established methods to reduce or prevent HAIs, and as a result, health care providers are under immense pressure to decrease the burden of these infections (AHRQ, 2012). The CDC (2015a) reports more than half of all HAIs do not occur in Intensive Care Units, but limited studies are available to describe where the majority of HAIs occur. Facility types like LTACHs and IRFs, where patients often transition to after their stay in Acute Care Hospitals, lack evidence-based data on HAIs. The available research performed in the United States is mostly older than five years old. As the U.S. population ages and patients are quickly discharged from Acute Care Facilities to other facilities for medical and nursing care, there needs to be current U.S. data to support the implementation of infection control measures and surveillance of nosocomial infections in all facility types.

This study provided valuable insight into three widespread HAIs, and a comparison of HAIs among three facility types in the U.S. This study influenced positive social change by revealing the gap in research in the various facility types of the U.S. Healthcare system. Chapter 2 provides a conceptual model for this study, with a focus on VAPs, CAUTIs, and CLABSIs and how they manifest in facility types like Acute Care Hospitals, LTACHs, and IRFs. The history of HAIs is discussed, including present issues that affect certain facility types, as well as reporting gaps and inconsistencies in previous research studies.

Chapter 2: Literature Review

Introduction

HAIs continue to be a major source of concern in all types of health care facilities, costing the healthcare industry billions of dollars annually (AHRQ, 2012). Eighty percent of all HAIs occur as a result of four specific infections (a) VAPs, (b) CAUTIs, (c) CLABSIs and (d) surgical site infections (SSIs), [AHRQ, 2012]. HAIs may be acquired in any facility in which healthcare is provided, for instance LTACHs, or IRFs. Umscheid et al (2011) estimated the associated cost and mortality of the extent of HAIs in American hospitals that are judiciously preventable. Between 65-70% of catheter-associated blood stream infections and 55% of VAP cases may be avoidable (Umscheid et al., 2011). Nevertheless, even though the impetus is there to eliminate HAIs, not all HAIs are preventable; almost 33% of CAUTIs and CLABSIs, and nearly 50% of all cases of VAPs are inevitable (Umscheid et al., 2011).

There is, and have been for quite some time, established methods to reduce and in some cases prevent HAIs; as a result, health care providers are under pressure to decrease the occurrence of these infections (AHRQ, 2012). Chapter 2 describes the three most common device-associated HAIs (VAPs, CLABSIs, and CAUTIs). In addition, this is a review of the role of the various facility types which includes Acute Care Hospitals, LTACHs, and IRFs. Determinants of HAIs, current research on HAIs, and what is known about various facility types are discussed based on the hypotheses being studied.

Literature Search Strategy

CINAHL, PUBMED, MEDLINE, Walden Library and Google Scholar were the top databases searched. The search words were *VAP, CAUTI, CLABSI, Acute Care Hospitals, LTACHs, Inpatient Rehabilitation, Nosocomial Infection and Healthcare associated infections and HAIs.* Once journal articles were retrieved, their reference lists were scoured and articles missed in the course of the initial search were included. Next, a search was performed using Google to make certain the search was inclusive of all the studied variables.

Inclusion Criteria

The purpose of this literature review was to find peer-reviewed studies pertaining to VAP, CAUTI, CLABSI, Acute Care Hospitals, LTACHs, and IRFs primarily focused on studies performed in the United States. Although HAIs are a worldwide problem, mostly studies performed in the U.S. were included because data analysis was conducted on secondary data that was collected from American residents. A total of 83 abstracts were located in PubMed, and then the full texts were sourced from Walden's Library and Google Scholar. A few studies dating back to the 1940's and 1950's were included to establish a historical perspective of the dependent variables. The strategy of this literature review focused on nine governmental websites and targeted full text scholarly journals, which included five retrospective, cohort, one prospective control trial, five prospective trials, six observational studies, 30 descriptive reports, nine governmental websites, seven surveys, two guidelines, and one discussion paper.

Exclusion Criteria

Only journals published in English were reviewed. Thirty-three journals were excluded, some of which were hypothetical models, opinion papers, or older than 5 years. Most studies performed outside of the U.S., were excluded, especially those performed in developing countries with dissimilar healthcare systems to the United States.

Historical Perspective

The first accessible peer-reviewed article on a HAI that could be located was by Wright (1940), who described how 2,831 infants were hospitalized in Prague, Czech Republic in 1858 and died from gastro-enteritis and septicemia. This tragedy led to mass hysteria, causing parents to fear seeking medical treatment. Rauchfuss, Grancher, and Hutinel made the first attempt at the end of the 19th century to provide isolation quarters, to detect infectious diseases, and to introduce sanitary actions into Children's Wards (Wright, 1940). These measures resulted in a decrease in mortality from 40% to 8% in one hospital (Wright, 1940). Yet, the awareness of HAIs dates back to over 150 years from the era of Florence Nightingale (a nurse) and Ignaz Semmelweis (a physician) in the 1800s (Mitchell & Gardner, 2013). Lane, Blum and Fee (2010) described how in 1847 Ignaz Semmelweiss reported how childbed fever was dispersed on the contaminated hands of Health Care Workers (HCWs), which was a stimulus that led to aseptic and antiseptic techniques. Similarly, Nightingale's legacies include teachings about sanitation and improving environmental hygiene, and the proposal for nurses to survey HAIs (Mitchell & Gardner, 2013). In the 1950's the public's eye was captured by staphylococcus aureus infections. This led to another paradigm shift, which led surgeons, infectious disease physicians, and microbiologists to focus on epidemiology and the management and control of HAIs. The efforts of these pioneers morphed into the idea that healthcare facilities had the ability and the obligation to prevent HAIs. The 1960's saw the establishment of hospital-based HAI control programs. Then by the 1970's, these programs increased substantially. In the latter years of the 1970's, the movement of HAIs in the U.S. morphed again, but this time it changed into a mandate, where the Joint Commission required healthcare facilities to adopt infection control programs. Nonetheless, the trend in the last ten years is for healthcare facilities to account for HAIs to their Department of Health, and as of January 31, 2013, 71% of U.S. States and territories instituted mandatory reporting laws (Herzig, Regan, Pogorzelska-Maziarz, Srinath & Stone, 2014).

Literature Review Related to Key Variables and/or Concepts

Healthcare-Associated Infections (HAIs)

The surveillance of HAIs is essential for patient safety, quality management, hospital budgeting, legal reasons, as well as public reporting (Adlassnig et al., 2014). The definition used to describe HAIs is described by The CDC (2015a), and is defined as infections that occurred on or after the third calendar day the patient was admitted to a healthcare facility. It is vital to understand there are different types of surveillance when it comes to HAIs.

There are several types of HAI surveillance methods. Sydnor and Perl (2011) describe hospital wide surveillance as the most common form of epidemiological surveillance. It is the most comprehensive, and includes ongoing surveys to identify HAIs. This method is expensive and pinpoints infections that cannot be prevented, and therefore this method is not usually recommended. Prevalence surveys determine the amount of new and existing cases of a particular organism in a specific location during a specified period of time. This type of survey may be used in single units or facility-wide, and is used to determine disease burden of particular organism, in addition to assessing the risk factors for some organisms in certain populations. Targeted surveillance focuses on specific units, patient population, and organism (for instance VAP, CAUTI or CLABSI). This type of surveillance allows Infections Prevention Practitioners to focus on high-risk patients and areas where evidence-based interventions have been proven to be successful. While periodic surveillance occurs only in specified time periods, for example every month, but this method is less time consuming and less expensive. A literature review on HAIs revealed that prevention measures and interventions to curtail HAIs are based on institution-specific surveillance; but from a public health point of view, which is to help the most amount of people at a time; a wider viewpoint is needed to study the issue of HAIs. On account of targeted surveillance, it is difficult to find data on the incidence of HAIs that occur outside of Intensive Care Units (Kang, Sickbert-Bennett, Brown, Weber, & Rutala, 2014).

Determinants. Historically, it was thought that the aerial spread of dust was associated with the spread of infection, whether from the sweeping of floors, to the fluffing of sheets from bed making, but it was later found that the role of dust in cross-infection was inconclusive (Edward, 1944). Nowadays, risk factors for HAIs includes the growing numbers of immunocompromised patients, doctors pervasively ordering broad-spectrum antibiotics for their patients, more invasive surgical procedures, as well as an aging population with numerous comorbidities (Kang et al., 2014).

Inhibitors to the Prevention of HAIs

Hand washing. Hand hygiene has long been touted as the most essential measure to prevent cross contamination of antimicrobial-resistant pathogens, and HAIs (Erasmus et al., 2010). Yet, when public health officials observed HCWs performing hand hygiene, compliance rates were inadequate. In a systematic review of research studies on compliance with the guidelines of hand hygiene in hospital settings, Erasmus et al (2010) found an overall median compliance rate of only 40%. Smiddy, O'Connell and Creedon (2014) found perceptions of the work environment and motivational factors are two fundamental concepts that seem to influence how HCWs comply with hand hygiene guidelines. Motivational factors are engrained in behaviorism, while the HCW's perception of the work environment is based on structural empowerment (Smiddy et al., 2014). Nevertheless, hand hygiene is a universal problem that needs standardized measures monitoring compliance (Erasmus, 2010; Smiddy et al., 2014).

Nurse burnout. A systematic review of 42 articles found the type of care a patient receives is associated with the prevalence of HAIs (Cimiotti, Aiken, Sloane & Wu, 2012). Cimiotti et al (2012) examined the effect of nurse staffing ratios and the burnout of nurses on two types of HAIs (urinary tract infections and SSIs). These researchers found the rates of these HAIs to be significantly lower in hospitals where nurses took care of fewer patients, and even increasing the nurse to patient ratio by a single patient was significantly associated with surgical site and urinary tract infections (Cimiotti et al., 2012).

