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Catheter-Associated Urinary Tract Infections of Hospitalized Patients Diagnosed With COVID-19

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This is to certify that the doctoral dissertation by

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Walden University
2024

Abstract

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by

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MA, Mississippi Valley State University, 2006

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

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Abstract

Catheter-associated urinary tract infections (CAUTIs) cause poor patient outcomes and lead to additional healthcare costs, therefore increasing the burden of healthcare. The problem addressed in this study was how CAUTIs have increased by 83% in patients who have been hospitalized with COVID-19 for over 48 hours, despite infection control and procedures being implemented. Therefore, the purpose of this quantitative study was to determine how patient type, age, gender, and infection control procedures are associated with an increase in CAUTI in patients who are hospitalized with COVID-19 for 48 hours or more. Being guided by the precaution adoption process model, this study followed a cross-sectional design using secondary data from the Centers for Disease Control and Prevention's National Healthcare Safety Network that involved hospitalized COVID-19 patients with indwelling urinary catheters who were hospitalized between 2020 and 2021. Data were analyzed using a logistic regression and a Wald test. The study found lower CAUTI rates and shorter hospitalization for non-hospitalized COVID-19 patients versus hospitalized ones. Individuals aged 55 and above showed different infection risks and hospitalization days; however, overall age and gender were not significantly linked to infection or hospitalization. Nurse-driven catheter removal showed no association with infections in hospitalized patients, considering patient type. Policymakers and healthcare providers can use these findings to develop targeted interventions for equitable care, mitigating health disparities, and fostering a just and inclusive public health system for all, regardless of age, gender, or social background.

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Dedication

To my amazing family Mary Grady, Geraldine Peyton, and the rest of my Grady and Peyton family I could not have done this without your prayers, support, and love.

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I would like to acknowledge and give my warmest thanks to my committee chairperson, Dr. German Gonzalez and Co-Chair Jamir Robinson, who made this work possible. Their guidance and advice helped me through all stages of writing my dissertation.

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Chapter 1: Introduction to the Studied Research

Indwelling urinary catheters are inserted into the bladder via the urethra and collect urine in patients who cannot pass urine normally. Approximately 15% to 25% of patients admitted to hospitals have short-term indwelling catheters, with some being inappropriately indicated, therefore leading to unnecessary use (Li et al., 2018). The high prevalence of catheter-associated urinary tract infection (CAUTI) can promote complications such as endocarditis and sepsis, leading to approximately 13,000 deaths per year in the United States (Letica-Kriegel et al., 2019). CAUTIs cause poor patient outcomes and lead to additional healthcare costs, therefore increasing the burden of healthcare. As such, the risks associated with indwelling catheter use during the COVID-19 pandemic are worthy of consideration. Such information could help better prepare hospitals for any future variants of COVID-19.

Currently, there are minimal studies that have focused on CAUTI during the COVID-19 pandemic. Studies have provided a hodgepodge of results. For example, Fakih et al. (2021) reported that central-line-associated bloodstream infections (CLABSIs) increased during the COVID-19 pandemic, whereas CAUTIs did not. Moreover, Baker et al. (2021) reported that CLABSIs and CAUTIs increased during the COVID-19 pandemic. These studies have highlighted a continued need to understand CAUTI incidence during the COVID-19 pandemic and other variables, such as age, gender, and infection control procedures, that could have been experienced as the pandemic continues into its third year. The inconsistency of results indicates minimal research that differentiates CAUTI among COVID-19 and non-COVID-19 patients.

Therefore, the aim of this study was to determine how patient type, age, gender, and infection control procedures are associated with an increase in CAUTI in patients hospitalized with COVID-19 for 48 hours or more.

Background of the Problem

The issue that prompted me to search the literature was CAUTI. Various studies have been conducted that have focused on indwelling urinary catheters; however, there appears minimal research that has focused on this topic during the COVID-19 pandemic. Those studies completed have provided mixed results. For example, Fakih et al. (2021) conducted a study that evaluated the impact of the COVID-19 pandemic on CLABSI and CAUTIs in hospitals. The study found that during the COVID-19 pandemic, the rates of CLABSI increased by 51%. Moreover, coagulase-negative Staphylococcus CLABSI increased by 130% and Candida spp by 56.9%. However, the study did not find any significant changes in CAUTI. Fakih et al.'s work is relevant to the present study, as it answered how COVID-19 had impacted the rates of indwelling catheter infections. Although the authors did not find any significant difference in the rates of CAUTIs during the COVID-19 pandemic compared to the non-COVID-19 period, they did find an increase in bacteria associated with catheter-related infections. This demonstrated an increased risk of getting catheter-related infections, including CAUTIs.

Additionally, Knepper et al. (2020), who investigated the high rates of device infection in patients with COVID-19, hypothesized that there would be higher device infection rates in patients with COVID-19. Using a retrospective cohort at a 555-bed safety-net hospital, these researchers found that media increased the usage of an

indwelling urinary catheter during the initial pandemic period, a 36% increase compared to a 25% increase in central venous catheter (CVC) devices during the COVID-19 pandemic. Importantly, in COVID-19 areas, the CAUTI rates were 83% higher compared to non-COVID-19 areas; the same trend was observed with CLABSI. This study is critical to discuss because it relates directly to the impact that COVID-19 has had on the use of in-dwelling catheters among hospitalized COVID-19 patients. Notably, Knepper et al. found that the use of indwelling catheters increased among COVID-19 patients and that an increase matched this in catheter-associated infections, such as CAUTI and CLABSI.

Ong et al. (2021) also investigated indwelling catheter use in COVID-19 patients by investigating device-associated infections and secondary nosocomial bacteremia in intensive care units to compare incidences between COVID-19 and non-COVID-19 patients. The study found that COVID-19 patients had indwelling urinary catheters, invasive mechanical ventilation, and central venous lines for longer than non-COVID-19 patients. Notably, the incidence of nosocomial infections among COVID-19 patients was 14.8% compared to 2.7% for non-COVID-19 patients. Of the nosocomial infections that were detected, 5 out of 10 were CAUTI related, whereas non-COVID-19 patients had only one CAUTI-related infection. This study was relevant to the current study as it reported the incidence of nosocomial infections among hospitalized patients during COVID-19. Because Ong et al. concluded that COVID-19 infections resulted in higher nosocomial infections, they identified CAUTI as the most detected nosocomial infection.

Therefore, their study demonstrated that hospitalized COVID-19 patients were at higher risk of experiencing nosocomial infections, including CAUTI.

To demonstrate how this issue was essential to research prior to COVID-19, Letica-Kriegel et al. (2019) conducted a study that focused on how CAUTIs involved common healthcare-related infections in many hospitals. The study concentrated on the remaining areas of interest regarding CAUTI development besides age and gender that studies had previously mentioned. The examination of catheter insertion duration would be essential to determine clinical countermeasures to avoid the increasing severity of complications. The research applied a retrospective cohort for pediatric and adult patients with catheters from 2012 to 2016. The observations on the resulting changes among different ages, gender, medical and surgical patients provided the view of time and indwelling; the catheter is used as necessary for CAUTI development. The use of three different settings to analyze the risk factors in CAUTI development for varied patient types, people of all ages, gender, and underlying health issues. Letica-Kriegel et al.'s findings revealed the impact of the number of days under catheterization as essential to involve better care. Increasing days are dangerous for CAUTI prevalence to rise. Females and pediatrics were at high risk compared to other surgical and medical patients contracting urinary tract infections (UTIs). Hospitalized patients with mobility problems, especially after surgery, included a higher number of those infected with UTIs after days with catheters.

In summary, previous studies have highlighted how CAUTIs remain a significant problem, even during the COVID-19 pandemic. Although there appears to be a mixture

of results regarding infections during the COVID-19 pandemic, a research gap appeared, specifically that there is limited understanding of how patient type, age, gender, and infection control procedures are associated with an increase in CAUTI in patients hospitalized with COVID-19 for 48 hours or more. Therefore, this study aimed to address this gap.

Problem Statement

The issue that prompted me to search the literature was CAUTI. The problem this study addressed was how CAUTIs have increased by 83% in patients who have been hospitalized with COVID-19 for over 48 hours, despite infection control and procedures being implemented due to the pandemic (Baker et al., 2021). According to a report by the Agency for Healthcare Research and Quality (AHRQ, 2015), there were approximately 722,000 hospital-acquired infections, and around 75,000 of these infections were fatal. Importantly, hospital-acquired infections cost U.S. hospitals an estimated $40 billion annually (AHRQ, 2015). Among hospital-acquired infections, CAUTI is one of the most common. Notably, approximately one fourth of hospital inpatients may have a short-term indwelling urinary catheter placed during their stay in the hospital. Moreover, complications associated with CAUTI increase the length of hospital stays by 2–4 days, resulting in excess healthcare costs and increased mortality (AHRQ, 2015). CAUTI was found to add $1,300 to $1,600 of costs per patient receiving services (AHRQ, 2015).

These statistics demonstrate that there are social costs associated with CAUTIs. Not only does CAUTI increase the length of stay in the hospital, but it also increases the risks of mortality and monetary costs of care of patients. During the COVID-19

pandemic, this problem has only been exacerbated, given the stretched resources in hospital settings and greater focus being paid on COVID-19 illness than other health conditions (Baker et al., 2021). Therefore, because CAUTI impacts the cost of healthcare, it is an important social problem in healthcare to consider. In 2020, when the COVID-19 pandemic was gaining a global footprint and hospitals were becoming overwhelmed with COVID-19 patients, much attention was being focused on COVID-19. Safety practices in preventing hospital-acquired infections could have been undermined. Seventy-five percent of UTI cases acquired were associated with a urinary catheter (CDC, n.d.).

Purpose of the Study

The purpose of this quantitative study was to determine how patient type, age, gender, and infection control procedures are associated with an increase in CAUTI in patients who are hospitalized with COVID-19 for 48 hours or more. CAUTIs have increased by 83% in patients who have been hospitalized with COVID-19 for over 48 hours, despite infection control and procedures being implemented due to the pandemic (Baker et al., 2021). I collected secondary data from the Centers for Disease Control and Prevention's (CDC) National Healthcare Safety Network that involved hospitalized COVID-19 patients with indwelling urinary catheters. In this study, different variables were studied. The dependent variable was CAUTIs, and the independent variables included age, gender, patient type (COVID-19 or non-COVID-19), and infection control procedures.

Research Questions and Hypotheses

The following research questions and hypotheses that guided this study:

RQ1: Is there an association between patient type and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization?

H_{01}: There is no association between patient type and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

H_{a1}: There is an association between patient type and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

RQ2: Is there an association between age and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization?

H_{02}: There is no association between age and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

H_{a2}: There is an association between age and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

RQ3: Is there an association between gender and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization?

H_{03}: There is no association between gender and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

H_{a3}: There is an association between gender and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

RQ4: Is there an association between nurse-driven timely removal of urinary catheters and CAUTIs among hospitalized patients when controlling for patient type?

H_{04}: There is no association between nurse-driven timely removal of urinary catheters and CAUTIs among hospitalized patients when controlling for patient type.

H_{a4}: There is an association between nurse-driven timely removal of urinary catheters and CAUTIs among hospitalized patients when controlling for patient type.

RQ5: Is there an association between urinary catheter care during placement and CAUTIs among hospitalized patients when controlling for patient type?

H_{05}: There is no association between urinary catheter care during placement and CAUTIs among hospitalized patients when controlling for patient type.

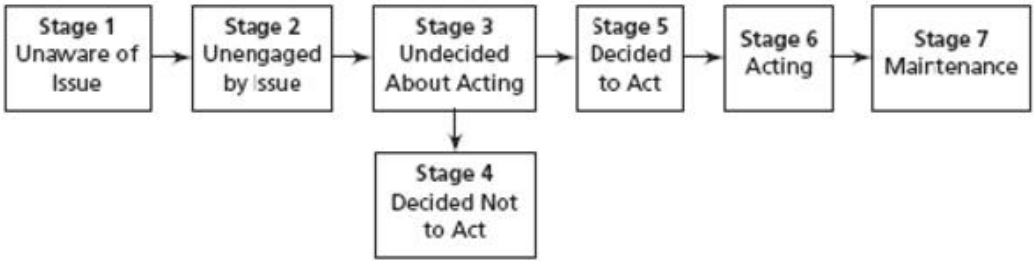
H_{a5}: There is an association between urinary catheter care during placement and CAUTIs among hospitalized patients when controlling for patient type.

Conceptual Framework

This study was guided by the precaution adoption process model (PAPM). PAPM allowed me to understand better how individuals make decisions and changes in their lives while adopting new behaviors or ceasing risky ones. This model consists of seven steps, as represented in Figure 1.

Figure 1

The Precaution Adoption Process Model



Note. Adapted from "The Precaution Adoption Process Model," by N. D. Weinstein, P. M. Sandman, and S. J. Blalock, in K. Sweeny, M. L. Robbins, and L. M. Cohen (Eds.), *The Wiley Encyclopedia of Health Psychology*, 2020, Wiley, (https://doi.org/10.1002/9781119057840.ch100).

The logical connection between this framework and the nature of the study included how health-protective behaviors for staff and patients improve the incidence rates of CAUTI by decisions informed through risk factors probability. For example, Step 1 of the model highlights how individuals can be unaware of an issue, while Step 2 sees them becoming aware of an issue but have remained unengaged. Step 3 is where the decision-making process can begin, where individuals can either decide not to act (Step 4) or act (Step 5). In Step 6, individuals start making changes by either adopting new

behaviors or ceasing risky ones, while the seventh step allows individuals to maintain new healthy behaviors (Weinstein et al., 2020). It is important to note that individuals who decide not to act end the process and do not continue to maintenance—Table 1 highlights how this model precisely aligns with this study.

Table 1

The Precaution Adoption Process Model Alignment

Step	Variable	Operationalization of variables
Unaware of the issue: Most patients hospitalized and receiving treatment for COVID-19 are unable to form an opinion about the issue at hand related to CAUTI.	Independent variable: Age	Nominal – Age: 1 – 18–24 2 – 25–34 3 – 35–44 4 – 45–54 5 – 55+
Unengaged by the issue: Have learned about the precaution issue but are not sure whether to do anything about it or not.	Gender	Nominal – Gender: 0 – Male 1 – Female
Maintenance	Patient type	Patient type – nominal: 1 – Patients hospitalized for COVID-19 2 – Patients not hospitalized for COVID-19
Decided to Act: Adopting a precautionary method. Decisions are informed through risk factors probability.	Dependent variable: Catheter Associated Urinary Tract Infections – Days of Hospitalization	Dependent variable: Scale (Length of time) 1 – In Place Urinary Catheter – in place >2 days on the date of infection or present for any portion of the calendar day 2 – Removed – Urinary Catheter in place > 2 days and removed the day before the date of infection 3 – Neither – Not catheter-associated urinary tract infection

Nature of the Study

To address the research questions in this quantitative study, the specific research design included a cross-sectional design using secondary data from the CDC's National Healthcare Safety Network that involved hospitalized COVID-19 patients with indwelling urinary catheters that were hospitalized between 2020 and 2021. For the planned research design, I collected archival data from the CDC's National Healthcare Safety Network. The CDC's National Healthcare Safety Network has monitoring and surveillance systems to collect and record the number of hospital-acquired infections each year. These data are part of quality improvement measures for hospitals and can be downloaded without permission from their online website. Essentially, hospital-acquired infections are a measure of quality and safety of care. The CDC's network provides data to states, regions, and the nation to help track hospital-acquired infections to reduce and ultimately eliminate them.