Independent Variables

Acute care hospitals. Half of all HAIs have been reported in intensive care units (Milosevic, 2014). This literature review revealed most studies on HAIs were performed in acute care facilities, and it is difficult to find data on the incidence of HAIs outside of Intensive Care Units (Kang et al., 2014). A major theme or trend in HAIs is the use of chlorhexidine gluconate (CHG) products. Numerous studies have identified that bathing patients daily with CHG products significantly reduce the risk of HAIs (Cassir et al., 2015; Kassakian, Mermel, Jefferson, Parenteau & Machan, 2011; Popp, Layon, Nappo, Richard & Mozingo, 2014). A second theme is the use of electronic technology to prevent, identify, monitor, and reduce HAIs. Schnall and Iribarren (2015) concluded the use of mobile telephone applications may improve cases of HAIs by providing easier access to guidelines of monitoring and support hand hygiene, and even step-by-step procedures used to decrease HAIs in clinical settings. Other studies described how electronic monitoring may be used to alert clinicians, which could result in earlier treatment interventions for patients (Koller, Black, Mandl, Rappelsberger & Adlassnig, 2013; Woeltje, Lin, Klompas, Wright & Zuccotti, 2014). The third theme was the use of bundles to assist clinicians in the care of patients. A bundle is similar to a framework where it provides structured evidence-based interventions to improve healthcare and patient outcomes by providing clear, consistent best practice approaches in a uniform and reliable manner (Institute of Healthcare Improvement, 2016). Bundles have been used in the care of numerous HAIs across the U.S., but were only effective when hospitals used the bundles consistently (Furuya et al., 2011).

Long-term acute care hospitals (LTACHs.). LTACHs are usually privately owned for-profit facilities that care for patients with long-term complex conditions (Marchaim et al., 2011). LTACHs originated in the 1980s to attempt to expedite the discharge of patients with complex healthcare needs from Intensive Care Units, in order to decrease Medicare costs (Weinstein & Munoz-Price, 2009). The patient populations in this facility-type has numerous comorbidities, are hospitalized for 25 days on average, are exposed to multiple drug resistant organisms, and often have high rates of HAIs (Weinstein & Munoz-Price, 2009). Admissions to LTACHs have increased astronomically from 13,732 patients in 1997, to 40,353 patients in 2006 (Marchaim et al., 2011). Studies on HAIs in LTACHs are also very limited (Eriksen et al., 2006; Munoz-Price, 2009). From a historical point of view, in 1973, the National Nosocomial Infection Survey (now called the NHSN) conducted a prospective study on the rates of HAIs nationwide. That study was performed on acute-care facilities, but no comparable surveys could be found for long term care institutions who deliver nursing care (Cohen, Hierholzer, Schilling & Snydman, 1979). By the same token, this literature review found a miniscule amount of peer-reviewed articles on HAIs performed in LTACHs.

Edward, Pupura and Kochvar (2014) explained a challenge unique to LTACHs is that central lines are usually inserted at a prior facility; therefore, LTACHs have no control in the insertion or maintenance techniques. In addition, patients admitted to LTACHs are usually already colonized with multi-drug resistant organisms, have been receiving antibiotics and have an implanted device for prolonged use (Munoz-Price, 2009). Studies in evidence-based studies in LTACH and HAIs performed in the United States in the last five years are very limited to nonexistent.

Inpatient rehabilitation facilities (IRFs). IRFs are governed by the rules of the CMS (CMS, 2013). IRFs use a multidisciplinary team to focus on individualized care to restore the skills, function, mobility, and independence of patients. Patients are expected to exercise a minimum of three hours per day, and stay in IRFs an average of 13 days (American Medical Rehabilitation Providers Association, 2015). During the patient's rehabilitation stay, they may be exposed to HAIs during treatment sessions, since they may share exercise equipment and socialize with others (Widner, Nobles, Faulk, Vos & Ramsey, 2014). This literature review found studies on IRFs were even sparser than the above facility types.

Dependent Variables

Ventilator-associated pneumonia (VAP). Since there is no single source available in the U.S. to monitor HAIs across all facility-types, like other authors (Erasmus et al., 2010; Magill et al., 2014), data for the three independent and dependent variables were obtained from various sources. The strength of these approaches is that researchers were able to estimate the burden of HAIs in the U.S; however, the weakness of these very methods is the absence of precise estimates of HAIs in all facility types nationwide.

A ventilator is a mechanical device used to breathe for/assist a patient to breathe. Although a ventilator is a life-saving piece of equipment, it also increases the patient's risk of acquiring pneumonia, because it provides a direct portal for germs to enter the lungs (CDC, 2010). VAP is a HAI that occurs in patients who were initiated on mechanical ventilators 48 hours or more once their airway was intubated (CDC, 2015b). In 2011, a national HAI prevalence survey found an estimated 157,500 cases of healthcare-associated pneumonias that occurred in acute care facilities (CDC, 2015b). Overall, the use of ventilators in different hospital units ranged from 0.01 to 0.4 per 100 patient days; while the pooled incidence of VAP among these units were 0.0 to .4 per 1,000 ventilator days (Dudeck et al., 2013). Buczko (2009) examined 13,759 patients who were on Medicare, and who received continuous ventilation in calendar year 2004, and who resided in long term care facilities and found almost 25% of this patient population contracted VAP, men were more likely to contract VAP, Blacks and Hispanics were less likely than Whites, and other races to acquire VAP, and length of stay and Medicare charges were higher for patients with VAP when compared to patients who did not contract a VAP (Buczko, 2009).

Catheter associated urinary tract infections (CAUTIs). CAUTIs are a standout amongst the most well-known HAIs that is accounted to the NHSN (CDC, 2015). Appropriate use of urinary catheters include the prevention of urinary retention, to accurately measure urine output especially in critically ill patients, to assist in wound healing of incontinent patients, for patients who are bedbound – such as those with spinal trauma or pelvic fractures, as well as a comfort measure for those receiving palliative care (Healthcare Infection Control Practices Advisory Committee, 2009). Urinary catheters are inserted through the urethra into the bladder and account for approximately

75% of CAUTIs acquired in a hospital (CDC, 2015). Up to 25% of hospitalized patients receive a urinary catheter and the largest risk for CAUTI is extended use of the urinary catheter (CDC, 2015). CAUTIs affect approximately 1.7 million American patients per year (Tillekeratne et al., 2013). Nevertheless, a 2013 progress report on HAIs revealed a six percent rise in CAUTIs between 2009 and 2013, but 2014 data revealed that cases of CAUTIs were on the decline (CDC, 2015b).

Central line-associated blood stream infection (CLABSI). As patients come to be more critically infirmed, there is increased use of central venous catheters, and although CVCs are meant to facilitate the treatment of patients, they are associated with increased illnesses, mortality, and lengthened hospital stays (Tang et al., 2014). The mortality rate for CLABSI ranges from 12% to 25% (CDC, 2011b). A number of evidence-based interventions exist to counteract CLABSI which include proper hand hygiene, sterile technique during insertion, insertion of CVCs into areas where they are less likely to become contaminated - like the subclavian or jugular vein as opposed to the femoral vein, meticulous skin care using CHG skincare products, and daily reevaluation of the necessity of the CVC (Tang et al., 2014). Still, in the last decade, the patterns of CLABSI incidence density rates have changed substantially in American Intensive Care Units, resulting in a decline of approximately 60% (Fagan, Edwards, Park, Fridkin & Magill, 2013). Nevertheless, nearly18,000 CLABSI cases keep showing up in American Intensive Care Units yearly, adding to patient demise and expanded healthcare expenses (Fagen et al., 2013). Nonetheless, a 2013 progress report on HAIs revealed a 46% drop in CLABSIs based on the ten procedures that were under surveillance from 2008 to 2013 (CDC, 2015b).

Prevention Measures

A meta-analysis of quasi-experimental studies and randomized control trials were performed in several units of Acute Care Hospitals and the use of CHG products were a common theme. Cheng, Cao, Li, Li and Zhang (2014) investigated the daily use of CHG for baths and found that baths performed daily with CHG products were significantly associated with decreased incidence of VAP. Other prevention measures of VAP included semi-recumbent body positioning, daily sedation vacation from the ventilator and proper hand hygiene (Cheng et al., 2014).

Fink et al (2011) examined the infection control prevention practices of indwelling urinary catheters performed at 75 Acute Care Hospitals of a nationwide program of the Hartford Institute of Geriatric Nursing. The results of this study varied, for instance 97% of healthcare personnel wore gloves, 89% washed their hands, and 81% maintained a sterile barrier; while 73% remembered to use a no-touch technique. Other prevention measures of CAUTIs were that 64% of hospitals provided training in CAUTI prevention to new graduates, but only 47% of hospitals confirmed their staff maintained competencies in the sterile techniques required for indwelling urinary catheters. Prevention measures for CLABSI include CHG skin preparation, hand hygiene, avoidance of placing central lines to the groins and discontinuing the use of unnecessary lines (Hsu, Weeks, Yang, Sawyer & Marstellar, 2014).

Summary and Conclusion

HAIs are commonplace in modern society and thousands of people die prematurely each year from these conditions. Eliminating HAIs is a top priority for the U.S. Government and many facilities alike. This literature review revealed no single source exists to monitor HAIs across all facility types in the U.S. Most of the current literature available reports only on Acute Care hospitals, even though more than 50% of HAIs transpire outside of Intensive Care Units. Many researchers report successful strategies to significantly reduce HAIs, for instance, the use of CHG wipes. Nevertheless, the cost and sustainability of such interventions still needs to be explored. Despite the shortage of experimental studies outside of Acute Care Hospitals, several descriptive and correlational studies do report on HAIs in Acute Care Hospitals, and although some of these data are relevant to other facility-types, LTACH and IRFs face unique challenges like a shortage of personnel and equipment. In additionally, theoretical models for HAIs are also sparse.

Thirty two states have answered the mandate to report data on HAIs to the NHSN (CDC, 2015d), and as a result of these "pay for performance" requirements, facilities have been using individualized, institution-specific surveillance methods to prevent, manage and curtail HAIs (Sydnor & Perl, 2011). Since no single system exists to monitor HAIs in all facility types in the U.S., it is difficult to state the reliability of all the institution-specific surveillance. Therefore, the U.S. continues to have a piecemeal system to address HAIs in all facility-types.

HAIs may be acquired in any facility in which healthcare is provided. It is estimated a third of all HAIs are preventable (Curtis et al., 2013). This is especially troubling because there are, and have been for quite some time, established methods to reduce or prevent HAIs, and as a result, health care organizations are under immense pressure to decrease the burden of these infections (AHRQ, 2012). As the prevalence of HAIs like VAP, and CLABSI decrease in the U.S., the mortality rate and costs are still astronomical, and while several studies provide evidence-based data to guide infection prevention measures, these studies mostly occur in Acute Care Facilities. Conversely, while the prevalence of HAIs is decreasing in American Acute Care Facilities, the prevalence in some other facility types is still unknown. The CDC (2015a), reports more than 50% of all HAIs do not occur in Intensive Care Units. Yet facilities like LTACHs, and IRFs where patients often transition to after their stay in Acute Care Hospitals (or Intensive Care Units), lack current evidence-based data on HAIs, and available studies are dated older than five years. As the U.S. population ages and patients are being discharged quickly from Acute Care Facilities to other facilities for medical and nursing care, there needs to be current U.S. data to support the implementation of infection control measures and surveillance of nosocomial infections in all facility types. This study provides valuable insight into three common HAIs and a comparison of HAIs among three facility types in the U.S. This study may contribute to positive social change by helping to identify any differences as to why HAIs occur/do not occur in certain types of healthcare facilities, thereby helping to prevent them.

Chapter 3 outlines the research design, research question and hypotheses, as well as provides a rationalization for using the selected research design. Additionally, the population, sample, and procedure used to extract the sample from the population are discussed in detail. The procedures, data collection, data analysis, and ethical considerations are debated, as well as an estimation of the power, sample size, and justification for the methods used in the power calculations. Next, a review of the procedures, participants and data collection were explored, as well as instrumentation, possible threats to validity, and measures taken to minimize validity and improve reliability. Finally, ethical procedures used to access and protect the data and its participants are expressed.

Chapter 3: Research Method

Introduction

This quantitative study examined information from the NHSN, which is an electronic database that monitors HAIs across the U.S. (CDC, 2013). The NHSN monitors in excess of 16,000 organizations across the U.S., and information was procured from a 2012 report (CDC, 2015a). This report summarized data collected for the Device-associated Module that were reported to the NHSN by participating hospitals for events that transpired between January to December 2012, and which were reported to the CDC by July 1, 2013 (Dudeck et al., 2013).

The overall purpose and intent of this study was to explore whether types of healthcare facilities in the United States bear any relationship on three major types of HAIs that were listed in the above 2012 report. Chapter 3 outlines the research design, research question and hypotheses, as well as provided a rationalization for using the selected research design. Also, the populace, test, and system used to separate the specimen from the populace were examined. The procedures, data collection, data analysis, and ethical considerations were discussed, as well as an estimation of the power, sample size, and justification for the methods used in the power calculations. Next, a review of the procedures, participants, and data collection was explored, as well as instrumentation, possible threats to validity and measures taken to minimize validity, and improve reliability. Finally, ethical procedures used to access the data and to protect the data and its participants were reviewed.

Research Design and Rationale

This study examined nine hypotheses, querying the relationship between types of healthcare facility types and three common types of HAIs listed in a CDC 2012 report. This study design was cross-sectional in the form of an analytical approach to investigate the association between HAIs and three types of healthcare facilities. There were three independent categorical variables, including (a) Acute Care Hospitals, (b) LTACHs, and (c) IRFs, and three dependent variables, including (a) VAPs, (b) CAUTIs, and (c) CLABSIs. Each dependent variable was measured by obtaining the number of reported infections.

This study was a secondary data analysis of a CDC's NHSN 2012 archived database. Thirteen different types of hospitals contributed to this archival data source, but only the top three facility types were selected. Dudeck et al. (2013) explained certain characteristics of the types of hospitals that may affect the rates of HAIs. For instance, the amount of patient beds available, rural versus urban hospitals, or whether a hospital is affiliated with a medical school. This study did not break down the amount of beds available in the three facility types chosen, nor did this study break down whether the selected type of facility was geographically located in an urban or rural area, nor did this study delineate whether the facility-type was affiliated with a medical school.

Mediating variables lie intermediate to the independent and dependent variables and are intervening factors that has the potential to change the impact of the predictor variable on the outcome variable (Mackinnon, 2011). The mediating variables in this study were units in which patients were located, for example Intensive Care Units, as well as patient acuity. If the relationship between facility types and HAIs were statistically significant among Acute Care Hospitals and LTACHs, then the level of care may be a mediating variable. However, no moderator or mediator was examined in this study.

Archival data was used from a population-level data source in the United States. The advantages of using archived data from the CDC was the availability of recent data on HAIs and health care facilities across the United States, as well as minimal to no cost to use the data. Conversely, disadvantages to using archival data include such things like complex survey designs. Researchers may need to familiarize themselves with the contents of the original research, like the codebook, manuals, and methods to comprehend the original purpose of the research in order to define the validity and reliability of the secondary data (Aponte, 2010).

Research Question and Hypotheses

The research question was created to determine if an association exists between HAIs and three healthcare facility types. This question concentrated on the device-associated module data that was previously gathered by participating hospitals in the NHSN from January to December 2012.

A single research question with nine hypotheses guided this study:

RQ 1: Is there any difference in the number of HAI infections (VAP, CAUTI, and CLABSI) among healthcare facility types (Acute Care Hospitals, LTACHs, and IRFs).

$H_0$1: There is no difference in number of VAP infections between Acute Care Hospitals and LTACHs.

$H1_a$: There is a difference in number of VAP infections between Acute Care Hospitals and LTACHs.

- Dependent Variable: number of VAP infections
- Independent Variable: Healthcare Facility type (Acute Care Hospitals, LTACHs, and IRFs).
- Statistical Analysis: Chi-square Analysis

H_02: There is no difference in number of VAP infections between Acute Care hospitals & IRFs.

$H2_a$: There is a difference in number of VAP infections between Acute Care hospitals & IRFs.

- Dependent Variable: number of VAP infections
- Independent Variable: Healthcare Facility type (Acute care hospitals & IRFs)
- Statistical Analysis: Chi-square Analysis

H_03: There is no difference in number of VAP between IRFs and LTACHs.

$H3_a$: There is a difference in number of VAP between IRFs and LTACHs.

- Dependent Variable: number of VAP infections
- Independent Variable: Healthcare Facility type (IRFs and LTACHs)
- Statistical Analysis: Chi-square Analysis

H_04: There is no difference in number of CAUTI between Acute care hospitals and LTACHs.

$H4_a$: There is a difference in number of CAUTI between Acute care hospitals and LTACHs.

- Dependent Variable: number of CAUTI
- Independent Variable: Healthcare Facility type (Acute care hospitals and LTACHs)
- Statistical Analysis: Chi-square Analysis

$H_0 5$: There is no difference in number of CAUTIs between Acute Care hospitals and IRFs).

$H5_a$: There is a difference in number of CAUTIs between Acute Care hospitals and IRFs).

- Dependent Variable: number of CAUTI
- Independent Variable: Healthcare Facility type (Acute care hospitals and IRFs)
- Statistical Analysis: Chi-square Analysis

$H_0 6$: There is no difference in number of CAUTIs between IRFs and LTACHs.

$H6_a$: There is a difference in number of CAUTIs between IRFs and LTACHs.

- Dependent Variable: number of CAUTI
- Independent Variable: Healthcare Facility type (IRFs and LTACHs)
- Statistical Analysis: Chi-square Analysis

$H_0 7$: There is no difference in number of CLABSI between Acute care hospitals and LTACHs.

$H7_a$: There is a difference in number of CLABSI between Acute care hospitals and LTACHs.

- Dependent Variable: number of CLABSIs

- Independent Variable: Healthcare Facility type (Acute care hospitals and LTACHs)
- Statistical Analysis: Chi-square Analysis

$H_0 8$: There is no difference in number of CLABSI between Acute care hospitals and Inpatient Rehabilitation Facilities

$H8_a$: There is a difference in number of CLABSI between Acute care hospitals and Inpatient Rehabilitation Facilities

- Dependent Variable: number of CLABSIs
- Independent Variable: Healthcare Facility type (Acute care hospitals and IRFs)
- Statistical Analysis: Chi-square Analysis

$H_0 9$: There is no difference in number of CLABSI between IRFs and LTACHs.

$H9_a$: There is a difference in number of CLABSI between IRFs and LTACHs.

- Dependent Variable: number of CLABSI
- Independent Variable: Healthcare Facility type (IRFs and LTACHs)
- Statistical Analysis: Chi-square Analysis

Chi-square tests of independence were used to test the nine hypotheses. This test is used when two nominal variables, each with two or more possible values, are specified. The aim was to determine whether the proportions for one variable were different among values of the other variables. For example, this study sought to understand whether infection rate differed among facility types. Measures of effect include the chi-square value and probability of error (p). A higher chi-square value reflects a greater likelihood that a significant effect was found. Assumptions associated with a chi-square test assume that the individual observations are independent. Further, cell counts must be greater than five (Tabachnick & Fidell, 2007).