The data points I used to answer the research questions consisted of patient type (COVID or non- COVID), age of the patient (18 or older), gender, nurse-driven timely removal of urinary catheters, urinary catheter care during placement, and length of time catheter dwelling was used, and number of days hospitalized. When collecting the data points, attention was given to the duration of the period of hospitalization and length of time for cauterization , the purpose of the study, and how this research will help improve the overall patient care safety and quality in the future.

Definition of Terms

Terms used regularly throughout this study are defined as follows:

Catheter-associated urinary tract infection (CAUTI): A CAUTI is defined as a UTI caused using a urinary catheter (Kranz et al., 2020).

Central-line-associated bloodstream infections (CLABSI): A CLABSI is defined as a serious infection that is experienced due to bacteria and viruses entering the bloodstream via the central line (Cho & Cho, 2019).

Central line: In this study, a central line, also known as a central venous catheter, or CVC, is defined as a catheter tube placed in the neck, chest, or groin to provide medication and fluids to patients. The central line is inserted into large veins (Render et al., 2006).

COVID-19: COVID-19, otherwise known as the Coronavirus disease of 2019, is an infectious and contagious disease and presents with a variety of symptoms that can include fever, cough, shortness of breath, difficulty breathing, congestion, cold-like symptoms, and a headache (CDC, 2021).

Indwelling urinary catheter: An indwelling urinary catheter is defined as a tube that is placed into the bladder to drain urine. This form of catheter is left in place in the bladder by water-filled balloons so that it can remain for more extended periods of time (Murphy et al., 2018). It is recommended that indwelling urinary catheters are not to be used for more than 30 days (Murphy et al., 2018).

Patient type: In this study, the patient type is defined as individuals diagnosed with COVID-19 or individuals who have not been diagnosed with COVID-19.

Urinary tract infection (UTI): A UTI is defined as an infection of the urinary system, including the bladder, urethra, kidneys, and ureters (Wong & Braga, 2019).

Assumptions

The following assumptions were acknowledged for this study. The first assumption was regarding the secondary dataset used for the analysis and the write-up of the results. It was assumed that the data collected would be sufficient to answer the research questions and either prove or disprove the hypotheses. To ensure that the data would be able to answer the research questions and hypotheses, I ensured that each variable was conceptualized and that each variable was represented within the dataset. A secondary limitation also includes the dataset. It was assumed that the information contained in the dataset is true and accurate, as it was collected by the CDC's National Healthcare Safety Network. The more accurate the dataset was, the more effective and reliable the results of the study were.

Scope and Delimitations

The scope of this quantitative study was centered on indwelling catheters and the prevalence of CAUTIs. Between 15% to 25% of patients admitted to hospitals have short-term indwelling catheters, with some being inappropriately indicated therefore leading to unnecessary use (Li et al., 2019). The high prevalence of CAUTIs can promote complications such as endocarditis and sepsis, leading to approximately 13,000 deaths per year in the United States (Letica et al., 2019). This study focused on the COVID-19 pandemic, as previous literature had highlighted that CAUTIs have increased by 83% in patients who have been hospitalized with COVID-19 for over 48 hours, despite infection control and procedures being implemented due to the pandemic (Baker et al., 2021; Diamond, 2020).

Therefore, this study was delimited to hospitalized COVID-19 patients with indwelling urinary catheters who have been hospitalized for 48 hours or more. Additionally, individuals in this study had to be 18 years of age and identified as any gender. Therefore, individuals who were not hospitalized for COVID-19, did not have indwelling urinary catheters, and those who were hospitalized for less than 48 hours were not included in this research. Additionally, individuals who were younger than 18 years of age were not represented in this study.

Limitations, Challenges, and Barriers

Some limitations, challenges, and barriers were experienced within this study. Potential challenges were that some hospitals did not collect data on infections control procedures. NHSN allows healthcare facilities to share information with clinicians and facility leadership, partners, and health department quality improvement organizations for medical facilities. Moreover, NHSN shares the data with the patients through the U.S. Department of Health and Human Services Hospital Compare website (CDC, 2018).

Therefore, some limitations must be identified. The first limitation is that the collected data could include information that may not be completely accurate, simply because hospitals that record data may have different definitions of variables. For example, when examining any data that focuses on infection control procedures, hospitals may have different procedures and are not necessarily streamlined within the dataset. This could have hindered the data analysis; however, to mitigate this limitation, I checked the data before determining if there are consistencies in the hospitals' approach when it comes to infection control procedures. In essence, when preparing the data for analysis, I

ensured that all records have identified variables: (a) patient type, (b) gender, (c) length of catheter use, and (d) infectious control procedures.

Significance

The significance of this study aimed to explain the association of CAUTIs among hospitalized covid patients between patient type (COVID-19 and non-COVID-19), comorbidities, age, gender, and infection control procedures. By understanding these associations, hospitals can address, improve, and protect the health of patients contracted CAUTIs during the COVID-19 pandemic to reduce such infections. This, in turn, will promote reduced healthcare costs for patients, higher effective treatments, and the ability to ensure that patients' health and safety are paramount when receiving medical services. In addition, this study's findings will impact positive social change by providing knowledge to medical care facilities and healthcare workers in taking precautions and following preventative protocols to reduce the risk of CAUTI among patients.

Summary

The problem that was addressed through this study is how CAUTIs have increased by 83% in patients who have been hospitalized with COVID-19 for over 48 hours, despite infection control and procedures being implemented due to the pandemic (Baker et al., 2021). Therefore, the purpose of this quantitative study was to determine how patient type, age, gender, and infection control procedures are associated with an increase in CAUTI in patients who were hospitalized with COVID-19 for 48 hours or more. The PAPM guided this study. It followed a cross-sectional design using secondary data from the CDC's National Healthcare Safety Network that involved hospitalized

COVID-19 patients with indwelling urinary catheters. For the planned research design, I collected archival data from the CDC's National Healthcare Safety Network.

This study follows a traditional five-chapter dissertation format. This chapter introduced the study, highlighting the problem being studied, the purpose, the research questions, and the hypotheses. I then discussed the theoretical model that will guide this study, defining commonly used terms, limitations and challenges, and the study's significance. The next chapter will include a comprehensive review of the literature, whereas Chapter 3 will present the study's methodology. In Chapter 4, I will report the study's results, and Chapter 5 will discuss all findings concerning previous literature.

Chapter 2: Literature Review

Literature Search Inquiry

This quantitative study aimed to determine how patient type, age, gender, and infection control procedures are associated with increased CAUTI in patients hospitalized with COVID-19 for 48 hours or more. CAUTIs have increased by 83% in patients who have been hospitalized with COVID-19 for over 48 hours, despite infection control and procedures being implemented due to the pandemic (Baker et al., 2021; Diamond, 2020). This section will present the review of related literature to situate the present study and highlight the gap that this study is designed to close.

The CINAHL, ProQuest, and PubMed databases were used to perform a complete electronic search of the literature. Boolean operators were used to combining keywords into relevant sentences. To find out more about CAUTI, I used the following search terms independently as well as in combination: *COVID-19*, *catheter-associated urinary tract infection (CAUTI)* or *urinary tract infection (UTI)*, and *hospital-acquired infections*. I restricted the search to items published between 2017 to 2022. A set of inclusion and exclusion criteria was used. Peer-reviewed and academic papers with abstracts in English were explicitly chosen. In addition, investigations involving children and non-human test subjects were excluded.

Conceptual Model

This study was guided by the PAPM, which allows for better understanding of how individuals make decisions and changes in their lives while adopting new behaviors or ceasing risky ones. There are seven steps within the PAPM model:

1. Unaware
2. Unengaged
3. Undecided about acting
4. Deciding not to act
5. Decided to act
6. Acting
7. Maintenance (Weinstein et al., 2020).

The logical connection between this framework and the nature of the study included how health-protective behaviors for staff and patients improve the incidence rates of CAUTI by decisions informed through risk factors probability. For example, Step 1 of the model highlights how individuals can be unaware of an issue, while Step 2 sees them becoming aware of an issue but have remained unengaged. Step 3 is where the decision-making process can begin, where individuals can either decide not to act (Step 4) or act (Step 5). In Step 6, individuals start making changes by either adopting new behaviors or ceasing risky ones, while Step 7 allows individuals to maintain new healthy behaviors (Weinstein et al., 2020). It is important to note that individuals who decide not to act end the process and do not continue to maintenance.

Previous studies have been conducted that have utilized this conceptual model within the healthcare field. Minimal studies have utilized this conceptual model within research depicting indwelling catheters or the experiences of CAUTI; however, research has been strong within the healthcare field. For example, the healthcare field has used the PAPM to understand decision-making in relation to the COVID-19 booster. Meyer et al.

(2022) conducted a quantitative study that focused on the COVID-19 booster in the United Kingdom. Collecting data via a survey, the authors surveyed over 2,000 people in October 2021 and found some interesting results in relation to their perceptions about the COVID-19 booster. Only 6.7% of participants were not engaged with the booster program, 13% were undecided, 1.5% decided not to receive the booster shot, and 8% already had received their booster shot. The authors found that the participants who reported that they were unengaged in a booster shot program were strongly associated with education level, their thoughts regarding how strongly the booster can help their immune system, and low household income. Therefore, the authors were able to use the PAPM to increase the effectiveness of messaging to the public to target individuals who were undecided about the COVID-19 booster.

Literature Review Related to Key Variables and/or Concepts

Healthcare-Associated Infections

Before COVID-19, healthcare-associated infections (HAIs) in the United States were already declining steadily. While there were still many cases, what was noticeable was that the rates were falling because of all the measures that hospitals were undertaking precisely for the purpose (Weiner-Lastinger et al., 2021). An HAI monitoring system known as the INICC is considered credible, so many healthcare institutions have used it to survey various hospitals' infection rates (Rosenthal, 2016). Based on this monitoring system. It was apparent that hospitals' preventative approaches were practical, as there was an evident and substantial decrease in CLABSI, Ventilator -Associated Event (VAE), and CAUTI rates between 2002 and 2019 (Rosenthal et al., 2022). The COVID-

19 pandemic led many researchers to hypothesize that whatever progress was made could be disrupted. When two waves of COVID-19 infections swept throughout the United States, some researchers noticed a higher incidence and number of hospitalizations (Ripa et al., 2021). During this time, it was expected that people with COVID-19 were also suffering from secondary infections; some of these were contracted within the hospitals themselves. Based on documented statistics, HAIs in the United States have occurred (Fakih et al., 2020; LeRose et al., 2020; McMullen et al., 2020).

During the second quarter of 2020, when hospitals across the United States responded to the rush of COVID-19 patients, elevated incidence of various infections, including CAUTIs, was discovered (Weiner-Lastinger et al., 2021). The risk of device-associated disease may increase because of more comorbid conditions, more excellent patient acuity, and the usage of devices for more extended periods (Weiner-Lastinger et al., 2021). The outbreak may have been exacerbated by changes in personnel patterns and procedures, greater critical care capacity, and changes in the use of personal protective equipment (Rebmann et al., 2021; Weiner-Lastinger et al., 2021).

HAIs, through the years, especially when the rates are on the rise, have been labeled a significant public health hazard. According to the World Health Organization, 2020, HAIs have influenced morbidity and mortality rates. At the same time, they are the reason why some patients experience double the length of hospitalization and incur tremendous healthcare-associated expenditures (Paul et al., 2020). Hospital-acquired infections can occur when individuals get medical treatment at a healthcare institution (Paul et al., 2020). CAUTIs, which account for 70% to 80% of all HAI diagnoses, are the

most common cause of HAIs (Mong et al., 2022; Ohanian & Gaines-Hill, 2019). More than 13,000 people die each year due to CAUTI in the United States, costing $340 to $450 million annually (Melnyk, 2018; Zurmehly, 2018). Patients with CAUTIs will need to stay 2–4 days in the hospital (Agado, 2020). In 2019, Texas saw just 0.712 new cases of CAUTI, a number much lower than the national average for the year (Agado, 2020).

According to the CDC, approximately 1.7 million hospitalized persons contract an HAI each year (Haque et al., 2018). An HAI is an infection that occurs in a healthcare setting. Surgical site infection (SSI), ventilator-associated event (VAE), Clostridium difficile infection (CDI), methicillin-resistant Staphylococcus aureus (MRSA), and vancomycin-resistant enterococcus (VRE) are the most common HAIs (VRE). HAIs are associated with increased hospital stays, morbidity, and mortality. Of the 1.7 million hospitalized patients in the United States who contract an HAI, 98,000 will die (Haque et al., 2018).

Factors Associated With CAUTI

CAUTI occurs when a catheter spreads infection throughout the urinary system. 15%–25% of hospitalized individuals receive a urinary catheter (CDC, 2015). CAUTI is most frequently caused by prolonged catheter use. Being feminine, paraplegic, or otherwise limited in mobility, and having a history of UTIs (CDC, 2015). According to the CDC's Standardized Infection Ratio (SIR) summary, 19,398 CAUTIs were reported in 2019 compared to 22,015 in 2018. For hospitals to minimize CAUTIs, catheter use should be confined to medical situations. At the same time, for healthcare organizations to prevent the spread of germs, sterile conditions must be used while inserting the

catheter and around the drainage site. This involves proper hand cleanliness prior to touching the patient's catheter. Finally, the catheter site should be thoroughly inspected for frequent pulling, tugging, kinking, or twisting.

This occurs following the insertion of a catheter into a large vein in the neck, chest, or groin (CDC, 2010b). CLABSI claims thousands of lives and costs the United States billions of dollars each year (CDC, 2010b). The CDC reported 18,009 cases of CLABSI in 2019, up from 19,188 in 2018. CLABSI is most frequently associated with prolonged central line use, prolonged ICU stay, immunocompromised patients, elderly patients, patients with renal impairment, and those who live in developing countries (CDC, 2010b). As with other HAIs, CLABSI may be prevented. Sterilization of the insertion site, removal of the central line when no longer required, and frequent dressing changes surrounding the mainline.