Methodology

A quantitative correlational research study, using an archival database from the CDC, was used to determine whether a relationship existed between HAIs and types of health care facilitates. A cross-sectional exploration configuration was utilized to explore the association between facility types and HAIs. A nonparametric chi-square test of independence was used to test the hypotheses.

Quantitative examination was proper for this specific exploration issue as the discoveries between HAIs and facility types were the target of the researcher. The discoveries were summarized in view of the measurements utilized. Quantitative exploration may be utilized to test theories or speculations and diminish an intricate issue into a smaller measure of variables in order to accommodate the inspection of the connections between the desired variables and potentially establish an association (Wimba, 2009).

Sampling and Sampling Procedures

This study was a secondary data analysis of a CDC's NHSN archived database, extracted from the Device-Associated Module and reported by participants to the NHSN for events that transpired between January and December 2012. A non-probability convenience sampling technique was used for this research. Purposive sampling is the non-probability testing where the segments that were researched were in view of the choice of the researcher (Laerd Dissertation, 2012).

Population and Sample

The NHSN's database is broadly utilized to monitor HAIs in the U.S (CDC, 2013). The NHSN affords interested parties with essential information to monitor locales and quantify the advancement of infection control processes (CDC, 2013). This framework monitors in excess of 16,000 organizations across the nation and data from this source was used for this study (CDC, 2015a). Utilizing information from this optional information source is fitting for this examination because the information is in the general population area, this study will not experience the ill effects of mortality, and there was no manipulation of the variables (Ashengrau & Seage, 2008). All extricated information was recorded utilizing the Statistical Package for the Social Sciences (SPSS), 23. Data on HAIs collected from the specific facility types (Acute Care Hospitals, LTACHs, & IRFs) by the NHSN were included in this study; while hospitals that were not enrolled with the NHSN and who were not from the specific facility types, were excluded. The data collection period was the year 2012, and included 4,444 healthcare facilities that were found in 50 states, territories, and the District of Columbia (Dudeck et al., 2013). The target populations were unidentifiable patients admitted to Acute Care Hospitals, LTACHs, and IRFs who acquired VAP, CAUTI, and CLABSI and were reported to the NHSN January to December 2012 (Dudeck et al., 2013).

Sample Size

The available sample for this study was determined by surveillance data reported to the NHSN in 2012. When considering sample size, power is defined as the probability to appropriately reject the null hypothesis that the estimated sample do not differ statistically between the original population and the study group of interest (Suresh & Chandrashekara, 2012). A type II error could occur if the researcher fails to identify an actual difference exist; and as a result, researchers are encouraged to set the false negative rate at a level they can tolerate to ensure their study is sufficiently powered (Ashengrau & Seage, 2008). Eighty percent is an acceptable power, and means a difference will be missed 20% of the time; therefore, power was set at 80% for this research. Several factors determine power, but sample size is one of the most important determinants (Crosby, DiClemente & Salazar, 2006).

A power analysis was performed to determine minimum sample size for the study. With chi-square models, there needs to be at least five counts per cell in the data (Ogus, Yazici & Gurbuz, 2007). For example, a 2x2 table needed to have a minimum of 20 cases. For this study, there were nine sets of 2x2 tables; therefore, a minimum of 180 cases were required. Options used to determine minimum sample size were: alpha error probability = .05.

Procedures for Recruitment, Participant, and Data Collection

The CMS encourages acute care hospitals to notify the CDC of certain HAIs (CDC, 2013). The primary source for data collection was the NHSN, and it was accessed via the CDC's website. It was relevant to collect data from this data source because the NHSN tracks more than 16,000 medical facilities nationwide (CDC, 2015). The NHSN provides interested parties with authoritative data to track areas and measure the advancement of infection deterrent measures (CDC, 2013). This data was stored on the CDC's website under "Data and Reports" and was available to the public at any time of day, free of charge and no permission or consent was required for its use. Specific demographic data were not collected on patients, and no patient identifiable information was part of the database; instead data was collected on the frequency of HAIs (VAPS, CAUTIs, & CLABSIs) in the three specific facility types chosen.

Instrumentation and Operationalization of Constructs

Instrumentation. The primary data source was the NHSN. This data was accessed via the CDC's website and was available free of charge to the public. The NHSN is the largest and most widely used electronic database that tracks HAIs in the United States (CDC, 2013). Furthermore, the NHSN is the best source to retrieve data on HAIs and health care facilities. In 2011, it was mandated Acute Care Hospitals report certain types of HAIs to the NHSN, if those facilities wished to receive full payments from the CMS. This mandate expanded the span of hospitals that contribute surveillance data into the NHSN's national repository (Yokoe et al., 2014). In order to establish validity and reliability in the data collection process of facilities reporting data to the NHSN, all facilities must adhere to the precise definitions of HAIs, as defined by the CDC; data was reported manually or electronically; then the CDC aggregated the data into a single database for 2012 (Dudeck et al., 2013).

Operationalization of Concepts

Independent variables. Healthcare facilities or health facilities are institutions that provide healthcare services and include hospitals, outpatient care centers, clinics, and specialized care centers (MedlinePlus, 2015). There are various subcategories of healthcare facilities, for instance, Critical Care Units, Step-Down Units and Inpatient

Wards. Three facility types were extracted from the NHSN's 2012 archival report (Acute Care Hospitals, LTACHs, & IRFs) and these represent the independent variables of this study.

Acute care hospitals. This literature review revealed a limited amount of evidence-based literature for the definitions of Acute Care Hospitals. Acute care services at the individual or population level are time sensitive and often performed rapidly to promote health, prevention, curation, rehabilitation or palliation (Hirshon et al., 2012). According to the Connecticut Department of Health (n.d.), Acute Care Hospitals are short-term hospitals that boast medical staff and supporting personnel to diagnose care and treat serious conditions.

Long-term acute care hospitals (LTACHs). LTACHs were created in the 1990s to attempt to expedite the discharge of patients with complex healthcare needs from Intensive Care Units, in order to decrease Medicare costs (Weinstein & Munoz-Price, 2009). The patient populations in this type of healthcare facility has numerous comorbidities, are hospitalized for 25 days on average, are exposed to multiple drug resistant organisms, and often have high rates of HAIs (Weinstein & Munoz-Price, 2009).

Inpatient rehabilitation hospitals (IRFs). IRFs serve a single part of a patients' care after being discharged from acute care services. IRFs are governed by the rules of CMS and are sometimes referred to as IRFs (CMS, 2013). IRFs use a multidisciplinary team to focus on individualized care to restore the skills, function, mobility, and independence of patients. Patients are expected to exercise a minimum of three hours per day, and stay in IRFs an average of 13 days (American Medical Rehabilitation Providers

Association, 2015). During the patient's rehabilitation stay, they may be exposed to HAIs during treatment sessions, since they may share exercise equipment and socialize with others (Widner, Nobles, Faulk, Vos & Ramsey, 2014).

Dependent variables. HAIs, or nosocomial infections, or hospital infections are defined as contagions that were absent when a patient was admitted to a healthcare facility (World Health Organization, 2016). HAIs are some of the most preventable causes of death in the United States, yet patients acquire HAIs while receiving treatment for a medical/surgical issue (HealthyPeople.gov, 2014). HAI was measured at the nominal (categorical) level where response options were VAP, CAUTI, and CLABSI. This study focused on whether an association existed between healthcare facility-type and HAIs - VAP, CAUTI, and CLABSI. These HAIs were extracted from a NHSN archival source, meaning the data was gathered at a previous time.

Ventilator-associated pneumonia (VAP). A ventilator is a life-saving piece of equipment that is used to introduce oxygen in a patient's airway system (CDC, 2010). Infections occur in the airway when pathogens enter the patient's respiratory system with the patient showing symptoms of new or worsening infiltrate, elevated white blood cell count, fever, changes in the characteristics of their sputum 48 to 72 hours after endotracheal intubation (Kalanuria, Zai & Mirski, 2014). VAP is the most common infection that befalls the critically ill Intensive Care Unit patient, and is the primary cause for patients to be on antibiotics in the Intensive Care Unit (Borgatta & Rello, 2014). VAP rates range from 1.2 to 8.5 cases per 1,000 mechanically ventilated (mv) days, and occurs in nine to 27% of all mv patients (Kalanuria et al., 2014).

Catheter associated urinary tract infection (CAUTI). CAUTIs are one of the most common HAIs that are reported to the NHSN (CDC, 2015). Appropriate use of urinary catheters include the prevention of urinary retention, to accurately measure urine output especially in critically ill patients, to assist in wound healing of incontinent patients with wounds, for patients who are bedbound – such as those with spinal trauma or pelvic fractures, as well as a comfort measure for those receiving palliative care (Healthcare Infection Control Practices Advisory Committee, 2009). Urinary catheters are inserted via the urethra into the bladder and account for about 75% of CAUTIs acquired in American hospitals (CDC, 2015). A quarter of all inpatients are given a urinary catheter; the largest risks for CAUTIs are extended use of urinary catheters (CDC, 2015). CAUTIs affect approximately 1.7 million American patients per year (Tillekeratne et al., 2013). A meta-analysis reported CAUTI rates of 3.4 cases for every 1,000 days a catheter remains in a patient's bladder in American Medical-Surgical Intensive Care Units (Tillekeratne et al., 2013).