VAEs arise due to germs invading the lungs via the ventilator tube. Per 1000 ventilator days, there are 2–16 occurrences (Tismit et al., 2017). A VAE algorithm specifies three steps. A stable patient develops a ventilator-associated condition after being on a ventilator for at least 2 days (Pea-López et al., 2019). When a Tier 1 patient exhibits signs and symptoms of sickness or develops a fever, they are prescribed an antibiotic for at least 4 days (Pea-López et al., 2019). Tier 2 patients have a positive culture from a list of specific specimens or respiratory secretions and a known pathogen or have a positive respiratory test (Pea-López et al., 2019). The CDC reported 24,724 VAE cases in 2019, up from 24,223 in 2018. Each year, the ventilator-associated pneumonia epidemic costs the U.S. healthcare system millions of dollars (Tismit et al.,

2017). At greatest danger are pregnant women, diabetics, those in a coma, those with chronic renal failure, and those with coronary artery disease (Luckraz et al., 2017). Hand hygiene, mouth washing, and cleaning or replacing equipment between patients all contribute to the prevention of a VAE.

Challenges of CAUTI

Approximately 13,000 fatalities a year are attributed to healthcare associated UTIs, resulting from more severe complications, such as sepsis and endocarditis (Dehghanrad et al., 2019; Mohammed & Musse, 2020). For an infection to be classified as a CAUTI, a patient must meet all of the following criteria: (a) have had an indwelling urinary catheter for more than 2 days by the date of the incident; (b) have at least one sign or symptoms, such as fever or suprapubic tenderness, costovertebral angle tenderness, urinary frequency or urgency or dysuria; and (c) have positive urine culture results (non-bacterial pathogens have been excluded since 2 years; Saran et al., 2018; Zurmehly, 2018). An attempt to lower CAUTI rates was pushed nationally in 2009 by the U.S. Department of Health and Human Services, who estimated that 69% of infections may be avoided. The use of hydrophilic-coated catheters shortened catheter time, and the sterile manner of placing catheters were some of the most effective strategies (Saran et al., 2018; Zurmehly, 2018). Even though CAUTI rates have decreased, there is still a lack of information on the risk factors for the illness, even though preventative efforts have been successful (Saran et al., 2018; Zurmehly, 2018).

The quality of patient treatment is jeopardized when an infection is contracted on the job. Prolonged catheterization, inconsistency in sterile treatment, and inadequate

urine flow are common causes of CAUTIs. In numerous investigations, an NDP CAUTI bundle technique has been demonstrated to reduce CAUTIs and side effects (Agado, 2020; Kranz et al., 2020). The CAUTI bundle was demonstrated to be one of the most effective therapies in several high-quality trials. The CAUTI bundle has been used in several acute care hospitals, long-term care institutions, and rehabilitation centers around the country. All sorts of medical institutions and services have found that it reduces CAUTIs (Hur et al., 2019; Parker et al., 2017; Zurmehly, 2017). The CAUTI package contains clinically acceptable indications for IUC insertion in the form of checklists, illustrations, and reminders (Johnson, 2018; Zurmehly, 2017). Catheter insertion, aseptic procedure, documentation, maintenance, continuous catheter monitoring, and catheter removal are all part of the process (Johnson, 2018; Zurmehly, 2017).

When calculating the CAUTI risk, the number of catheter days in each type of hospital unit (medical intensive care and medical/surgical wards) and the number of hospital beds, as well as the academic teaching status and particular facility types (i.e., children's hospital, military, and Veterans Affairs) are all taken into consideration. For example, given these denominator numbers, it is possible to predict the number of infections in each institution. The observed infections are divided by the projected infections, and the SIR is calculated due to this division (Letica-Kriegel et al., 2019). The CDC regularly measures HAI rates and denominator characteristics to guarantee that an SIR of 1.0 represents the "average" hospital in the United States. Since the most recent rebaselining in 2015, HAIs have continuously declined (Letica-Kriegel et al., 2019).

Not all risk adjustments are created equal. Risk-adjusted measures exist in various shapes and sizes, and the methods used to execute them are as diverse as the measures themselves. Patient safety indicators (PSIs), the National Surgical Quality Improvement Program of the American College of Surgeons, and performance measures created by the Society of Thoracic Surgeons are among the quality indicators utilized by the AHRQ. Some of these programs only employ unit- and hospital-level data for risk adjustment, while others only use encounter-level data (Fuller et al., 2020; Hsu et al., 2019).

When AHRQ measures are produced from CMS claims data, encounter-specific clinical characteristics of patients, such as their comorbidities and admission source, are considered. According to the American Heart Association's guidelines, every patient's PSI-12 (perioperative pulmonary embolism) risk adjustment is based on more than tens of comorbid conditions and hundreds of procedures (Salmasian et al., 2021). However, risk adjustment for CAUTI is mainly determined by the total number of catheter days in each kind of hospital ward. Catheter days are unlikely to be helpful as a risk-adjustment measure in clinical practice. Increasing the SIR by decreasing the denominator may help minimize infection risk by lowering the denominator. This limitation can be overcome by including patient-level variables in the computing process (Salmasian et al., 2021).

An indwelling urinary catheter is the most prevalent cause of nosocomial UTIs, the most common HAIs (Cai et al., 2022; Meddings et al., 2019; Van Decker et al., 2021). In clinical studies until recently, the issue of CAUTIs had been largely ignored. However, a heightened interest in nosocomial infections has been spurred on by external factors, including mandatory public reporting of conditions and the environment of "zero

tolerance" for hospital-acquired diseases (Cai et al., 2022; Meddings et al., 2019; Van Decker et al., 2021). There have been or will be recommendations issued by several institutions about CAUTI and the related but different conditions of catheter-associated asymptomatic bacteriuria (Meddings et al., 2019; Van Decker et al., 2021).

The measures to prevent catheterization and remove urinary catheters that are no longer needed are vital to the guidelines. Increased knowledge that CAUTI and ASB are separate illnesses and should be treated (or not) properly is another area of strength (Millard et al., 2021; Nicolle et al., 2019; Takahashi et al., 2021). Expert reviews have helped to identify knowledge gaps in CAUTI and areas where clinical trial data falls short, but guidelines can only be as good as the research they are based on. Poor study design or inability to distinguish between CAUTI and ASB might restrict clinical trials on antimicrobial catheters to prevent CAUTI (Millard et al., 2021; Nicolle et al., 2019; Takahashi et al., 2021). CAUTI may be determined from ASB by its symptoms and signs, but few current clinical trials address how to treat it when it occurs (Millard et al., 2021; Nicolle et al., 2019; Takahashi et al., 2021).

Avoiding unwanted insertions of the Urinary Catheter (UC), reducing the duration of catheterization, and practicing adequate catheter care and management are all ways to reduce the risk of developing a CAUTI (Gyesi-Appiah et al., 2020; Mong et al., 2022; Mota & Oliveira, 2019). Evidence-based guidelines for CAUTI prevention propose these procedures (Gyesi-Appiah et al., 2020; Mong et al., 2022; Mota & Oliveira, 2019). UC management and CAUTI prevention are primarily the responsibility of nurses, as the insertion and maintenance of urinary catheters fall under the purview of the nursing

profession (Mong et al., 2022). As a result, safe UC treatment relies heavily on nurses' knowledge of and attitude toward CAUTI prevention. It has been demonstrated that nurse-led interventions not only enhance patient outcomes in the case of CAUTIs (Durant, 2017; Mong et al., 2022; Tyson et al., 2020) but also help to cut down on the prevalence of the use of indwelling catheters in patients who are hospitalized (Durant, 2017). Patients with indwelling UC, regular bladder ultrasounds, catheter reminders, stop orders, and cessation protocols have reduced their CAUTI rates through nurses' involvement in systematic monitoring (Tyson et al., 2020). The literature emphasizes that nurses' awareness of current recommendations might enable them to oppose inappropriately used catheters.

There is still a gap between nurses' understanding and current practice regarding UC treatment (Mong et al., 2022). HAIs might be caused by a lack of nurses' awareness and application of fundamental infection control practices, according to several additional studies (Mong et al., 2022). When nurses lack basic information about infection control and prevention, it puts patients' health at risk (Mong et al., 2022). Previous research suggests that educational intervention is required (Menegueti et al., 2019; Mong et al., 2022). The Theory of Planned Behavior shows that an individual's attitudes and actions are closely linked; therefore, having a good outlook is as important as having the necessary information (Montano & Kasprzyk, 2015).

The most significant risk factor for CAUTI is prolonged catheter use (Al Mohajer & Darouiche, 2013). There is a daily risk of 3 to 7% contracting bacteriuria (Rebmann & Greene, 2010). When a catheter is left in place for longer than one month, the risk of

infection increases (Institute for Healthcare Improvement, 2011). Among patients with bacteriuria, CAUTI is most likely to occur in 10% of cases, whereas bloodstream infection is most likely to occur in 3% of cases. The Institute for Healthcare Improvement published a report in 2011 stating that when indwelling urinary catheters are not utilized appropriately, patients are exposed to mechanical and physiological dangers (Perrin et al., 2021). They can reduce the risk by avoiding the installation of unnecessary catheters and by reducing the amount of time spent on the catheter. Stricter policies on hand hygiene, early catheter removal in uncomplicated surgeries, catheter alternatives, and asepsis on catheter insertion and maintenance all have an effect (Perrin et al., 2021). In addition, the supervision of a closed drainage system, unobstructed urine flow, and proper training of those responsible for catheter insertion was revealed to be effective evidence-based strategies to prevent CAUTI (Perrin et al., 2021). The use of a mixture of these tried-and-true treatments can make the prevention of CAUTI much more straightforward. Patient outcomes can be improved by implementing three to five evidence-based procedures that are implemented consistently and in concert as part of a care bundle (Perrin et al., 2021). In the literature, catheter care can be divided into four parts. These are minimizing improper catheter usage, aseptic catheter insertion, maintaining catheters per recommendations, and continuously evaluating the need for catheters. These four parts can be combined into a single bundle of care. A wide range of actions is necessary to properly execute a change in clinical practice (Perrin et al., 2021). Preventing CAUTIs can be accomplished through various methods, including nurse-focused education and guidelines, daily catheter checklists, and decision-making algorithms. According to

studies, using standardized catheter care checklists significantly reduced the frequency of nonspecific UTIs and bacteriuria (Perrin et al., 2021).

Catheterization Complications: CAUTI and CLABSI

Indwelling urinary catheterization can lead to complications that can significantly and negatively affect patients' physical, emotional, and social well-being. Catheter infections can lead to worse quality of life characterized by a heightened risk of hospitalization. They usually lead to the very least UTI and other complications in the bladder. Several bladder problems have been documented in various studies linked to catheterization. These include obstructions, leaks, urethral bleeding (or urethritis), bladder spasms (or calculi), vesicoureteral reflux (or reflux into the bladder), and eventually bladder cancer (Arcens et al., 2018; Fukushima et al., 2021; Letica-Kriegel et al., 2019). This is true for persons who have indwelling urinary catheterization for a short time, especially if they have these for an extended period.

CAUTIs account for between 25 and 50% of all HAIs. People over the age of 65 who have had catheterizations for a more extended period and those who are unwell, fat, or otherwise immunocompromised are at greater risk of developing CAUTI than the general population (Letica-Kriegel et al., 2019). According to Ndomba (2022), Gram-negative bacteria include Escherichia coli, Klebsiella aerogenes, and Proteus mirabilis. CAUTI is most caused by Staphylococcus aureus and Enterococcus species, Pseudomonas aeruginosa, and GPB (Gram-positive bacteria), among other pathogens. Multidrug-resistant (MDR) strains can come from any source, including the patient's gut microbiota, even though E. coli and Klebsiella species are the bacteria that are most

impacted. Patients with IUC are at risk of getting these superbugs through the spread of germs in the hospital setting. According to the World Bank, men and women over 50 are at greater risk of IUC than people in low- and middle-income nations. According to recent research by Ndombia et al., 9.6% of outpatients had long-term IUC, higher than the national average (2012). Suppose the catheter is left in place for an extended time, the risk of CAUTI increases. Patients with CAUTI account for 42–50% of IUC patients in LMICs, whereas it accounts for 8.5–10% of IUC patients in wealthier countries. The prevalence of CAUTI among people from low-income backgrounds may be exacerbated by a lack of adequate healthcare infrastructure, poor infection-prevention strategies, and no stringent regulatory oversight (Ndomba et al., 2020).

Using urinary catheters in hospitals may worsen UTIs and other problems (Prieto et al., 2020). Experts say that urinary catheters are commonly employed (Prieto et al., 2020; Saint et al., 2018). With the help of emergent but efficient techniques, there can be the elimination of unnecessary urological catheterizations in hospitals (Prieto et al., 2020; Saint et al., 2018). Catheter-associated UTI (CAUTI) among patients on district nurse caseloads will not decrease without a systematic plan to track the rate. There can be a reduction in CAUTI risk by addressing long-term catheterization (Saifullah et al., 2020). E. was the subject of a recent investigation by the FBI. Important intervention targets were reducing the incidence of E. coli bacteremia, ensuring that catheters are used correctly, and improving the management of UTIs (Jones et al., 2020). Urinary catheter usage and treatment are well-established in hospitals and the public, based on evidence-based practice (Jones et al., 2020).

Only when medically required and when alternative therapies have proven futile should catheters be used (Lightner et al., 2022). When a patient with a short-term catheter is released or moved, a clear strategy is essential to ensure prompt assessment and removal of the catheter (Lightner et al., 2022). Infection rates are lowered, hospital stays are reduced, and unnecessary catheterizations are avoided when proper antibiotic medication is practiced. This positively impacts public health and patient experience (Lightner et al., 2022).

CAUTIs and their associated effects cost an average of $2400 per patient per year in healthcare costs (Agado, 2020). CAUTIs can have short-term and long-term unfavorable effects that can even be disabling, depending on the severity of the illness (Agado, 2020). For example, when it comes to career and caregiving duties, this can contribute to psychological stress for many families (Agado, 2020). With no breadwinner, spiraling personal finances, and an emotional toll that has left them reeling, families afflicted by CAUTIs are unraveling (Menegueti et al., 2019). Organizations that fail to handle CAUTIs suffer more significant social, administrative, and financial risks. At the same time, they suffer higher legal and ethical risks (Johnson, 2018). Nurses and other healthcare workers are responsible to their patients to promote health, avoiding damage, and alleviate suffering (Menegueti et al., 2019).