Catheter Related Blood Stream Infections (CRBSI)/Central Line-Associated Bloodstream Infection (CLABSI). The vocabulary used to describe various types of catheters is unclear, because some researchers and practitioners reference various characteristics of catheters informally (CDC, 2011a). Catheters are labeled based on the area of the body that it occupies for instance peripheral, venous or arterial; anticipated timeline for use; insertion site; the pathway taken to insert the catheter; or other special characteristic of the catheter, for example the number of lumens, or whether infused with heparin (CDC, 2011a). Similarly, the vernacular used to define intravascular catheter-associated infections is confusing since CRBSI and central line-associated bloodstream infection (CLABSI) are commonly used reciprocally even though the meanings are not the same. The term CRBSI is used as a clinical definition to diagnose and treat patients and requires precise laboratory test to identify whether the catheter is the source of the blood stream infection (BSI). CRBSI is not usually used for surveillance purposes (CDC, 2011a). It is difficult to determine if a BSI is a CRBSI since the indwelling catheters in the patient cannot always be removed, some laboratories do not perform quantitative blood cultures, and labeling of the catheters by healthcare personnel must be accurate (CDC, 2011a). The term CLABSI is a simpler term used by the NHSN. CLABSI is a primary BSI that occurs within 48 hours of a BSI that is unrelated to an infection from another source (CDC, 2011a). Nearly 70% of CLABSIs are preventable, and it has been long established that prolonged use of central lines are associated with higher infection rates (Jones, Stewart & Roszell, 2015).

Data Analysis Plan

Whenever secondary data is used, there is a potential for missing or miscoded data (Frankrort-Nachmias, 2008). However, discrepancies that could not be resolved were excluded from the data. A 2012 report was accessed and data on the independent and dependent variable included; while data involving other facility types and specific units in those facility types were excluded. The available NHSN data were pooled summary data that was available in pooled means and percentiles. The chosen independent and dependent variables were stratified, and the total cases for the outcome variable summed up and reflected in tables. The SPSS version 23 was used to analyze this secondary data.

Threats to Validity

External validity. All social exploration include estimation or perception, and at whatever point we measure or watch, we need to verify we are measuring or watching what we set out to do. The legitimacy of exploration frequently alludes to the conclusions that are drawn about the nature of our measures (Frankfort-Nachmias & Nachmias, 2008). A significant question is whether the research findings are generalizable to larger populations and whether the findings may be applied to various social and political settings. Two primary issues of external validity are the reactive arrangements in the research procedure, and the representativeness of the sample (Frankfort-Nachmias & Nachmias, 2008).

Representativeness of the sample. Generalizability refers to the extent in which the findings of the research can be generalized to different settings and wider populations (Frankfort-Nachmias & Nachmias, 2008). This sample was the best representation of the U.S. population, especially since the CMS required all acute care hospitals to report HAIs to the CDC in 2011, if they wished to receive full compensation (CDC, 2013). Thirteen facility types contributed data to the 2012 report that was used, but only three facility types were chosen; therefore, results of this study are generalizable to the three facility types chosen.

Timing. The prevalence of most HAIs in the U.S. is decreasing (CDC, 2015a). Data used in this study was collected in 2012; therefore prevalence rates for HAIs could be even lower in some types of facilities at the time of this study. Nevertheless, 2012 was the year targeted for data analysis, but infection rates are always changing.

Location. This study analyzed facility types in which patients acquired HAIs. It is also noteworthy that: The pooled mean rates for CLABSI and central line device utilization (DU) ratios in critical care units of LTACH were higher in all facility types (Dudeck et al., 2013). CLABSI and central line DU ratios were higher in nearly every type of critical care area. Urinary catheter DU ratios and pooled mean rates for CAUTI were higher in the ward units of LTACH, when compared to almost any other types of location on a hospital ward (Dudeck et al., 2013). The pooled mean rates for CAUTIs were significantly higher in non-critical care units of CAHs, than in Critical Care Units of CAH ($p < .0001$), (Dudeck et al., 2013); however, CAH was not a facility-type in this study. Furthermore, category of birth weight and VAP rates were higher in Level two Neonatal Intensive Care Units (NICU), than in Level three NICUs (Dudeck et al., 2013). Nevertheless, NICUs were excluded and units were not stratified by wards, since the focus of this research was facility type, and not ward types. Only non-NICU data were extracted from the dataset.

Internal Validity

Natural variables are changes in the units contemplated amid the exposition period, or changes in the instrument of estimation, or the responsive impact that happened in the study (Frankfort-Nachmias & Nachmias, 2008). According to Frankfort-Nachmias & Nachmias (2008), the following are threats to internal validity, which may invalidate any causal interpretation found in research findings:

History. History denotes all events that happened during the study period might affect the unit or the individuals studied and provide an opposing explanation for changes observed in the dependent variable. For example, during the course of this study, studies were probably being performed nationwide to decrease the prevalence of HAIs in different types of healthcare facilities. Nevertheless, the NHSN 2012 report on HAIs and facility types boast the most current data at the time of this study.

Potential confounding. Confounding variables are brought about by the existence of extraneous factors and distort the association between the independent and dependent variables (Gerstman, 2008). Lurking variables that could influence the outcome of this study were the size of a medical facility (bed size), geographical location and medical school affiliation. Since it was not possible to exclude facility-type based on bed size, geographical location, or medical school affiliation, these variables remained lurking variables and were included.

Ethical Procedures

This study was a quantitative secondary data analysis of archival data found on the CDC's NHSN website. Data was provided in aggregated tables and patient information was completely anonymous. Furthermore, an application was made to Walden's Institutional Review Board (IRB) to ensure this research study complied with Walden's ethical standards, as well as the federal regulations of the United States. The summary data used for this research data was compiled by Dudeck et al (2013), this 2012 report is in the public jurisdiction and patient and institution-specific data were not identifiable, and not a single attempt was made to identify any facility types located in the database. In order to protect the public and maintain academic integrity to the participants and facility types in this study, IRB approval was sought from Walden University's IRB before data was analyzed. The IRB approval number for this study is 08-27-15-0134009.

Summary

There is a heightened level of awareness that seeks to decrease HAIs in healthcare facilities in the United States (United States Department of Health and Human Services, 2016). Although a myriad of studies have investigated the association between HAIs in specific units located in various types of healthcare facilities, no study could be located that compared HAIs in various facility-types. Chapter 3 presented a comprehensive methodology for this quantitative research design of archival data. Some HAIs are more predominant in certain types of units in healthcare facilities (Dudeck et al., 2013); but this analysis focused on whether an association existed among three HAIs that were reported in a NHSN 2012 report. This study had three independent and dependent variables and the chosen statistical test was the chi-square test of independence. Chapter three delineated the methodology used in this quantitative retrospective study of archival data. Potential threats to validity and proposed measures to minimize validity and improve reliability were outlined. Deliberate steps were then taken to maintain data integrity, and data analyses were not performed until approval was obtained from Walden's IRB. Chapter 4 discusses the results, including demographic statistics and representativeness of the population.

Chapter 4: Results

Introduction

The purpose of this study was to determine if facility type is associated with HAIs. This quantitative study had an overall purpose and intention to explore whether types of healthcare facilities in the United States bore a relationship to three major types of HAIs. There were three independent categorical variables, Acute Care Hospitals, LTACHs, and IRFs and three dependent variables, VAP, CAUTI, and CLABSI. Chapter 4 presented the procedure used for data analysis, demographics of the target population, and analyses of the research question and results of the hypotheses.

Data Analysis Procedure

Inferential statistics were used to draw conclusions from the sample tested. SPSS was used to code and tabulate scores collected from the survey and provide summarized values where applicable, including the mean, central tendency, variance, and standard deviation. Chi-squared tests of independence were used to evaluate the research question and hypotheses.

RQ 1: Is there any difference in number of HAIs (VAP, CAUTI, and CLABSI) among healthcare facility types (Acute Care Hospitals, LTACHs, and IRFs).

$H_0$1: There is no difference in the number of VAP infections between Acute Care Hospitals and LTACHs.

- Dependent Variable: number of VAP infections
- Independent Variable: Healthcare Facility type (Acute Care Hospitals, LTACHs, and IRFs).

- Statistical Analysis: Chi-square Analysis

$H_0$2: There is no difference in the number of VAP infections between Acute Care hospitals and IRFs

- Dependent Variable: number of VAP infections
- Independent Variable: Healthcare Facility type (Acute care hospitals and IRFs)
- Statistical Analysis: Chi-square Analysis

$H_0$3: There is no difference in the number of VAP between IRFs and LTACHs.

- Dependent Variable: number of VAP infections
- Independent Variable: Healthcare Facility-type (IRFs and LTACHs)
- Statistical Analysis: Chi-square Analysis

$H_0$4: There is no difference in the number of CAUTIs between Acute care hospitals and LTACHs.

- Dependent Variable: number of CAUTIs
- Independent Variable: Healthcare Facility type (Acute care hospitals and LTACHs)
- Statistical Analysis: Chi-square Analysis

$H_0$5: There is no difference in number of CAUTIs between Acute Care hospitals and IRFs.

- Dependent Variable: number of CAUTIs
- Independent Variable: Healthcare Facility type (Acute care hospitals and IRFs)
- Statistical Analysis: Chi-square Analysis

$H_0$6: There is no difference in the number of CAUTIs between IRFs and LTACHs.

- Dependent Variable: number of CAUTIs
- Independent Variable: Healthcare Facility type (IRFs and LTACHs)
- Statistical Analysis: Chi-square Analysis

$H_0$7: There is no difference in the number of CLABSIs between Acute care hospitals and LTACHs.

- Dependent Variable: number of CLABSIs
- Independent Variable: Healthcare Facility type (Acute care hospitals and LTACHs).
- Statistical Analysis: Chi-square Analysis

$H_0$8: There is no difference in the number of CLABSIs between Acute care hospitals and IRFs.

- Dependent Variable: number of CLABSIs
- Independent Variable: Healthcare Facility type (Acute care hospitals and IRFs)
- Statistical Analysis: Chi-square Analysis

$H_0$9: There is no difference in the number of CLABSIs between IRFs and LTACHs.

- Dependent Variable: number of CLABSIs
- Independent Variable: Healthcare Facility type (IRFs and LTACHs)
- Statistical Analysis: Chi-square Analysis

Prior to analyzing the research question, data cleaning and data screening were undertaken to ensure the variables of interest met appropriate statistical assumptions. The assumptions for nonparametric tests including random samples and independent observations were not violated. Chi-squared tests of independence were run to determine if any differences existed between the variables of interest. Summary details of the variables and tests used to evaluate hypotheses 1-9 are displayed in table 1.

Table 1

Summary Details of the Variables and Analyses used to Evaluate Hypotheses 1-9

Hypotheses	Independent Variable	Dependent Variable	Analysis
1	Ventilator Associated Pneumonia (VAP non-NICU)	Acute Care Hospitals vs Long-term Acute Care Hospitals	Chi-squared Test of Independence
2	Ventilator Associated Pneumonia (VAP non-NICU)	Acute Care Hospitals vs Inpatient Rehabilitation Facilities	Chi-squared Test of Independence
3	Ventilator Associated Pneumonia (VAP non-NICU)	Long-term Acute Care Hospitals vs Inpatient Rehabilitation Facilities	Chi-squared Test of Independence
4	Catheter Associated Urinary Tract Infection (CAUTI non-NICU)	Acute Care Hospitals vs Long-term Acute Care Hospitals	Chi-squared Test of Independence
5	Catheter Associated Urinary Tract Infection (CAUTI non-NICU)	Acute Care Hospitals vs Inpatient Rehabilitation Facilities	Chi-squared Test of Independence
6	Catheter Associated Urinary Tract Infection (CAUTI non-NICU)	Long-term Acute Care Hospitals vs Inpatient Rehabilitation Facilities	Chi-squared Test of Independence
7	Central Line Associated Blood Stream Infections (CLABSI)	Acute Care Hospitals vs Long-term Acute Care Hospitals	Chi-squared Test of Independence
8	Central Line Associated Blood Stream Infections (CLABSI)	Acute Care Hospitals vs Inpatient Rehabilitation Facilities	Chi-squared Test of Independence
9	Central Line Associated Blood Stream Infections (CLABSI)	Long-term Acute Care Hospitals vs Inpatient Rehabilitation Facilities	Chi-squared Test of Independence

Demographics

Secondary data were collected from the NHSN regarding a sample of 4,444 healthcare facilities operating in the United States during 2012. Thirteen different types of hospitals contributed to this archival data source, but only three facility types were selected. The available NHSN data were pooled, summary data that were available in pooled means and percentiles.

Analyses of Hypotheses 1-9

Hypotheses 1-9 were evaluated using chi-squared tests of independence to determine if any significant differences existed between healthcare facility types (Acute Care Hospitals, LTACHs, & IRFs) and HAIs (VAP, CAUTI, & CLABSI). Specifically, the dependent variable for hypotheses 1-3 was the frequency rates of the HAI - VAP (VAP nonNICU). The dependent variable for hypotheses 4-6 was the frequency rates of CAUTI nonNICU. The dependent variable for hypotheses 7-9 was the frequency rates of CLABSIs.

The independent variable for hypotheses 1, 4, and 7 were two types of health care facilities including Acute Care Hospitals and LTACHs. The independent variable for hypotheses 2, 5, and 8 were two types of health care facilities including Acute Care Hospitals and IRFs. The independent variable for hypotheses 3, 6, and 9 were two types of health care facilities including LTACHs and IRFs. However, for hypotheses 2 and 3, no data was collected for IRFs. Therefore, no analyses could be conducted for hypotheses 2 and 3.

Results of Hypothesis 1

$H_0 1$: There is no difference in the number of VAP infections between Acute Care Hospitals and LTACHs.

$H_a 1$: There is a significant difference in the number of VAP infections between Acute Care Hospitals and LTACHs.

Using SPSS 23, a chi-squared test of independence was conducted to determine if significant differences existed between the frequency of VAP infections and the number of ventilator days at acute care hospitals compared to LTACHs. Results indicated a significant difference did exist between acute care hospitals and LTACHs, χ^2 (1) = 237.24, *p.* < .001, *phi* (φ) = .009. That is, the ratio of days spent on a ventilator by number of VAP infections were significantly higher for LTACH (2965.550 days per infection) compared to acute care hospitals (749.871 days per infection). Thus, the null hypothesis for research question 1 was rejected in favor of the alternative hypothesis. However, based on Cohen's (1988) criteria, a *phi coefficient* (φ) ≤ .10 indicates a very small effect. Frequency statistics for number of VAP infections and ventilator days are displayed in table 2 by facility types.

Table 2

Frequency Statistics of the Number of VAP Infections and Ventilator Days Spent by Acute Care Hospitals and Long-term Acute Care Hospitals

Facility Type	# of VAP	Ventilator Days	Ratio (ventilator days / # of VAP)
Acute Care Hospitals	3839	2878756	749.871
Long-term Acute Care Hospitals	111	329176	2965.550
Total	3950	3207932	812.135

Results of Hypothesis 4

$H_0 4$: There is no difference in the number of CAUTIs between Acute care hospitals and LTACHs.

$H_a 4$: There is a significant difference in the number of CAUTIs between Acute care hospitals and LTACHs.

Hypothesis 4 was evaluated using a chi-squared test of independence to determine if significant differences existed between the frequency of CAUTIs and the number of urinary catheter days at acute care hospitals and LTACHs. Results indicated a significant difference did not exist between healthcare facility types (acute care hospitals & LTACHs), $\chi^2(1) = 2.78$, $p. = .095$, *phi* (φ) < .001. That is, the ratio of days spent using a urinary catheter by number of CAUTIs was not significantly different for IRFs (327.188 days per infection) compared to acute care hospitals (516.080 days per infection) and LTACHs (498.981 days per infection). Thus, the null hypothesis for research question 4 was retained. Frequency statistics of number of CAUTIs and urinary catheter days are displayed in table 3 by facility types.

Table 3

Frequency Statistics of the Number of CAUTIs and Urinary Catheter Days Spent by Acute Care Hospitals and Long-term Acute Care Hospitals

Facility Type	# of CAUTI	Urinary Catheter Days	Ratio (urinary catheter days / # of CAUTI)
Acute Care Hospitals	33075	17069333	516.080
Long-term Acute Care Hospitals	2685	1339763	498.981
Total	36679	18709782	510.095

Results of Hypothesis 5

$H_0$5: There is no difference in the number of CAUTIs between Acute Care hospitals and IRFs).

H_a5: There is a significant difference in the number of CAUTIs between Acute Care hospitals and IRFs).

Hypothesis 5 was evaluated using a chi-squared test of independence to determine if significant differences existed between the frequency of CAUTIs and the number of urinary catheter days at acute care hospitals and IRFs. Results indicated a significant difference did exist between healthcare facility types (acute care hospitals & IRFs), χ^2 (1) = 187.80, *p.* < .001, *phi* (φ) = .003. That is, the ratio of days spent using a urinary catheter per CAUTI was significantly lower for IRFs (327.188 days per infection) compared to acute care hospitals (516.080 days per infection). Thus, the null hypothesis for research question 5 was rejected in favor of the alternative hypothesis. However, the phi coefficient φ = .003 indicated a very small effect size existed (Cohen, 1988). Frequency statistics of number of CAUTIs and ventilator days are displayed in table 4 by facility-types.

Table 4

Frequency Statistics of the Number of CAUTIs and Urinary Catheter Days Spent by Acute Care Hospitals and Inpatient Rehab Facility

Facility Type	# of CAUTI	Urinary Catheter Days	Ratio (urinary catheter days / # of CAUTI)
Acute Care Hospitals	33075	17069333	516.080
Inpatient Rehab Facility	919	300686	327.188
Total	36679	18709782	510.095

Results of Hypothesis 6

$H_0$6: There is no difference in the number of CAUTIs between IRFs and LTACHs.

H_a6: There is a significant difference in number of CAUTIs between IRFs and LTACHs.

Hypothesis 6 was evaluated using a chi-squared test of independence to determine if significant differences existed between the frequency of CAUTIs and the number of urinary catheter days at LTACHs and IRFs. Results indicated a significant difference did exist between healthcare facility types (LTACHs & IRFs), χ^2 (1) = 122.93, *p.* < .001, *phi* (φ) = .009. That is, the ratio of days spent using a urinary catheter per CAUTI was significantly lower in IRFs (327.188 days per infection) compared to LTACHs (498.981 days per infection). Thus, the null hypothesis for research question 6 was rejected in favor of the alternative hypothesis. However, the phi coefficient φ = .009 indicated a very small effect size existed (Cohen, 1988). Frequency statistics of number of CAUTIs and ventilator days are displayed in table 5 by facility types.

Table 5

Frequency Statistics of the Number of CAUTI Infections and Urinary Catheter Days Spent by Long-term Acute Care Hospitals and Inpatient Rehab Facility

Facility Type	# of CAUTI	Urinary Catheter Days	Ratio (urinary catheter days / # of CAUTI)
Long-term Acute Care Hospitals	2685	1339763	498.981
Inpatient Rehab Facility	919	300686	327.188
Total	36679	18709782	510.095

Results of Hypothesis 7

$H_0$7: There is no difference in number of CLABSIs between Acute care hospitals and LTACHs.

H_a7: There is a significant difference in the number of CLABSIs between Acute care hospitals and LTACHs.

Hypothesis 7 was evaluated using chi-squared test of independence to determine if significant differences existed between the frequency of CLABSIs and the number of central line-days at acute care hospitals and LTACHs. Results indicated a significant difference did exist between acute care hospitals and LTACHs, χ^2(1) = 11.84, *p.* = .001, *phi* (φ) = .001. That is, the ratio of days spent on the central line by number of CLABSIs was significantly higher for acute care hospitals (1,010.203 days per infection) compared to LTACHs (932.131 days per infection). Thus, the null hypothesis for research question 7 was rejected in favor of the alternative hypothesis. However, the phi coefficient φ = .001 indicated a very small effect size existed (Cohen, 1988). Frequency statistics of the number of CLABSIs and central line days are displayed in table 6 by facility-types.