There is a direct correlation between the usage of antibiotics to treat HAIs (increased morbidity and mortality) and the development of antibiotic-resistant bacteria. Physicians and nurses are two of the most common vectors for HAIs. Therefore, their role in infection control must be regarded seriously (Paul et al., 2020). More than a third

of all US hospital infections are caused by UTIs (Salmanov et al., 2019). UTIs related to catheters have increased steadily in the United States over the last few decades. This trend is expected to continue. In 2011, acute care hospitals in the United States recorded 93,000 cases of CAUTI (Rosenthal et al., 2016). The most common cause of UTIs in hospitals is using a temporary urine catheter. Over 13,000 people die each year from CAUTIs, the most frequent UTIs in the United States (Salmanov et al., 2019).

According to Rosenthal et al. (2016), CAUTI was more common in patients in intensive care units because they were more likely to have catheters in place (83% vs. 21%). An analysis of 703 critical care units in 50 countries found that CAUTI occurred at 5.07 occurrences per 1000 catheter days between 2010 and 2015. (Rosenthal et al., 2016). According to a study conducted in two Brazilian critical care units, there are seven cases of CAUTI for every 1000 catheter days. Proven interventions include teaching healthcare workers (HCWs) to monitor the prevalence of CAUTI and proper catheter insertion and management to reduce the risk of infection (Rosenthal et al., 2016). CAUTI incidence can be reduced by removing catheters when they are no longer clinically necessary. HCWs' assumption that patients with life-threatening conditions are required to use the device is also a significant hurdle. It is one strategy to shift away from perception-based judgments to evidence-based ones to promote the adoption of protocols in the clinical environment with clearly defined criteria for indwelling urinary catheters (Rosenthal et al., 2016).

Solutions Prior to COVID-19

Through the years, preventive measures against CAUTI have been employed by various hospitals. Among the top solutions was better CAUTI preventative education. Once the CAUTI preventive education package was applied across the whole hospital, researchers found that the incidence of CAUTI dropped significantly. According to the study's findings, education and monitoring are critical to success (Coventry et al., 2021; Sharahi et al., 2019). According to research, this evidence-based practice's long-term viability might be improved by designing a champion for each unit (Coventry et al., 2021; Sharahi et al., 2019). The researchers concluded that education is crucial for every process improvement endeavor, but so are monitoring and feedback (Coventry et al., 2021; Sharahi et al., 2019). Specifically, information on the CAUTI bundle helped patients adhere to the new approach, resulting in decreased use of IUCs and better results (Coventry et al., 2021; Sharahi et al., 2019).

The broader use of health information technology (HIT) has also contributed to better healthcare outcomes (Coventry et al., 2021). White Plains Hospital in New York employed HIT as part of a successful CAUTI preventive program to identify persons with IUC (Coventry et al., 2021). Staff documented IUCs using HIT, which improved the monitoring process, leading to significant reductions in CAUTI cases (Coventry et al., 2021). According to findings, patients' demographics and data on urinary catheters and hospital room time may be collected and evaluated using HIT (Coventry et al., 2021). Information technology (HIT) can remind front-line employees to check on patients with an IUC and provide data on catheter use (Coventry et al., 2021).

In addition, patients with urinary incontinence, patients nearing the end of life, accurate intake and output measurement, specific surgical procedures, immobilization, and the treatment of sacral ulcers and perineal sores were all seen to have benefitted from catheterization in some cases way. An IUC should be checked regularly for those who meet the requirements. To prevent CAUTI, IUCs should be utilized, measured, and monitored (Coventry et al., 2021). Nevertheless, only a small number of patients, such as those who have a blocked bladder outlet, those who are critically ill, those who are designated as perioperative patients, those who have open sacral or perineal wounds, and those who will be immobilized for an extended period, such as those with neurological conditions or those who need comfort measures at the end of life, should be fitted with IUCs (Coventry et al., 2021). Using IUC in patients who do not fit into one of the categories stated in the recommendations is discouraged (Ardehali et al., 2019; Siregar et al., 2021). For those patients who meet the criteria, clinicians should use an aseptic technique and sterilized equipment to implant an IUC (Ardehali et al., 2019; Siregar et al., 2021). The catheter must be sealed to allow the patient's urine to flow. Preventing the transmission of infection is critical while servicing catheters. Hence it is best left to qualified professionals. If the catheter is no longer needed, it is recommended to remove it (Coventry et al., 2021).

Researchers through the years have repeatedly concluded that catheters should be removed at the earliest clinically appropriate time, and the number of unnecessary catheters should be minimized. Antibiotics should only be administered when clinically necessary (Buetti & Timsit, 2019; Clarke et al., 2020; Sari et al., 2022). There should be

more awareness and training for nursing staff on the latest guidelines (Buetti & Timsit, 2019; Clarke et al., 2020; Sari et al., 2022).

Chronic and lifestyle illness patients' lives have been transformed thanks to advancements in medical technology. However, these devices often put patients at risk for infection (Andersen & Flores-Mireles, 2019). Indwelling urinary catheters are among the most often utilized invasive medical devices. When used for short or extended periods of time, urinary catheters safely remove urine from the bladder (Andersen & Flores-Mireles, 2019). According to estimates, more than 30 million urinary catheters are used in the United States each year (Andersen & Flores-Mireles, 2019).

Catheterization rates in non-intensive care units (ICUs) are at 20%, and in ICUs are at 61%, respectively, reflecting this (Andersen & Flores-Mireles, 2019). Patients with comatose or incontinent states, neurogenic bladders, spinal cord injuries, urinary flow obstructions (such as enlarged prostate), or acute urinary retention may benefit from these medications, which are widely prescribed. Patients with surgical procedures such as urogenital operations, cesarean sections, hysterectomies, laparoscopy, and orthopedic treatments are also likely to have a urinary catheter (Adersen & Flores-Mireles, 2019). Unfortunately, inserting a urinary catheter puts patients in the hospital at risk of developing catheter-associated bacteriuria, which rises by 3–6% each day the catheter is in place (Adersen & Flores-Mireles, 2019). As high as 50% of hospitalized patients will have had an infection within 7–10 days following catheterization. A serious hazard to public health is CAUTIs, which account for 40% of all hospital-acquired infections and cause 30% of all infection-related deaths (Adersen & Flores-Mireles, 2019). One strategy

to reduce the risk and severity of CAUTIs is to reduce the number of catheters (Adersen & Flores-Mireles, 2019). The incidence of CAUTI appears to be reduced by these preventative measures. Despite these efforts to prevent CAUTI, it is difficult to treat the infection because the microorganisms that cause it: (1) can form biofilms on the catheter's surface (microbial communities embedded in a self-produced polymeric matrix) and (2) are becoming antibiotic-resistant (Adersen & Flores-Mireles, 2019). Ongoing CAUTI preventive efforts have focused on coating catheter surfaces with bactericidal molecules (mainly antimicrobials) or an anti-fouling formulation to inhibit bacteria adhesion (Adersen & Flores-Mireles, 2019). Various coatings' efficacy in vitro, CAUTI animal models, and human clinical studies will be discussed and contrasted below. This section will also discuss the host's reaction to urinary catheterization and innovative techniques based on the host–catheter–microbe interactions (Adersen & Flores-Mireles, 2019).

COVID-19 and HAIs

Global healthcare systems have been severely disrupted by the COVID-19 pandemic (Bacollini et al., 2021). High hospitalization rates due to the widespread and prolonged transmission of SARS-CoV-2 have necessitated quick expansions in hospital capacity (Bollini et al., 2021). A rapid and unexpected surge of patients has forced healthcare services to respond fast (Bollini et al., 202). In addition, patients with COVID-19 are more likely to require ventilator support, making intensive care units (ICUs) among the most vulnerable hospital wards to the pandemic's effects (Bollini et al., 2021). Most intensive care units (ICUs) were restructured to provide proper treatment and cope

with the stress of an emergency. Certain typical activities may have been significantly impacted due to a lack of healthcare workers and a significant rise in ICU beds and supply-demand (Bollini et al., 2021).

Infection control efforts, such as the prevention of HAIs, may have been harmed due to these incidents. Putting all efforts towards slowing the spread of SARS-CoV-2 could have resulted in a lack of focus on other standard HAI preventive approaches, including monitoring and containment tactics (Bollini et al., 2021). Personal protective equipment (PPE) supply constraints might also have been caused by the COVID-19 reaction, which is critical for HAI management [12, 13]. Increased risks of infection from cross-contamination between patients may have been exacerbated by the fast growth in ICU capacity, lower staff-to-patient ratios, more extended stays, and more difficult patients (Bollini et al., 2021). The enormous selective pressure on antibiotics during the pandemic may have helped raise bacterial resistance (Bollini et al., 2021).

Before examining how the pandemic influenced CAUTI rates, this section provides an overview of how the pandemic triggered an increase in HAIs in general. One form of HAIs is the scary effects of taking more antibiotics than one should, which can be harmful or deadly. According to studies, most patients with COVID-19 were treated empirically with antibiotics in a hospital environment. Researchers found that COVID-19 individuals are more likely to be taking antibiotics than the general population because they have elevated levels of inflammatory blood markers associated with a bacterial infection, such as procalcitonin and C-reactive protein. However, the problem is that a microbiologically verified bacterium co-infection was not found in most of these

individuals. Instead, in a study, it was found that only 7% of the 3834 COVID-19 patients studied in a recent comprehensive analysis had proven bacterial co-infections, according to the findings (Lansbury et al., 2020). In addition, Rawson et al. found an 8% frequency of bacterial/fungal co-infection during hospitalization.

Nevertheless, given all these small percentages, broad-spectrum antibiotics were widely used, despite the lack of evidence for bacterial co-infections and the absence of antimicrobial stewardship concerns. Administering and taking antibiotics more than what is necessary is an influential group of HAIs prevalent during the pandemic. The frequency of bacterial co-infection in COVID-19-infected hospitalized patients is less than 10%.

The Effects of COVID on CAUTI Rates

COVID-19 is caused by SARS-CoV-2, a new type of coronavirus. On December 31, 2019, the WHO received a report of a cluster of ‘viral pneumonia patients in Wuhan, China, which led to the discovery of this relentless virus that quickly escalated into a pandemic (World Health Organization, 2019). The most common symptoms of COVID-19 are fever, dry cough, and lethargy. Several other symptoms might accompany the flu, such as the infected person losing his smell, experiencing conjunctivitis and sore throat, and suffering from chills and disorientation. Other symptoms can accompany these experiences, such as headache, rashes, vomiting, and diarrhea. Because fever exceeding 38°C, shortness of breath, loss of appetite, disorientation, and chest pain or pressure characterize severe cases of COVID-19 sickness, many would feel compelled to be hospitalized.

Many different infections can occur in the urinary system. Urinary passages are in the upper (in the kidneys) and lower body (bladder and urethra). Uncomplicated lower UTIs are still the most common infection in general care. When it comes to bacterial infections in infants under two, UTIs account for many cases (Ramsay et al., 2022). The boys' UTI rates were more significant in the first six months of life. UTIs can induce kidney scarring in babies, especially if accompanied by urinary tract abnormalities, although this is uncommon. Hypertension, proteinuria, renal injury, and chronic renal failure needing dialysis are all possible outcomes for adults with renal scarring. Few individuals with SARS-COVID2 or COVID 19 reported urinary symptoms (Jones et al., 2020). Given all these linkages, there was an anticipation among healthcare workers that COVID 19 individuals would experience a prevalence of UTIs. Subsequently, there was an expectation that there would also be an increase in CAUTI, CLABSI, and other HAIs due to the pandemic and rising hospitalizations.

The incidence of CLABSI and CAUTI is more significant in those with COVID (Baker et al., 2021; Knepper et al., 2020; Weiner-Lastinger et al., 2022). CLABSIs and CAUTIs are more common in people with coronavirus illness than in those not affected. Baker and colleagues (2021); Knepper and associates (2020); Weiner-Lastinger and associates (202022). Baker et al. (2021) used negative binomial mixed models to examine the connection between COVID-19 surges and HAIs, hospital-onset infections, and cluster rates in 148 HCA Healthcare-affiliated hospitals from March 1 to September 30, 2020, to see if COVID-19 spikes were associated with HAI and cluster rates. HAIs were shown to be more common because of the pandemic. During the early days of the

pandemic, hospitals were overrun by infected patients, which led to an increase in central line infection, CAUTI, and methicillin-resistant MRSA bacteremia (Baker et al., 2021). Baker et al. (2021) concluded that without considering COVID-19, there were 60% more CLABSI, 43% more CAUTI, and 44% more MRSA cases than expected throughout the seven months. The authors further reported that the load on COVID-19 was not connected to C at this time. Infection with Clostridium difficile. Microbiological data from 81 hospitals backed up the findings. Surges in COVID-19 were related to hospital-onset bloodstream infections and multidrug-resistant pathogens, including MRSA and vancomycin-resistant enterococcus. Finally, hospital-acquired pathogen clusters rose (Baker et al., 2021). COVID-related duties need to be included in routine hospital infection control, according to the researchers.

In the earlier study by Knepper et al. (2020), results showed that during the early days of the pandemic, IUC usage climbed 36% (998 to 1355 catheter days, p=0.13), whereas CVC usage increased 25% (997 to 1246 CVC days, p=0.13). Meanwhile, the rates of CLABSI rose (0.0 and 1.6 infections/1000 CVC days, p=0.08). COVID-19 locations had 83% higher CAUTI and 65% higher CLABSI rates than non-COVID-19 areas. Orders for urine and blood cultures were 69% and 73% in COVID-19 districts. The researchers found that both IUC and CVC were used more often during the early stages of the pandemic. The Covid-19 pandemic emphasized the significance of hand cleanliness and infection control techniques as suggested by the World Health Organization and the CDC to lessen the different types of HAIs, CAUTI included (Mitra et al., 2021).

During the pandemic, the percentage of COVID-19 patients who experienced CLABSI episodes was five times higher than that of non-COVID-19 patients (Gad & AbdelAziz, 2021). According to the researchers, patients with COVID-19 who developed CLABSI after an average of 18 days in the hospital were found to have been hospitalized for an extended period. It is not uncommon for patients in health care facilities to get CAUTIs. The length of catheterization is a substantial risk factor for CAUTIs (Gad & AbdelAziz, 2021). The researchers more than just highlighted these increases in infection rates; they also summarized the methods for minimizing CAUTIs by systematically reviewing current techniques and interventions (Gad & AbdelAziz, 2021). The Cochrane Library and Medline (through Ovid) were searched for evidence from January 2005 to April 2021. Symptomatic CAUTI in adults was the primary or secondary endpoint in all the trials included in this meta-analysis (Gad & AbdelAziz, 2021). Only the 1145 papers that met the inclusion criteria for randomized trials and systematic reviews were reviewed, appraised, and their data abstracted. There were 1145 items found in total, and only 59 matched the inclusion criteria. Catheterization duration, the rationale for catheterization, catheter types, UTI prophylaxis, and educational concepts and methodologies were all examined in studies relevant to CAUTI prevention. The incidence of CAUTI is associated with catheterization duration; longer-term catheterization should only be performed when necessary (Gad & AbdelAziz, 2021). The researchers also concluded that catheterization should only be used when the individual case warrants it, depending on the patient's medical history. Instead of when clinically necessary, systemic prophylaxis is still a question mark in the scientific community (Gad &

AbdelAziz, 2021). Aside from being more cost-effective, antibiotic-impregnated catheters minimize the likelihood of symptomatic CAUTI and bacteriuria. Antibiotic prophylaxis can cause antibiotic resistance, adverse effects, and a rise in healthcare expenses (Gad & AbdelAziz, 2021).