Table 6

Frequency Statistics of the Number of CLABSIs and Central Line Days Spent by Acute Care Hospitals and LTACHs

Facility Type	# of CLABSI	Central Line Days	Ratio (central line days / # of CLABSI)
Acute Care Hospitals	14462	14609553	1010.203
Long-term Acute Care Hospitals	2114	1970525	932.131
Total	16679	16758806	1004.785

Results of Hypothesis 8

$H_0$8: There is no difference in the number of CLABSIs between Acute care hospitals and IRFs.

H_a8: There is a significant difference in the number of CLABSIs between Acute care hospitals and IRFs.

Hypothesis 8 was evaluated using chi-squared test of independence to determine if significant differences existed between the frequency of CLABSIs and the number of central line-days at acute care hospitals and IRFs. Results indicated a significant difference did exist between acute care hospitals and IRFs, $\chi^2(1) = 30.02$, *p.* $< .001$, *phi* (φ) = .001. That is, the ratio of days spent with a central line by number of CLABSIs was significantly higher for IRFs (1735.223 days per infection) compared to acute care hospitals (1010.203 days per infection). Thus, the null hypothesis for research question 8 was rejected in favor of the alternative hypothesis. However, the phi coefficient φ = .001 indicated a very small effect size existed (Cohen, 1988). Frequency statistics of the number of CLABSIs and central line days are displayed in table 7 by facility-types.

Table 7

Frequency Statistics of the Number of CLABSIs and Central Line Days Spent by Acute Care Hospitals and IRFs

Facility Type	# of CLABSI	Central Line Days	Ratio (central line days / # of CLABSI)
Acute Care Hospitals	14462	14609553	1010.203
Inpatient Rehab Facility	103	178728	1735.223
Total	16679	16758806	1004.785

Results of Hypothesis 9

$H_0$9: There is no difference in the number of CLABSIs between IRFs and LTACHs.

H_a9: There is a significant difference in the number of CLABSIs between IRFs and LTACHs.

Hypothesis 9 was evaluated using chi-squared test of independence to determine if significant differences existed between the frequency of CLABSIs and the number of central line-days at LTACHs and IRFs. Results indicated a significant difference did exist between LTACHs and IRFs, $\chi^2(1) = 38.66$, *p.* $< .001$, *phi* (φ) = .004. That is, the ratio of days spent with a central line by number of CLABSIs was significantly higher for IRFs (1735.223 days per infection) compared to LTACHs (932.131 days per infection). Thus, the null hypothesis for research question 9 was rejected in favor of the alternative hypothesis. However, the phi coefficient φ = .004 indicated a very small effect size existed (Cohen, 1988). Frequency statistics of the number of CLABSIs and central line days are displayed in table 8 by facility types.

Table 8

Frequency Statistics of the Number of CLABSIs and Central Line Days Spent by Long-term Acute Care Hospitals and IRFs

Facility Type	# of CLABSI	Central Line Days	Ratio (central line days / # of CLABSI)
Long-term Acute Care Hospitals	2114	1970525	932.131
Inpatient Rehab Facility	103	178728	1735.223
Total	16679	16758806	1004.785

Summary

Information discovered from this study might find an association between healthcare facilities and HAIs; thus, allowing for practical measures to be taken to target certain healthcare facilities. This study influenced positive social change by revealing the gap in research in the various facility types of the healthcare system. While Acute Care Facilities are leading the healthcare industry in terms of research on HAIs, evidence-based research in other facility types are sparse.

This study used secondary data that were collected from the NHSN regarding a sample of 4,444 healthcare facilities operating in the United States during 2012. Thirteen different types of hospitals contributed to this archival data source, but only three facility types were selected. Chapter 4 presented the procedures used for data analysis, as well as the analyses for the nine hypotheses presented in this study.

Of the seven categories of HAIs and facility-type analyzed, six out of seven hypotheses resulted in statistically significant differences, while a difference was not found in one hypothesis. A significant difference existed between Acute Care Hospitals and LTACH in the ratio of days spent on ventilators by number of VAP infections. However, a significant difference did not exist between Acute Care Hospitals and LTACH in the ratio of CAUTIs. A significant difference existed between the frequency of CAUTIs in Acute Care Hospital versus IRF based on the ratio of days spent using a urinary catheter. A significant difference also existed between the frequencies of CAUTIs in LTACH versus IRFs. A significant difference existed between the frequencies of CLABSIs in Acute Care Hospitals versus LTACH. A significant difference also existed between the frequencies of CLABSIs in Acute Care Hospitals versus IRF. Finally, a significant difference existed between the frequencies of CLABSIs in IRFs versus LTACHs. Chapter 5 presents a detailed interpretation of the findings of this study, and the significance of the associated findings alongside the strengths and limitations. Recommendations were proposed for future studies, and then the social change implications were explored.

Table 9

Summary of Results from the Chi-squared Tests of Independence for Hypotheses 1-9

Hypothesis	Independent Variable	Dependent Variable	Analysis	Sig. (*p*)
1	Ventilator Associated Pneumonia (VAP non-NICU)	Acute Care vs Long-term Acute Care Hospitals	Chi-squared Test of Independence	< .001
2	Ventilator Associated Pneumonia (VAP non-NICU)	Acute Care Hospitals vs Inpatient Rehabilitation Facilities	Chi-squared Test of Independence	N/A
3	Ventilator Associated Pneumonia (VAP non-NICU)	Long-term Acute Care Hospitals vs Inpatient Rehabilitation Facilities	Chi-squared Test of Independence	N/A
4	Catheter Associated Urinary Tract Infection (CAUTI non-NICU)	Acute Care vs Long-term Acute Care Hospitals	Chi-squared Test of Independence	.095
5	Catheter Associated Urinary Tract Infection (CAUTI non-NICU)	Acute Care Hospitals vs Inpatient Rehabilitation Facilities	Chi-squared Test of Independence	< .001
6	Catheter Associated Urinary Tract Infection (CAUTI non-NICU)	Long-term Acute Care Hospitals vs Inpatient Rehabilitation Facilities	Chi-squared Test of Independence	< .001
7	Central Line Associated Blood Stream Infections (CLABSI)	Acute Care Hospitals vs Long-term Acute Care Hospitals	Chi-squared Test of Independence	.001
8	Central Line Associated Blood Stream Infections (CLABSI)	Acute Care Hospitals vs Inpatient Rehabilitation Facilities	Chi-squared Test of Independence	< .001
9	Central Line Associated Blood Stream Infections (CLABSI)	Long-term Acute Care Hospitals vs Inpatient Rehabilitation Facilities	Chi-squared Test of Independence	< .001

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

This quantitative study had an overall purpose and intention to explore whether types of healthcare facilities in the United States affects three major types of HAIs. This exploration examined secondary data that was collected and aggregated by the CDC's NHSN on 4,444 facilities located across 53 regions of the U.S. including states, territories, and the District of Columbia. Facilities included, submitted a minimum of 1 month of device-associated data, based on patients who were being monitored in healthcare facilities. The theoretical framework that grounded this study was the EnvID, which used a systems theory approach to incorporate and analyze different information from numerous disciplines (Eisenberg et al., 2007). The concepts for this study were entered into the EnvID framework in order to answer how the hypothesis of this model relates to this study. As such, a conceptual framework was fashioned from the EnvID to create a figure representing the social determinants of HAIs.

Interpretation of the Findings

An extensive literature review for this study revealed that Acute Care Facilities were the leading healthcare facility type in terms of research on HAIs. Evidence-based research conducted on other facility types in the United States in the last 5years was very sparse. The CDC (2015a) reports more than half of all HAIs do not occur in Intensive Care Units, where the sickest patients are usually housed. However, limited studies were available to explain where the next 50% of HAIs occur. Nevertheless, when the focus was shifted from Acute Care Facilities to other facility types that patients commonly transition to, like IRFs or LTACH, nationwide studies were rare and or outdated. The findings from this study extended the current body of knowledge on what is known about HAIs and facility types in the United States, and may serve to narrow the gap of knowledge in what is unknown about HAIs in LTACH and IRFs in the U.S. healthcare system.

This study proposed one research question, along with nine hypotheses. The 2012 NHSN report used did not provide data for hypotheses numbers 2 and 3; therefore, data could not be analyzed. Nonetheless, of the seven categories of HAIs and facility types analyzed, six out of seven hypotheses resulted in statistically significant differences, while a difference was not found in one hypothesis.

Systems thinking are increasingly being utilized in contemporary public health (Trochim, Cabrera, Milstein, Gallagher & Leischow, 2006), and the EnvID framework uses a systems theory approach (Eisenberg et al., 2007). Three interrelated characteristics of EnvID framework are the environment-disease relationships, the forces at work that influence the transmission of disease pathogens, and the disease burden (Eisenberg et al., 2007).

Characteristics and environmental changes substituted in the EnvID to create the social determinants of HAIs as seen in Figure 1 include (a) overuse of antibiotics, (b) multidrug resistance organisms, (c) urban versus rural facility types, (d) medical school affiliation, (e) the unit of an organization in which sick patients were housed/various levels of organizations, (f) sicker hospitalized patients generally requiring more invasive procedures, and (g) sicker patients housed in Intensive Care Units for treatments where they received more medical treatments to survive. Half of all HAIs have been reported in intensive care units (Milosevic, 2014). This literature review revealed most studies on HAIs were performed in acute care facilities (Kang et al., 2014).

Factors that affect the transmission of HAIs include poor hand-hygiene and cross-contamination. In a systematic review of research studies on compliance with the guidelines of hand hygiene in hospital settings, Erasmus et al. (2010) found an overall median compliance rate of only 40%. Smiddy, O'Connell, and Creedon (2014) found perceptions of the work environment and motivational factors are two fundamental concepts that seem to influence how HCW complies with hand hygiene guidelines. Motivational factors were ingrained in behaviorism, while the HCW's perception of the work environment was based on structural empowerment (Smiddy et al., 2014). Of the HAIs presented in this study, all could be transmitted by poor hand hygiene. Hand hygiene remains a universal problem that needs standardized measures to monitor compliance (Erasmus, 2010; Smiddy et al., 2014).

Another characteristic of the environment to disease relationship was nurse burnout. A systematic review of 42 articles found the type of care a patient received was associated with the prevalence of HAIs (Cimiotti, Aiken, Sloane & Wu, 2012). Cimiotti et al (2012) examined the effect of nurse staffing ratios and the burnout of nurses on two types of HAIs (urinary tract infection & SSI). These researchers found the rates of these HAIs to be significantly lower in hospitals where nurses took care of fewer patients, and even increasing the nurse-to-patient ratio by a single patient was significantly associated with surgical site and urinary tract infections (Cimiotti et al., 2012). Nurses are an integral part of the three facility types studied in this work and although caregiver/nurse burnout and stress was not the focus of this study, those factors could explain why most of the hypotheses studied were statistically significant.

The relationship between the environmental characteristics and the disease transmission cycle results is the disease burden (Eisenberg et al., 2007). In this case, the disease burdens were changes in the frequency of HAIs. This may be manifested in reduced HAIs, behavior changes from HCW, as well as standardized best practices in all facility types nationwide. As the U.S. population ages and patients are discharged from Acute Care Facilities to other facilities for medical and nursing care, there needs to be current U.S. data to support the implementation of infection control measures and surveillance of HAIs in all facility types.

The lack of current data on HAIs in U.S. LTACHs and IRFs is a problem since it is commonplace for patients to move unrestrictedly through the healthcare system, for instance from acute-care facilities to rehabilitation or long-term care facilities (Sydnor & Perl, 2011). Although, it is well documented that infection control measures like the use of CHG products, the use of electronic technology to prevent, identify, monitor and reduce HAIs, and the use of Bundles significantly reduce HAIs; these interventions are primarily studied in Acute Care Facilities and as a result, it is reasonable to deduce that the transmission of HAIs in healthcare facilities may never be eradicated if current infection control measures for other facility types like LTACHs and IRFs are not included and studied.

Limitations of the Study

Secondary data were collected from the NHSN regarding a large sample of 4,444 healthcare facilities operating in the United States during 2012. Thirteen different types of hospitals contributed to this archival data source, but only three facility types were selected. Limitations to the use of secondary data include limited data quality. The available NHSN data were pooled summary data that was available in pooled means and percentiles. However, this sample was the best available representation of the U.S. population.

The summary data used for this research data was self-reported by facilities across America, aggregated by the CDC's NHSN, and then assembled in a 2012 report which was in the public domain. Contributing healthcare facilities in the United States reported voluntarily and/or as a result of state mandates, federal reporting programs, and quality prevention initiatives. It was assumed all facilities reported data on HAIs truthfully and timely and were representative of their population.

An important limitation of this study was data for hypotheses two and three were missing from the database. No data was reported for VAP in LTACH and IRFs. Therefore, no analyses were conducted for hypotheses 2 and 3. Furthermore, Surgical Site infections (SSIs) are among the most common types of HAIs (Custodio et al., 2014). Nonetheless, SSIs were excluded from this study because SSIs were not reported in the CDC's 2012 report either. Likewise, Critical Access Hospitals are a major facility-type, but were also not reported in the secondary data source studied; therefore, had to be excluded from this study.

Dudeck et al (2013) explained certain characteristics of the type of hospitals that may affect the rates of HAIs, for instance, the amounts of patient beds available, rural versus urban hospitals, or whether a hospital is affiliated with a medical school. This study did not break down the amount of beds available in the facility types chosen, nor did this study breakdown whether the selected type of facility was geographically located in an urban or rural area; nor did this study delineate whether the facility types were affiliated with a medical school.

Furthermore, no prior studies could be found that queried the relationship between facility types and the three chosen HAIs as listed in the CDC 2012 report that was used. Several researchers have reported singular studies on interventions used in their particular settings to reduce HAIs, but no research could be found that compared HAIs to the many facility types available in the U.S. In addition, this study design is retrospective in the form of an analytical approach; therefore, causation could not be confirmed (Aponte, 2010). These limitations could be improved in the future with greater access to the NHSN database, instead of using summary data.

Additionally, chi-squared tests of independence were used to evaluate the research question and the available data for seven hypotheses. Since seven individual chi-square tests were conducted, this increased the chance of type 1 errors (Peres-Neto, 1999). However, Bonferroni adjustment was used on the results received from the chi-square tests. To calculate the Bonferroni adjustment, the significance level (.05) was divided by the number of tests (.05/7=.007), which means if any *p*-values were larger than .007, the results were not statistically significant (Laerd Statistics, 2013). As realized in Table 9, the *p*-values for six out of nine hypotheses were .001 or less, meaning these results were likely significant.

Recommendations

This study examined whether healthcare facility-type affects the frequency of HAIs. Six out of the seven hypotheses studied resulted in significant differences between HAIs and facility types. Yet, more studies are needed to comprehend why certain HAIs are more prevalent in one type of facility type over another. All the same, the prevalence of most HAIs in the U.S. is decreasing (CDC, 2015a). Data used in this study was collected in 2012; therefore, prevalence rates for HAIs could be even lower in some types of facilities at the time of this study. For that reason, further studies are needed to examine the most recent population-level data as it becomes available.

Evidence-based studies in LTACHs and HAIs performed in the United States in the last five years are very limited to nonexistent. Furthermore, this literature review found current studies on IRFs performed in the U.S. were even scarcer than those of LTACHs. It appeared a great majority of the studies surrounding infection control measures in the U.S. were conducted in Acute Care Facilities, yet patients routinely move from one facility-type to the next. Infection control measures like the use of CHG wipes, the use of electronic technology to prevent, identify, monitor and reduce HAIs, and the use of Bundles have been shown to significantly reduce HAIs. However effective, these interventions are primarily studied in Acute Care Facilities and further research is needed to examine their effectiveness in other facility types, in order to further decrease the disease burden of HAIs across the U.S. Healthcare industry. To add credence to this hypotheses, a study published in the CDC's Morbidity and Mortality Weekly Report on August 7, 2015 revealed that systemized approaches to interrupt the proliferation of HAIs could have a more substantial impact on reversing the incidence of HAIs than individualized programs based on independent facilities (Slayton et al., 2015), this finding is also congruent with the systems approach to infection control as mentioned in this research. And so, another recommendation is to use a systems approach to standardize HAI prevention best practices to all facility types across the U.S. Healthcare system.

Implications for Social Change

Multiple studies have been performed in U.S. Acute Care Hospitals that detailed the effectiveness of multiple infection prevention measures. Yet, there is barely current studies performed in the U.S. to describe infection prevention measures in LTACH or IRFs. Facilities like LTACHs and IRFs are facility types where patients often transition to after their stay in Acute Care Hospitals, but these facility types lack current evidence-based data on HAIs, and available studies are outdated. As the U.S. population ages and patients are being discharged quickly from Acute Care Facilities to other facility types for medical and nursing care, there needs to be current U.S. data to support the implementation of infection control measures and surveillance of nosocomial infections.

Two prominent implications for social change are presented in this research. At the outset, the findings of this population-level study adds to the current body of knowledge, supporting the claim that a scarce amount of evidence-supported data exist in the American research literature to support infection prevention measures in LTACH and IRFs. This information is fundamental to patient safety, since patients commonly move from one facility type to another for their healthcare needs. Consequently, the results of these health statistics reveal a health threat to patients transferring among facility types. The results of this study is vital to inform public health policies in order to duplicate similar proven infection control measures used in Acute Care Facilities to LTACH and IRFs. Moreover, as a number of states are in the initial stages of developing programs to address antibiotic-resistant infections in various healthcare settings (Slayton et al., 2015), this study provided an inclusive list of current, peer-reviewed studies performed in the United States in three different healthcare facility types.

Also, this research presented the best available evidence to show numerous significant differences in the frequency of three common HAIs in various health care facility types in the United States. Furthermore, this knowledge extended the current body of knowledge and supply evidence to public health policy makers to support systems based approaches to tackle infectious diseases in all facility types, and the social change implication is the continued reduction of HAIs in the United States.

Conclusion

To the best of my knowledge, this study is a leader in the exploration of whether healthcare facility types are associated with HAIs. Themes for infection control measures found in peer-reviewed studies revealed that the use of CHG products, electronic monitoring of HAIs, and the use of Bundles are successfully being used in the U.S.

Healthcare industry to reduce and prevent HAIs. Nevertheless, those measures are primarily studied in Acute Care Facilities (Kang et al., 2014).

This study tested seven hypotheses to answer a single research question, and to determine whether facility types are associated with HAIs. Of these seven hypotheses, six demonstrated an association between healthcare facility types and the three selected HAIs. Ultimately, these findings extended the current body of knowledge on what is known about HAIs and facility types like Acute Care Facilities, and may serve to narrow the gap of knowledge on what is unknown about other facility types (LTACHs and IRFs), and HAIs in the U.S. Healthcare industry.

Even though the rates of most HAIs in the U.S. are decreasing, concerted efforts are needed to eliminate HAIs using systems based approaches, instead of the current strategies. Recommendations for future research support examination of the feasibility and sustainability to duplicate infection control measures currently being implemented in Acute Care Facilities and study these measures in other facility types like LTACHs and IRFs. An additional recommendation is to use a systems approach to standardize HAI prevention best practices to all facility types, and the social change implication is the continued reduction of HAIs across the U.S. healthcare system.

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