Since they can inhibit bacterial cell wall synthesis, protein synthesis, nucleic acid synthesis, sterols in cell membranes, and various metabolic steps, antimicrobials have become the most popular coating and a focus of recent research (Adersen & Flores-Mireles, 2019). Antimicrobials also account for most of the current research. Each of these subcategories contains antimicrobials with a distinct mechanism of action. The components of either target is shared by all bacterial species or target factors specific to a particular bacterial strain (Adersen & Flores-Mireles, 2019). There are several hurdles to overcome before a catheter can be made with an effective antibiotic against most infections, including the possibility of adverse effects in the patient due to conserved targets between bacterial species. Antimicrobial peptides, bacteriophages, natural bioactive compounds, and microbe-responsive coatings are some of the newer classes of catheter coatings that are becoming more popular. A wide range of possible coatings and modifications are available. However, this section will focus on those studied in-vitro or in-vivo for use with urinary catheters (Adersen & Flores-Mireles, 2019).

There have been many studies done on indwelling urinary catheters. However, there appears to be minimal research on this issue during the COVID-19 epidemic. The outcomes of the investigations were mixed. To assess the influence of the COVID-19 pandemic on CLABSI and CAUTI in hospitals (Fakih et al., 2020). During the COVID-

19 epidemic, CLABSI rates climbed by 51%. More than 130% rise in CLABSI and 56.9% increase in Candida spp. The research found no significant differences in CAUTI. My study is pertinent to this suggested study since it addressed how COVID-19 affected the incidence of ICU infections. The study found a rise in bacteria linked with catheter-related illnesses during the COVID-19 pandemic but no significant variation in the incidence of CAUTIs. CAUTIs are among the most common catheter-related infections. Knepper et al. (2020) also looked at the increased incidence of device infection in covid-19 patients. The study expected that covid-19 patients would have greater device infection rates. The study employed a 555-bed safety-net hospital as a cohort. During the early stages of the pandemic, media boosted the use of an indwelling urine catheter by 36%, compared to a 25% increase in CVC devices. CAUTI rates were 83% higher in COVID-19 regions than in non-COVID-19 areas, and the same was true for CLABSI. It is a crucial study since it explicitly links COVID-19's influence on using in-dwelling catheters among COVID-19 hospitalized patients. The study indicated that indwelling catheter use rose among COVID-19 patients, as did catheter-associated illnesses such as CAUTI and CLABSI. Ong et al. (2021) compared COVID-19 with non-COVID-19 patients' rates of device-associated infections and subsequent nosocomial bacteremia in critical care units. A longer time with urinary catheters, invasive mechanical ventilation, and central venous lines was reported in COVID-19 patients. Notably, 14.8% of COVID-19 patients had nosocomial infections compared to 2.7% of non-COVID-19 patients. Five out of ten nosocomial infections were CAUTI-related, while non-COVID-19 patients had just one. For this investigation, the incidence of nosocomial infections among

hospitalized patients during COVID-19 is critical. Because COVID-19 infections led to more nosocomial infections, CAUTI was the most prevalent nosocomial infection. Thus, hospitalized COVID-19 patients had a greater risk of nosocomial infections, including CAUTI.

Before COVID-19, Letica-Kriegel et al. (2019) published a study on how catheter-associated UTIs were frequent healthcare-related infections in several hospitals. The study focused on CAUTI development beyond the age and gender previously studied. Examining catheter implantation duration would help develop clinical countermeasures to prevent problems from worsening. From 2012 to 2016, a retrospective cohort of pediatric and adult catheter patients was studied. The view of time and indwelling is offered by observing diverse ages, genders, and medical and surgical patients. The study by Letica-Kriegel et al. (2019) emphasized the importance of catheterization days in improved treatment. Increasing days is risky for CAUTI prevalence. Females and children had a higher incidence of UTIs than other surgical and medical patients.

Patients with mobility issues, especially after surgery, had more UTIs following days with catheters. CAUTIs are still a substantial concern, even during the COVID-19 epidemic. According to previous research, patients with COVID-19 who have been hospitalized for 48 hours or longer had an increased risk of CAUTI due to patient type, age, gender, and infection control techniques. Therefore, this proposed study seeks to fill that need. Few researchers assessed the risks of using a catheter passport, despite it being a recommended activity to improve catheter management (Prieto et al., 2020). It is said

that catheter passports effectively assisted the transition from hospital to home (Prieto et al., 2020), among other positive findings. Community nurses' decision-making on catheter management was not apparent, nor was it clear if the passport influenced their ability to remove catheters when they were no longer needed. When patients migrate between healthcare facilities and their homes, it is critical to know more about catheter overuse, the effectiveness of catheter passports, and other strategies to enhance catheter management (Prieto et al., 2020).

The prevalence of UTIs in patients with COVID-19 can be inferred from some of the research evaluated. To begin, Bardi et al. (2021) found a UTI prevalence of 8% in 140 patients admitted to the critical care unit, with most of these infections being catheter-associated. Moreover, among 1016 patients hospitalized in five hospitals in the United States, Karaba et al. (2021) found a 3.0% prevalence rate. UTIs may be overdiagnosed in more than 60% of individuals with COVID-19 (Tanislav & Kostev, 2022). Consequently, the UTI frequency related to COVID-19 appears to be relatively low.

According to Johansen et al. (2022), patients undergoing hemodialysis with a CVC are susceptible to catheter-related bloodstream infections. The U.S. Department of Health and Human Services is working to prevent and monitor similar incidents. The government has launched many initiatives to limit catheters and the risks of infection in dialysis centers. Through its ESRD Quality Incentive Program, CMS now incorporates standardized fistula ratios and long-term catheter rates in its quality measurements for patients on maintenance hemodialysis. By the end of 2019, more than 80% of patients

begin hemodialysis using a catheter; as such, avoiding catheter-related bloodstream infections remained a primary concern. The National Healthcare Safety Network (NHSN) and the CDC have developed infection prevention techniques and toolkits. The ESRD Quality Incentive Program includes bloodstream infection statistics adjusted for catheter usage prevalence.

COVID-19 Measures and CAUTI Rates

The pandemic of coronavirus disease 2019 (COVID-19) in 2020 prompted efforts to reduce coronavirus transmissions within dialysis centers. Both personnel and patients were obliged to wear PPE masks, gowns, and eye protection. Also, dialysis equipment and stations were regularly cleaned and disinfected. These steps were also meant to help eliminate CAB infections by 2020, but they did not. From March 1, 2018, to November 30, 2020, intravenous antibiotic usage in dialysis facilities and bloodstream infection hospitalizations among Medicare patients using catheter hemodialysis were studied. We also calculated non-catheter-associated sepsis rates to compare hospitalization rates for bloodstream infections over time.

Results showed that gowning, masking, and enhanced disinfection in dialysis facilities had reduced catheter-associated bloodstream infections, even beyond recent steps to limit catheter-associated bloodstream infections in the hemodialysis population. In 2009, the CDC encouraged outpatient dialysis clinics to join a collaborative study project on bloodstream infections. Using the National Healthcare Safety Network for infection surveillance and feedback, staff education and competency testing, chlorhexidine as skin antisepsis, catheter care monitoring, and patient education and

engagement were all part of the team's plan. These techniques led to a 54% reduction in access-related bloodstream infections after a 15-month intervention, which lasted four years.

With the COVID-19 pandemic, infection rates started to fall in 2020, maybe due to improved sanitation and disinfection (Biddle et al., 2020). Some COVID-19 intra-facility transmission policies must be maintained to reduce catheter-associated bloodstream infections. Infection rates fell somewhat between September and November 2020. Infection-prevention methods probably declined because the overall incidence of COVID-19 disease in the US dropped over time. Infection rates may have slowed.

COVID-19 resulted in the addition of amendments to operating regulations for healthcare settings. Masks are required, hospital visits are prohibited, and beds must be kept six feet apart. COVID-19 recommendations included reductions in time spent within the room, cancellations of elective treatments, and improvements in hand hygiene. These changes may affect how frequently HAIs arise in hospitals. Cole and Barnard (2020) observed a decline in HAI prevalence during the COVID-19 pandemic. The study examined MRSA, VRE, and Extended-Spectrum Beta-Lactamase (ESBL), which are all multidrug-resistant organisms (MDROs). In 2020 Q1, the authors received pre-COVID rates; in 2020 Q2, we obtained COVID rates. All MDRO rates declined dramatically in COVID-19's second quarter.

Several experiments revealed that the COVID-19 pandemic decreased HAI rates. McMullen et al. (2020) examined hospital-acquired infections rates in New York City and St. Louis. The rates of CAUTI and CLABSI increased, but the rate of CDI decreased.

They hypothesized that low-acuity patients stayed at home due to the pandemic, whereas high-acuity patients sought treatment. This increased infection rates by lowering the denominator. McMullen, Smith, and Rebmann ascribe the decline in CDI rates to improved hand hygiene, facility disinfection, mask regulations, and increased social distance (McMullen et al., 2020).

The exact cause of the COVID-19 pandemic is unknown. Following the COVID-19 pandemic, the CDC improved infection control guidelines, which may help reduce HAI occurrence. However, individuals with a greater acuity level are more likely to contract an infection than those with a lower level, raising the HAI rate's numerator. Before and after the COVID pandemic, this study will compare HAI rates in COVID and non-COVID units at Nebraska Medicine.

Even though HAIs can currently be averted, Lecy- Schoenherr (2022) found that the problem persists. Many HAIs may be avoided if hospitals follow the CDC's infection prevention recommendations. SARS-CoV-2, also known as COVID-19, first appeared towards the end of 2019, and quickly spread over the globe. The CDC recommended additional infection prevention and control measures during the COVID-19 pandemic. Before and during the COVID-19 pandemic, the HAI rates in COVID and non-COVID units have been compared. HAI data collected before and after COVID-19 was used to investigate any differences in the rates of CLABSI, CAUTI, and VAE (VAE). There was also a comparison of COVID-19 data with data on HAI rates from other units. Before the COVID-19 pandemic, VAEs per 1,000 ventilator days tended to be somewhat higher (17.83 vs. 17.04, p=0.01). There was a significantly higher rate of VAEs per 1,000

ventilator days in COVID-19 units than in non-COVID-19 units (18.28 vs. 16.50). CLABSI and CAUTI rates did not differ substantially ($p>0.05$).

HAI prevention and control activities are significantly impacted by COVID-19. Patients who are critically ill and require long-term hospitalization may divert resources from infection prevention and control efforts. However, the necessity for preventative and control measures and improved prevention and control strategies is becoming increasingly recognized.

According to Advani et al. (2021), the COVID-19 outbreak severely strained hospital resources, staff, and operations. One of our main study aims was to see how the COVID-19 pandemic affected HAI incidence and trends. Methods. From 2018 to 2021, 51 hospitals were studied for CLABSI, CAUTI, and Clostridium difficile (CDI, VAE). These models employed time as a covariate to determine the mean hospital-level monthly incidence rates (IR). Using segmented regression analysis, CAUTI, CLABSIs, and CDI data were gathered from January 2018 to February 2020 and from March 2020 to March 2021 (Advani et al., 2021). (SR). The SR model was not appropriate for VAE. All models were built in SAS 9.4. CLABSIs increased 50% from 0.6 to 0.9/1000 catheter days (P 0.001). CAUTI, however, showed no difference (P=0.87). The CLABSI and CAUTI SR models were comparable. CDIs decreased from 3.5 to 2.5/10,000 patient days (P 0.001), while the SR model suggested an increasing trend shift (Figure 3). VAEs rose 700% during the pandemic, from 6.9 to 59.7/1000 ventilator days (P=0.15) (Advani et al., 2021). The pandemic saw an increase in a central line and ventilator usage but not in urinary catheter use (Advani et al., 2021). During the COVID-19 pandemic, CLABSIs

and VAEs increased significantly, whereas CAUTIs remained stable. Infection-specific traits, resource shortages, personnel concerns, increased device usage, evolving testing procedures, and surveillance criteria limitations all contribute to this development (Advani et al., 2021).

According to Halverson et al. (2022), the continuing COVID-19 epidemic has shaken the world and US medical communities. While excellent hospital-acquired infection prevention standards and procedures exist, the influence of the pandemic on these best practices has not been adequately studied. There were predictions that the complexity of safety practices implemented to reduce COVID-19 transmission risks to healthcare providers increased device-related infections, CAUTIs, and central line-associated bloodstream infections. One prime example would be the prohibition to enter patients' rooms frequently. Increased environmental cleaning was also projected to reduce MRSA and Clostridium infections. The pandemic's influence on HAIs is still being studied. Halverson et al. (2022) assessed the pandemic's impact on CAUTIs, CLABSIs, MRSA, and CDIs in two Illinois hospitals. Surgical site infections were excluded due to the pandemic's considerable shift in surgical volume. A linear regression model also includes nurse staffing levels and COVID-19 case rates to evaluate factors related to increasing HAI rates. This is a multi-center retrospective cohort study of inpatients admitted to two hospitals in Illinois between September 2017 and December 2020. During the pandemic, CLABSI per 1,000 patients and device days increased significantly, Infections per 1,000 patients increased significantly, and CAUTI per 1,000

showed the same movement. There were substantial increases in premium pay hours and RN per patient days.

Uncertainty exists over the pandemic's impact on HAI. Fear, quarantine, or isolation of patients may increase HAI rates (Kang et al., 2021). Reducing HAI rates could be possible with improved hand hygiene and PPE usage. The purpose of the research was to determine the impact of the COVID-19 pandemic on CLABSI and CAUTI infections connected with healthcare (CAUTI). Overall, the NHSN was given CLABSI rates and CAUTI SIRs for the whole hospital, including the medical intensive care unit (MICU), converted to a COVID-19 intensive care unit during the pandemic. Before and throughout the pandemic (Q1 2015–Q4 2019), changes in CLABSI and CAUTI rates and SIRs were analyzed using an independent-sample t-test (Kang et al., 2021). Results revealed that the CLABSI and SIR rates in our COVID-19 patients' medical critical care unit increased significantly. Overworked nurses, the prone posture, and the difficulties of infection management during isolation are all possible contributors to this result (Kang et al., 2021).

According to experts, hospital processes and caseloads have changed dramatically due to the outbreak of COVID-19. CAUTIs and central line-associated bloodstream infections are two HAIs that directly impact the reporting and risk adjustment framework. CMS, the Leapfrog Hospital Safety Grade, and Vizient's Quality and Accountability Study all incorporate indicators related to HAIs in their public and private grading schemes for hospitals, as do other organizations such as the American Hospital Association (Cole & Barnard, 2021; O'Toole, 2021; Pakyz et al., 2021; Read et al. 2021).

Although the importance of preventing these infections is well acknowledged, lowering the rate of HAIs remains a significant challenge and source of contention. The COVID-19 pandemic presents a once-in-a-lifetime opportunity to rethink how we assess and compare healthcare-associated infections in the future (Cole & Barnard, 2021; O'Toole, 2021; Pakyz et al., 2021; Read et al., 2021).

Since the risk of infection varies significantly across patients and depending on their care, hospital-acquired infection rates are not comparable between institutions. Hospitals that care for older or complex patients are more likely to have higher rates of hospital-acquired infections (HAIs) than hospitals that care for younger patients with less complex diseases. Increased HAIs occur even if they apply the same stringent infection control procedures as the other hospitals (Boncea et al., 2021; Laurent et al., 2020). To compute the standardized infection rate (SIR) for each institution, the CDC considers the predicted characteristics of their patients and the services they provide. Therefore, hospitals are obliged by the National Healthcare Safety Network to report their observed cases of healthcare-associated infections (HAIs) as well as data on the population at risk (the denominator) to be able to perform risk adjustments (NHSN) (Boncea et al., 2021; Haque et al., 2018; Laurent et al., 2020). In the case of each HAI, a thorough risk adjustment strategy is in place.

Several factors, including the course of the disease and the judgments of the medical team, contribute to the higher risk of CLABSI in COVID-19 patients. It is common for patients who need hospitalization to be in critical condition and spend more time there (Baccolini et al., 2021; Bhatt et al., 2021). The simplicity with which femoral

lines may be put in patients with highly acute diseases may increase the use of femoral lines for central access. Doctors may believe it is safer because the insertion is in the femoral vein rather than in the subclavian or internal jugular veins (McMullen et al., 2020). A greater incidence of acute renal injury3 is also linked to COVID-19, necessitating the use of central access for dialysis in a considerable proportion of those affected. Prioritizing patients with lower risk venous access, such as midlines and peripheral catheters, will be more difficult in the future, as physicians are more reluctant in the future (McMullen et al., 2020).

Many elements of treatment for COVID-19 patients are associated with CLABSI, and they are essential to keep in mind. Since the COVID-19 virus has been found in healthcare workers, several facilities restrict the completion of imaging examinations that may be deemed unnecessary to minimize exposure. These missed imaging experiments would have been crucial (for example, lack of abdominal imaging to support an intraabdominal infection process). Posing patients prone to increase oxygenation has been demonstrated to have favorable outcomes (Aldawood et al., 2021; Azeem et al., 2021). When these patients are turned, they may experience pressing, straining, and friction at the locations of their central lines. Additionally, the insertion site will be less visible, and more fluid will accumulate, posing a danger to the dressing's integrity if patients remain prone (Aldawood et al., 2021; Azeem et al., 2021).

There are a variety of nursing-related activities that might affect the risk of CLABSI. To reduce the use of personal protection equipment, healthcare workers are encouraged to group their tasks when caring for these patients (Aloush & Alsaraireh,

2018; McMullen et al., 2020; Myatra, 2019). During the time of COVID-19, these activities by the nurses leading to CLABSI are further highlighted (McMullen et al., 2020). Patients' fatigue during these care visits may prompt them to rush through time-sensitive procedures like sterilizing needleless access devices, making them less attentive during subsequent appointments. Patients see fewer visits to their rooms due to innovative care arrangements being tested in hospitals around the country (McMullen et al., 2020). Examples include moving medicine pumps and dialysis devices out of the patient care area onto corridors. As a result, the risk of CLABSI is increased. These ideas can lead to subpar infection control procedures (for example, tubing being left on a floor, raising the possibility of contamination). In some situations where patient surges result in many critical care cases, it may be necessary to pull support staff from noncritical care areas where they may have less expertise with high-risk central lines and CLABSI prevention procedures (McMullen et al., 2020).

Researchers claimed that it was conceivable that focusing on hand hygiene because of the pandemic, in general, might lower infection rates. During PPE removal, hand hygiene may be negatively affected, which may be true in the event of cross-contamination management (Ling et al., 2021; Jones et al., 2021; Papay, 2020; Putrawan et al., 2021). When patient treatment is compressed into a single visit, the need for proper hand hygiene is more likely to be neglected, which makes it more difficult to ignore (Ling et al., 2021; Jones et al., 2021; Papay, 2020; Putrawan et al., 2021).

Several interrelated factors might cause a rise in CAUTI patients. McMullen et al. (2020) showed that two institutions found a decrease in instances per 1,000 days of

urinary catheter use. Hospital A saw a 179% increase in cases per 1,000 urinary catheter days, while Hospital B saw a 57% increase in the rate of cases per 1,000 urinary catheter days) (McMullen et al., 2020). Patients with lower acuity and those using urinary catheters will be less likely to get UTIs if the overall census is reduced (McMullen et al., 2020).

COVID-19 patient hospitalizations were shown to have higher acuity and more extended stays, resulting in an overall increased CAUTI risk relative to non-COVID-19 patients, even though we have not observed statistically significant increases in the early phase of cases. Traumatic injuries may result from straining and tugging throughout the healing process when one is prone (McMullen et al., 2020). Nursing practice adjustments, such as batch tasks of care with the possibility for poor hand hygiene compliance and withdrew support workers with less awareness of CAUTI prevention protocols, may also impact CAUTI transmission. Because alternatives entail more time-consuming nursing procedures that would necessitate more room entrances and the need for personal protective equipment, this patient group is likely to reject the removal of unnecessary urine catheters (McMullen et al., 2020).

Summary and Conclusion

Due to the pandemic, infection control and procedures have been established, yet CAUTIs have increased by 83% in patients hospitalized for over 48 hours (Baker et al., 2021). In 2011, the AHRQ reported 722,000 hospital-acquired illnesses, 75,000 fatal. Infections cost US hospitals an estimated $40 billion yearly (AHRQ, 2015). CAUTI is a prevalent hospital-acquired illness. Notably, nearly one-fourth of hospital inpatients may

get a short-term indwelling urinary catheter. Complications of CAUTI lengthen hospital stays by two to four days, increasing healthcare expenses and death (AHRQ, 2015). CAUTI adds $1,300-$1,600 in expenditures per patient (AHRQ, 2015). These figures show that CAUTIs have societal consequences. CAUTI increases hospital stay, mortality risk, and patient care expenses. The COVID-19 pandemic has worsened this issue due to limited hospital resources and a greater focus on COVID-19 sickness than other illnesses (Baker et al., 2021). CAUTI is a significant societal issue in healthcare because it affects healthcare costs. COVID-19 was the subject of considerable attention in 2020 as the epidemic spread globally and hospitals became inundated with COVID-19 patients. Preventing hospital-acquired infections may have been compromised. 75% of UTI patients had a urinary catheter (CDC, n.d.). This quantitative study aims to determine how patient type, age, gender, and infection control procedures are associated with increased CAUTI in patients hospitalized with COVID-19 for 48 hours or more. CAUTIs have increased by 83% in patients who have been hospitalized with COVID-19 for over 48 hours, despite infection control and procedures being implemented due to the pandemic (Baker et al., 2021). I will collect secondary data from the CDC's National Healthcare Safety Network that will involve hospitalized COVID-19 patients with indwelling urinary catheters. In this study, different variables will be studied. The dependent variable will be CAUTIs, and the independent variables will include age, gender, patient type (COVID-19 or non-COVID-19), and infection control procedures.

Chapter 3: Methodology

CAUTIs has increased by 83% in patients who have been hospitalized with COVID-19 for over 48 hours, despite infection control and procedures being implemented due to the pandemic (Baker et al., 2021). Therefore, the purpose of this quantitative study was to determine how patient type, age, gender, and infection control procedures are associated with increased CAUTI in patients hospitalized with COVID-19 for 48 hours or more. This chapter will present the study's methodology. I will begin by discussing the research design and rationale, the study's population, and sampling procedures. The data collection procedures will then be discussed, followed by the instrumentation and operationalization of constructs, the data analysis plan, and ethnical procedures.

Research Design and Rationale

This study followed a quantitative method that utilizes a cross sectional design. In this study, the independent variables included age, gender, and patient type, whereas the dependent variable were CAUTIs– Days of Hospitalization, as represented in the following research questions and hypotheses:

RQ1: Is there an association between patient type and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization?

H_{01}: There is no association between patient type and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

H_{a1}: There is an association between patient type and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

RQ2: Is there an association between age and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization?

H_{02}: There is no association between age and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

H_{a2}: There is an association between age and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

RQ3: Is there an association between gender and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization?

H_{03}: There is no association between gender and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

H_{a3}: There is an association between gender and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

RQ4: Is there an association between nurse-driven timely removal of urinary catheters and CAUTIs among hospitalized patients when controlling for patient type?

H_{04}: There is no association between nurse-driven timely removal of urinary catheters and CAUTIs among hospitalized patients when controlling for patient type.

H_{a4}: There is an association between nurse-driven timely removal of urinary catheters and CAUTIs among hospitalized patients when controlling for patient type.

RQ5: Is there an association between urinary catheter care during placement and CAUTIs among hospitalized patients when controlling for patient type?

H_{05}: There is no association between urinary catheter care during placement and CAUTIs among hospitalized patients when controlling for patient type.

H_{a5}: There is an association between urinary catheter care during placement and CAUTIs among hospitalized patients when controlling for patient type.

I selected a quantitative method because the purpose of this study was to determine how patient type, age, gender, and infection control procedures are associated with increased CAUTI in patients hospitalized with COVID-19 for 48 hours or more. Because the purpose of quantitative research is to determine relationships or make predictions between differing variables via statistical, mathematical, and computational techniques (Fryer et al., 2018), this method is best aligned with this study. A qualitative method was considered but ultimately rejected, because the purpose of qualitative research is to explore a phenomenon, collecting data that focuses on the perceptions and

lived experiences of participants (Creswell & Creswell, 2017). Therefore, by conducting qualitative research, I would not be able to make determinations of the dataset, as no statistical or mathematical computations can take place.

I also selected a cross sectional design. A cross sectional design is a quantitative research method that is typically used when working with precollected data and is popular within the healthcare field (Wang & Cheng, 2020). The purpose of a cross sectional design is to better understand any determinations within a dataset that calls for the assessment of the prevalence of disease in clinic-based samples (Wang & Cheng, 2020). There are many benefits of conducting a cross sectional study, which include the ability to measure prevalence for all factors being researched, and the essence of being able to study multiple outcomes and exposures (Kesmodel, 2018). Therefore, a cross sectional design was selected, because it was in strong alignment with the purpose of this study, which was to determine how patient type, age, gender, and infection control procedures are associated with increased CAUTI in patients hospitalized with COVID-19 for 48 hours or more.

Methodology

Population

Because this study is utilizing secondary data, I collected data from the CDC's National Healthcare Safety Network, which has monitoring and surveillance systems to collect and record the number of hospital-acquired infections each year. Between 2020 and 2022, there were approximately 324,800 patients who were hospitalized with COVID-19, were 18 years and older, and resided in the United States (CDC, 2022). The

target population from the database includes the data of the hospitalized COVID-19 patients with indwelling urinary catheters who had been hospitalized for 48 hours or more.

Sampling and Sampling Procedures

When collecting data, I followed a purposive sampling method. A purposive sampling method uses strict criteria when selecting a sample, as well as a researcher's judgments (Campbell et al., 2020). I collected secondary data from the CDC's National Healthcare Safety Network; the following criteria was met when selecting the dataset for this study:

- Patients were 18 years and older.
- Patients were hospitalized with and without COVID-19 (e.g., patient type).
- Patients were admitted to the hospital for 48 hours or more.
- Patients resided in the United States.
- Patients had an indwelling urinary catheter.
- The dataset identified infection-control procedures.

Records that did not reflect the above criteria were not utilized in this study's data analysis. I conducted a power analysis using G*Power, which resulted in a recommended sample size of 385. The sample size of 385 takes into consideration a confidence level of .95, an effect size of .30, and a margin of error of 5% (Wang & Cheng, 2020).

After receiving permission to conduct the study, I collected the data from the CDC's National Healthcare Safety Network, where data are available to the public. I

downloaded the data from https://www.cdc.gov/nhsn/acute-care-hospital/index.html. I did not require any institutional permission from the CDC to access the data.

Data Collection Procedures

Because I collected secondary data from the CDC's National Healthcare Safety Network, I did not work directly with any participants. However, before conducting the study, I received approval from Walden University's Institutional Review Board (IRB). I did not begin the study or start collecting data until approval was received. After receiving the approval, I downloaded data from https://www.cdc.gov/nhsn/acute-care-hospital/index.html. When downloading the data, I ensured that each data record contains the following: (a) patient age, (b) patient gender, (c) patient type (e.g., COVID-19 or non-COVID-19), (d) patients that had indwelling urinary catheters, (e) patients admitted into the hospital for 48 hours or more, and (f) patients who resided in the United States. Any records that did not contain all information or criteria were not used in this study. To ensure that the dataset remains valid, I did not change or alter the data in any manner.

Instrumentation and Operationalization of Constructs

There were no instruments used in this study because I collected secondary data from the CDC's National Healthcare Safety Network. However, it was important to describe the operationalization of constructs of the variables that were being studied within this research. Table 2 highlights how each variable was measured, including the independent variables of age, gender, and patient type, and the dependent variables of CAUTIs and days of hospitalization.

Table 2

Operationalization of Constructs

Variable	Operationalization of variables
Independent variable: Age	Nominal- Age 1 – 18–24 2 – 25–34 3 – 35–44 4 – 45–54 5 – 55+
Gender	Nominal – Gender 0 – Male 1 – Female
Patient type	Patient Type – Nominal 1 – Patients hospitalized for COVID-19 2 – Patients not hospitalized for COVID-19
Dependent variable: Catheter Associated Urinary Tract Infections – Days of Hospitalization	Dependent Variable – Scale (Length of time) 1 – In Place Urinary Catheter – in place >2 days on the date of infection or present for any portion of the calendar day 2 – Removed – Urinary Catheter in place > 2 days and removed the day before the date of infection 3 – Neither – Not catheter-associated urinary tract infection

Data Analysis Plan

I completed this quantitative cross sectional study's analysis using the Statistical Package for the Social Sciences (SPSS; Version 26). Before beginning the analysis, I cleaned the data following these specific steps:

- I reviewed the data to ensure that it is completed in full.
- I reviewed the data to ensure that all required variables were in each record.

- I ensured that the records were not duplicated within the dataset.
- If any records were missing data, I deleted the record and did not use it in the study's analysis.
- I did not add or alter the data in any manner (see Ilyas & Chu, 2019).

After the data were cleaned, I conducted the analysis using IBM SPSS (Version 26). When conducting the analysis, I utilized a logistic regression. A logistic regression assists researchers in predicting a dependent variable based upon the independent variables in the dataset (Boateng & Abaye, 2019). When conducting the logistic regression, I used a Wald test to determine whether there was any significance between the variables. A Wald test is best used to determine significant variables from a range of predictors, telling researchers which variables are significant (Boateng & Abaye, 2019). I conducted a logistic regression for each of the research questions, while also analyzing control variables that include length of catheterization and number of days of hospitalization (RQ1, RQ2, RQ3), and patient type (RQ4 and RQ5). I was able to confirm each of the hypotheses, answer the research questions, and then report the results in Chapter 4 of this dissertation.

Threats to Validity

There were no known threats to validity when completing this study. However, I proceeded with caution because secondary data were used to carry out this study. I collected data from the CDC, and the way the dataset was originally collected could have been a threat to validity since different hospitals had varying definitions and protocols for recording variables, creating inconsistencies within the dataset. For example, infection

control procedures differed across hospitals, making it challenging to analyze the data uniformly. To address this issue, efforts were made to carefully examine the data and identify any potential variations in the approach to infection control procedures among hospitals. All records were thoroughly checked to ensure that essential variables, including patient type, gender, length of catheter use, and infection control procedures, were accurately identified and standardized for analysis. Despite these efforts, it is essential to acknowledge that some inherent difficulties may have persisted in the data analysis process due to the heterogeneity of the collected information from various healthcare facilities. Another possible threat to validity is the infection control procedures that were being utilized due to COVID-19. Although the CDC reported that infection control procedures had been utilized by the different hospitals or medical facilities, the infection control procedures could have been approached differently. Because no data were collected on specific infection control procedures, this could potentially be highlighted as a threat to validity.

Ethical Procedures

There are certain ethical procedures that was considered when conducting this study. First, I did not begin the study until I received permission from Walden University's IRB. After receiving permission to begin the study, I collected the data. Because I collected secondary dataset that is available to the public via the Internet, I was not required to receive permission to do so. Additionally, the data collected did not contain any patient names or identifying information, as it presents as anonymous. Nevertheless, I handled the data correctly, storing and using the data on a password-

protected flash drive that is stored in a locked filing cabinet located inside my personal residence. Once the data were downloaded, I did not change or alter the data in any manner.

Summary

CAUTIs have increased by 83% in patients who have been hospitalized with COVID-19 for over 48 hours, despite infection control and procedures being implemented due to the pandemic (Baker et al., 2021). Therefore, the purpose of this quantitative study was to determine how patient type, age, gender, and infection control procedures are associated with increased CAUTI in patients hospitalized with COVID-19 for 48 hours or more. This chapter presented the study's methodology. I began by discussing the research design and rationale, the study's population, and sampling procedures. The data collection procedures were then discussed, followed by the instrumentation and operationalization of constructs, the data analysis plan, and ethnical procedures. In Chapter 4, I will present the study's findings.

Chapter 4: Results

Data Analysis and Results

CAUTIs has increased by 83% in patients who have been hospitalized with COVID-19 for over 48 hours, despite infection control and procedures being implemented due to the pandemic (Baker et al., 2021). Therefore, the purpose of this quantitative study was to determine how patient type, age, gender, and infection control procedures were associated with increased CAUTI in patients hospitalized with COVID-19 for 48 hours or more. This chapter will present the study's analysis following the methods outlined in the previous chapter. Data analysis of this research began with cleaning the collected data, making sure all initial criteria for selection of variables/features were met, thereby ensuring all patients captured in the analysis were 18 years and older, had been hospitalized with and without COVID-19 (e.g., patient type), had been admitted to the hospital for 48 hours or more, resided in the United States, had an indwelling urinary catheter. I ensured that the dataset had identified infection-control procedures. In the following analysis step, a simple random sampling method was employed to ensure an equal opportunity for all participants to be chosen. This method was used to randomly select 385 samples for the study.

The data were collected from the CDC's National Healthcare Safety Network and then analyzed, first using the descriptive analysis method to review the frequency of the selected sampled patients. This study followed a quantitative method with a cross sectional design. The independent variables included age, gender, and patient type,

whereas the dependent variable included CAUTIs – days of hospitalization, as represented in the following research questions and hypotheses:

RQ1: Is there an association between patient type and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization?

H_{01}: There is no association between patient type and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

H_{a1}: There is an association between patient type and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

RQ2: Is there an association between age and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization?

H_{02}: There is no association between age and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

H_{a2}: There is an association between age and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

RQ3: Is there an association between gender and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization?

H_{03}: There is no association between gender and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

H_{a3}: There is an association between gender and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

Descriptive Analysis

The data reveal that the population studied consists of slightly more female (54.5%) than male (45.5%) patients. When considering the age range, the largest portion of the population fell within the 55+ age group (46.5%), followed by the 18–24 age group (16.6%). The remaining age groups had smaller percentages. In terms of patient types, the data indicate that most patients (70.1%) were hospitalized due to COVID-19, while a smaller portion (29.9%) were not hospitalized. When it came to the management of urinary catheters, a higher percentage (56.4%) of patients had their catheters timely removed by nurses, whereas 43.6% did not receive nurse-driven timely removal.

Regarding urinary catheter care during placement, the majority of patients (63.1%) did not receive specific care for their urinary catheters during placement, while a smaller percentage (36.9%) did receive such care. Among patients who developed CAUTIs, the data indicate that a comparable number had urinary catheters in place for

more than 2 days on the date of infection or for any portion of the calendar day (41.6%), of the catheter removed the day before the infection (42.1%). A smaller percentage (16.4%) did not have CAUTIs.

Table 3

Descriptive Analysis

Variable	*n*	%
Gender		
Male	175	45.5
Female	210	54.5
Age range		
18–24	64	16.6
25–34	57	14.8
35–44	39	10.1
45–54	46	11.9
55+	179	46.5
Patient type		
Patients hospitalized for COVID-19	270	70.1
Patients not hospitalized for COVID-19	115	29.9
Nurse-driven timely removal		
No	168	43.6
Yes	217	56.4
Urinary catheter care during placement		
No	243	63.1
Yes	142	36.9
Catheter Associated Urinary Tract Infections – Days of Hospitalization		
In Place Urinary Catheter – in place >2 days on the date of infection or present for any portion of the calendar day	160	41.6
Removed – Urinary Catheter in place > 2 days and removed the day before the date of infection	162	42.1
Neither – Not catheter-associated urinary tract infection	63	16.4

Logistic Regression

Two logistic regression analyses were conducted with different variables, and the results are presented in Table 4 and Table 5. The two columns of interest for the study are the B and Sig. columns. The B column in the table represents the coefficient estimates for each variable in the logistic regression analysis. These coefficients indicate the magnitude and direction of the relationship between the independent variables and the dependent variable. The Sig. column in the table provides the significance values associated with each variable in the logistic regression analysis. This value indicates the probability of observing the obtained coefficient or a more extreme value if the null hypothesis were true (i.e., there is no relationship between the independent variable and the dependent variable).

In Table 4, the significant values can be interpreted to determine whether the variables are statistically significant in relation to CAUTIs and days of hospitalization. A significance value below a chosen threshold of 95% ($\alpha = 0.05$) suggests that the variable has a statistically significant association with the outcome. Before determining whether there is an effect of the independent variables age, gender, and patient type on the dependent variable CAUTIs – Days of Hospitalization, it first needs to be established whether it was worth including the control variable in the analysis. In other words, it is important to know whether the covariate significantly predicts the outcome. The covariate had a significant effect and was used in the analysis.

CAUTIs: The coefficient estimates for the different categories of CAUTIs represent the change in the log odds of CAUTIs and days of hospitalization for patients.

The control was not statistically significant. This means that whether a patient had a urinary catheter in place for more than 2 days at the infection date or any part of that day (p = .686), or if they had a urinary catheter removed after being in placed for more than 2 days and removed the day before the date of infection (p = .777), as well as non-catheter-associated UTI (p = .612), did not show significant differences. However, neither of the coefficient estimates is statistically significant, as indicated by the corresponding significance values. This implies that the specific CAUTIs and days of hospitalization for patients do not significantly impact the outcome of CAUTIs.

Hypothesis 1

Patient Type: The coefficient estimate for Patient Type (1) represents the change in the log odds of CAUTIs days of hospitalization for patients not hospitalized for COVID-19 compared to patients hospitalized for COVID-19. The coefficient estimate is negative (-0.522), indicating a lower likelihood of CAUTIs days of hospitalization for non-hospitalized patients. Furthermore, the significance value of 0.035 suggests that patient type is a statistically significant predictor of the outcome. Therefore, I will reject the null hypothesis and support the claim that there is an association between patient type and CAUTIs among hospitalized patients when controlling for the length of catheterization and the number of days of hospitalization.

Hypothesis 2

Age: The coefficient estimates for the different age groups indicate the change in the log odds of CAUTIs days of hospitalization for age range 25–34, 35–44, 45–54, and 55+ years compared to the reference group of patients ages 18–24 years. However, Age

(1), Age (2), and Age (3) were not statistically significant (p = .630, .729, and .837, respectively), as indicated by the corresponding significance values. Among the individual age groups, only Age (4), which identifies patients 55 years and above, has a significant association (Sig. = 0.041) with the outcome. This suggests that individuals in this specific age group of patients have a different likelihood of CAUTIs and days of hospitalization compared to the reference group of patients aged 18 to 24 years.

Thus, it can be concluded that the variable of age as a whole does not have a significant association with CAUTIs days of hospitalization, as indicated by a significance value of (p = .106). Therefore, this study accepts the null hypothesis and supports the claim that there is no association between age and CAUTIs among hospitalized patients when controlling for the length of catheterization and the number of days of hospitalization.

Hypothesis 3

Gender: The coefficient estimate for Gender (1) represents the change in the log odds of CAUTIs days of hospitalization for the female gender, referencing the male gender. The coefficient estimate is close to zero (B = -0.012), indicating a negligible difference between female patients when referenced to their male counterparts. Additionally, the significance value (p = .955) suggests that gender is not a statistically significant predictor of the outcome. Therefore, the study supports the null hypothesis that there is no association between gender and CAUTIs among hospitalized patients when controlling for the length of catheterization and the number of days of hospitalization.

Table 4

Variables in the Equation

	Variable	B	*SE*	Wald	*df*	Sig.	Exp(B)
Step 1[a]	Age			7.643	4	.106	
	Age (1)	-.181	.377	.232	1	.630	.834
	Age (2)	.144	.415	.120	1	.729	1.155
	Age (3)	-.082	.396	.043	1	.837	.922
	Age (4)	-.618	.302	4.188	1	.041	.539
	Gender (1)	-.012	.218	.003	1	.955	.988
	Patient Type (1)	-.522	.247	4.456	1	.035	.594
	Catheter Associated Urinary Tract Infections			.754	2	.686	
	Catheter Associated Urinary Tract Infections (1)	.068	.238	.081	1	.777	1.070
	Catheter Associated Urinary Tract Infections (2)	.271	.313	.750	1	.386	1.311
	Constant	-.159	.313	.257	1	.612	.853

[a] Variable(s) entered on Step 1: Catheter Associated Urinary Tract Infections – Days of Hospitalization.

Controlling for Patient COVID or Non-COVID

The control variable patient type had a coefficient estimate of -0.510, indicating a negative relationship with the outcome. The significance value (p = .036) suggests that this variable is statistically significant in predicting the outcome and should be included in the study. The exponentiated coefficient (Exp(B)) of 0.601. Including the 95% confidence interval when presenting the odds ratio (Exp (B)) adds a level of statistical precision and helps in interpreting the significance of the results. The 95% confidence interval provides a range within which the true odds ratio is likely to fall with 95% confidence. If the confidence interval includes the value of 1, it suggests that there may not be a significant effect, whereas if it excludes 1, it indicates a potential statistical

significance. indicates that patients not hospitalized for COVID-19 have a 0.601 times lower likelihood of CAUTIs days of hospitalization compared to patients hospitalized for COVID-19.

Hypothesis 4

In this analysis, the variable nurse-driven timely removal has a coefficient estimate of -0.229, indicating a negative relationship with the outcome. However, the significance value (p = .290) suggests that this variable is not statistically significant in predicting the outcome. Therefore, the null hypothesis that there is no association between nurse-driven timely removal of urinary catheters and CAUTIs among hospitalized patients when controlling for patient type was retained.

Hypothesis 5

The subcategories of CATUIs (1) and (2) have coefficient estimates of 0.012 and 0.189, respectively. However, their corresponding significance values (p = .960 and .541, respectively) indicate that neither of these subcategories is statistically significant in predicting the outcome. Thus, the different categories of CATUIs are not statistically significant in predicting the outcome of CAUTIs days of hospitalization. Therefore, the null hypothesis that there is no association between urinary catheter care during placement and CAUTIs among hospitalized patients when controlling for patient type is retained.

Table 5

Variables in the Equation

	Variable	B	*SE*	Wald	*df*	Sig.	Exp(B)
Step 1[a]	Nurse-driven timely removal (1)	-.229	.216	1.121	1	.290	.796
	Catheter Associated Urinary Tract Infections			.412	2	.814	
	Catheter Associated Urinary Tract Infections (1)	.012	.234	.003	1	.960	1.012
	Catheter Associated Urinary Tract Infections (2)	.189	.309	.374	1	.541	1.208
	Patient Type (1)	-.510	.243	4.383	1	.036	.601
	Constant	-.303	.221	1.873	1	.171	.739

[a] Variable(s) entered on Step 1: Patient Type.

Summary

In this analysis, the B and Sig. columns of the table were examined, which provided coefficient estimates and significance values, respectively, for each variable in the logistic regression analysis. The coefficients in the B column indicated the magnitude and direction of the relationship between the independent variables and the dependent variable. The significance values in the Sig. column represented the probability of observing the obtained coefficient or a more extreme value if the null hypothesis were true. By interpreting the significance values, we determined the statistical significance of the variables in relation to CAUTIs and days of hospitalization.

For Hypotheses 1–3, before analyzing the effects of age, gender, and patient type on CAUTIs and days of hospitalization, the significance of the control variable was assessed. It was found that the specific categories of CAUTIs (e.g., in-place urinary catheter, removed - urinary catheter, and non-catheter-associated UTI) were not

statistically significant predictors of the outcome. This indicated that the different types of CAUTIs did not significantly impact the likelihood of CAUTIs and days of hospitalization for patients.

Regarding the hypotheses, for Hypothesis 1 (patient type), the coefficient estimate showed a negative value (-0.522), suggesting a lower likelihood of CAUTIs and days of hospitalization for non-hospitalized patients compared to those hospitalized for COVID-19. The significance value (0.035) indicated that patient type was a statistically significant predictor of the outcome. Therefore, the null hypothesis was rejected, supporting the claim of an association between patient type and CAUTIs among hospitalized patients when controlling for catheterization length and hospitalization duration.

For Hypothesis 2 (age), the coefficient estimates for different age groups were analyzed. Age(1), Age(2), and Age(3) were not statistically significant predictors, but Age(4), patients aged 55 years and above, showed a significant association (Sig. = 0.041) with the outcome. This implied that patients in the age group of 55 years and above had a different likelihood of CAUTIs and days of hospitalization compared to the reference group (18-24 years old). However, when considering age as a whole, it was found to have no significant association with CAUTIs days of hospitalization (p = .106). Therefore, the null hypothesis was accepted, indicating no association between age and CAUTIs among hospitalized patients when controlling for catheterization length and hospitalization duration.

For Hypothesis Three (gender), the coefficient estimates for the female gender (B = -0.012) indicated a negligible difference compared to the male gender. The significance value ($p = 0.955$) suggested that gender was not a statistically significant predictor of the outcome. Thus, the study supported the null hypothesis, indicating no association between gender and CAUTIs among hospitalized patients when controlling for catheterization length and hospitalization duration.

For hypothesis 4 and 5, the logistic regression analysis revealed that the control variable "Patient Type" had a coefficient estimate of -0.510, indicating a negative relationship with the outcome. The significance value ($p = 0.036$) suggests that this variable is statistically significant in predicting the outcome and should be included in the study. Additionally, the exponentiated coefficient (Exp(B)) of 0.601 indicates that patients not hospitalized for COVID-19 have a 0.601 times lower likelihood of CAUTIs days of hospitalization compared to patients hospitalized for COVID-19. Alternatively, the variable "nurse-driven timely removal" had a coefficient estimate of -0.229, but the significance value ($p = 0.290$) indicates that it is not statistically significant in predicting the outcome. Therefore, the study accepts the null hypothesis, concluding that there is no association between nurse-driven timely removal of urinary catheters and CAUTIs among hospitalized patients when controlling for patient type. Similarly, the subcategories of "Catheter Associated Urinary Tract Infections" (1) and (2) showed coefficient estimates of 0.012 and 0.189, respectively, but their corresponding significance values ($p = 0.960$ and $p = 0.541$) indicate that neither of these subcategories is statistically significant in predicting the outcome. Hence, the different categories of

“Catheter Associated Urinary Tract Infections” do not have a significant association with CAUTIs days of hospitalization, supporting the acceptance of the null hypothesis.

Chapter 5: Discussion

In the context of the COVID-19 pandemic, CAUTIs have emerged as a concerning and challenging complication for hospitalized patients. Recent research by Baker et al. (2021) highlighted a staggering 83% increase in CAUTI cases among patients hospitalized with COVID-19 for more than 48 hours, even with stringent infection control protocols. This alarming trend underscored the urgency to understand better the factors contributing to CAUTI in this specific patient population. Therefore, this study investigated CAUTI factors among hospitalized COVID-19 patients, guided by the following research questions and hypotheses:

RQ1: Is there an association between patient type and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization?

H_{01}: There is no association between patient type and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

H_{a1}: There is an association between patient type and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

RQ2: Is there an association between age and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization?

H_{02}: There is no association between age and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

H_{a2}: There is an association between age and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

RQ3: Is there an association between gender and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization?

H_{03}: There is no association between gender and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

H_{a3}: There is an association between gender and CAUTIs among hospitalized patients when controlling for length of catheterization and number of days of hospitalization.

RQ4: Is there an association between nurse-driven timely removal of urinary catheters and CAUTIs among hospitalized patients when controlling for patient type?

H_{04}: There is no association between nurse-driven timely removal of urinary catheters and CAUTIs among hospitalized patients when controlling for patient type.

H_{a4}: There is an association between nurse-driven timely removal of urinary catheters and CAUTIs among hospitalized patients when controlling for patient type.

RQ5: Is there an association between urinary catheter care during placement and CAUTIs among hospitalized patients when controlling for patient type?

H_{05}: There is no association between urinary catheter care during placement and CAUTIs among hospitalized patients when controlling for patient type.

H_{a5}: There is an association between urinary catheter care during placement and CAUTIs among hospitalized patients when controlling for patient type.

The results of this study indicated that patient type was a significant predictor, with non-hospitalized patients having a lower CAUTI risk. For the second hypothesis that focused on age and CAUTIs, it was revealed that age (55+ years) was associated with an increased likelihood of CAUTI. I examined how different age groups impact the likelihood of CAUTIs and days of hospitalization compared to a reference group (patients aged 18-24 years). Age 1 (25-34 years), Age 2 (35-44 years), and Age 3 (45-54 years) did not show statistically significant associations with the outcome, as indicated by their respective significance values (Sig.). However, Age(4), 55 years and above, did display a significant association (Sig. = 0.041) with the outcome. This implies that patients aged 55 years and above have a different likelihood of experiencing CAUTIs and days of hospitalization compared to the reference group (18-24 years).

Hypothesis 3, which focused on gender, showed no significant gender association with CAUTI risk. Despite the variations among the individual age groups, when

considering the overall impact of the age variable on CAUTIs days of hospitalization, the analysis did not find a statistically significant association (p = .106). This result leads to accepting the null hypothesis, suggesting that there is no substantial link between age and CAUTIs among hospitalized patients when accounting for the duration of catheterization and the length of hospital stay. The results further indicated that patient type was a significant predictor, while nurse-driven catheter removal was not associated with CAUTI risk. Subcategories of CAUTI were also not significant predictors.

This chapter concludes the dissertation by providing a discussion of the results. In this chapter, I interpret the results and discuss findings concerning previous research. Then, I will highlight the essential implications and limitations experienced during the study. This chapter will then conclude with recommendations for future research.

Interpretation of Results

In this section, I will interpret the results of this study concerning existing literature. I will explore how the findings can contribute to understanding CAUTI risk factors among patients while highlighting consistencies or disparities between this study's results and previous research. This information will provide a comprehensive perspective on CAUTI prevention and management in the context of the COVID-19 pandemic.

Patient Type as a Significant CAUTI Predictor

This study concluded that patient type was a significant predictor, with non-hospitalized patients having a lower CAUTI risk. This finding does align with previous literature that supports the notion that CAUTI risk may vary based on the healthcare

setting and patient status (e.g., Chadha et al., 2023; Salmasian et al., 2021). For example, Chastain et al. (2019) reported that non-hospitalized patients receive care in less invasive settings with fewer indwelling catheters or better infection control measures, contributing to their lower CAUTI risk. These findings underscore the importance of considering patient type in CAUTI prevention strategies and tailoring interventions based on the care setting. While this study reinforces the significance of patient type as a predictor, it also adds valuable insights to the existing knowledge base. By examining this relationship within the unique context of COVID-19 hospitalized patients, this study has contributed to a deeper understanding of how infectious disease outbreaks, such as the pandemic, can impact CAUTI risk among different patient populations.

To align this finding with hospitalized patients, Rosenthal et al. (2016) reported that CAUTI was more prevalent in intensive care unit (ICU) patients due to a higher likelihood of having catheters in place (83% vs. 21%). The authors completed a comprehensive analysis of 703 critical care units across 50 countries, revealing a CAUTI rate of 5.07 occurrences per 1,000 catheter days between 2010 and 2015. Similarly, a study conducted in two Brazilian critical care units found seven CAUTI cases per 1000 catheter days. To mitigate CAUTI risk, the authors found that proven interventions included educating healthcare workers on monitoring CAUTI prevalence, appropriate catheter insertion, and management. Encouraging the removal of catheters when clinically unnecessary is vital, as healthcare workers' assumption that patients with life-threatening conditions require catheter use can impede prevention efforts. Shifting towards evidence-based protocols with clearly defined criteria for indwelling urinary

catheters is essential to promote the adoption of best practices in all clinical settings (Rosenthal et al., 2016).

Age Linked to Higher CAUTI Likelihood

The second hypothesis, which focused on age as a determinant of CAUTI, yielded significant findings. This study revealed that individuals aged 55 years and above exhibited an increased likelihood of CAUTI. These findings align with prior research, consistently highlighting older adults' heightened susceptibility to healthcare-associated infections, including CAUTI, due to various contributing factors (e.g., Rosenthal et al., 2016). Specifically, Rosenthal et al. (2016) reported that age-related physiological changes, such as decreased bladder capacity and weakened immune responses, render older adults more vulnerable to UTIs. Furthermore, Rosenthal et al. noted that older adults often present with a higher burden of comorbidities, experience prolonged hospital stays, and undergo more frequent indwelling catheter usage, all of which further elevate their risk of CAUTI. Supporting this evidence, other researchers have also underscored the significance of physiological changes in the urinary system with aging, which may lead to urinary retention and incomplete bladder emptying, providing a conducive environment for bacterial growth and infection (e.g., Ligon et al., 2022). Moreover, Tesini and Dumyati (2023) emphasized that the prevalence of indwelling urinary catheters in older patients undergoing medical procedures or requiring prolonged bed rest exacerbates the risk of CAUTI. These collective findings contribute to a deeper understanding of CAUTI risk factors among older populations and underscore the importance of targeted preventive measures in this vulnerable demographic.

Gender and CAUTI Risk

Hypothesis 3, focusing on gender and its association with CAUTI risk, revealed no significant gender difference. This result aligns with several studies in the existing literature (e.g., Gunardi et al., 2021) that have also reported no substantial gender-based disparities in CAUTI susceptibility. However, research on the relationship between gender and CAUTI risk has produced inconsistent findings across various studies. Some investigations have suggested that females might have a slightly higher CAUTI risk due to anatomical differences and shorter urethral length (e.g., Franjić, 2023). In contrast, others have found no significant gender-based associations (e.g., Smith et al., 2019). These contradictory outcomes may stem from variations in study populations, healthcare settings, and sample sizes. Notably, research and healthcare practices have increasingly emphasized the significance of infection prevention protocols, irrespective of gender (e.g., Dorn et al., 2023). Advances in catheter insertion techniques, infection control measures, and catheter management have minimized gender-based disparities in CAUTI risk (Werneburg, 2022). Although this study's findings align with previous literature, further exploration of gender-specific factors influencing CAUTI risk remains essential. Ongoing research can aid in refining preventive strategies and developing evidence-based interventions tailored to specific patient groups.

Nurse-Driven Timely Removal of Urinary Catheters

This study accepted the fourth null hypothesis that there is no association between nurse-driven timely removal of urinary catheters and CAUTIs among hospitalized patients when controlling for patient type. This result has added to the existing body of

literature on CAUTI prevention. Previous research has shown mixed results regarding the impact of nurse-driven timely removal of catheters on CAUTI rates (e.g., DePuccio et al., 2020; Russell & Watters, 2019). For example, some studies have reported a positive correlation between the timely removal of catheters and reduced CAUTI incidence, suggesting that proactive catheter management practices can effectively decrease infection rates (e.g., Alqarni, 2021). However, other researchers have failed to identify a significant association between catheter removal protocols and CAUTI risk, mirroring the results of the current study. The inconsistencies in previous literature might be attributed to variations in study designs, patient populations, and healthcare settings.

Additionally, the effectiveness of catheter removal protocols may be influenced by healthcare provider adherence to guidelines, the frequency of catheter assessments, and overall infection control practices within healthcare facilities (da Silva Gama, 2019). While this study's results indicate no significant association between nurse-driven timely removal of urinary catheters and CAUTI, it underscores the importance of continuous research and improvement in catheter management practices. Yeruva et al. (2023) reported that implementing evidence-based guidelines for catheter removal and encouraging healthcare providers to prioritize timely removal when clinically appropriate could lead to better CAUTI prevention outcomes. However, future research is warranted to explore additional factors that may impact CAUTI risk and to identify best practices for catheter management in hospitalized patients to optimize patient outcomes and reduce infection rates.

Urinary Catheter Care During Placement

The finding that there is no association between urinary catheter care during placement and CAUTI among hospitalized patients when controlling for patient type contributes to ongoing investigations and research in the existing literature on CAUTI prevention. For example, prior research has yielded varied results regarding the impact of catheter care during placement on CAUTI rates (e.g., Gray et al., 2023). Some studies have reported a positive correlation between meticulous catheter care during placement and reduced CAUTI incidence (e.g., Balu et al., 2021), indicating that adherence to rigorous insertion protocols and infection prevention measures can effectively lower infection rates. Conversely, other investigations have failed to identify a significant association between catheter care practices during placement and CAUTI risk, aligning with this current study's results (Zou et al., 2023).

The inconsistencies in previous literature may be attributed to differences in study methodologies, sample populations, and healthcare settings. The effectiveness of catheter care during placement may be influenced by factors such as healthcare provider compliance with guidelines, level of training, and variations in infection control practices within healthcare facilities. While this study's results indicate no significant association between urinary catheter care during placement and CAUTI, it also underscores the importance of continued research and advancements in catheter care protocols. Implementing evidence-based guidelines for catheter insertion and care, as well as promoting consistent adherence to these protocols, could lead to improved CAUTI prevention outcomes. Therefore, future research is warranted to explore additional factors

that may influence CAUTI risk and to identify best practices for catheter care during placement in hospitalized patients. A comprehensive understanding of the impact of catheter care protocols is crucial to enhance patient safety and reduce CAUTI rates effectively.

Implications

The implications of this study are multifaceted and carry significant importance for both clinical practice and public health. Despite infection control measures, the observed 83% increase in CAUTI cases highlights the pressing need to prioritize preventive strategies in managing urinary catheters among COVID-19 patients (Baker et al., 2021). Therefore, healthcare facilities must consider implementing tailored infection control protocols, regularly monitoring catheter use, and timely catheter removal to mitigate the risk of CAUTI and its associated complications. Additionally, this study's results showing that non-hospitalized patients had a lower CAUTI risk than hospitalized individuals highlight the potential advantages of considering non-invasive treatment alternatives or early discharge when appropriate. Such measures could alleviate the strain on hospital resources and improve patient outcomes.

Moreover, the identified association between older age (55 years and above) and a higher CAUTI risk among COVID-19 patients emphasizes the need for focused attention in geriatric care settings (Mrziglod et al., 2023). Healthcare providers must prioritize implementing targeted preventive strategies and maintaining vigilant monitoring for older patients with urinary catheters to minimize the adverse impact of CAUTI on their overall health and well-being. The lack of significant gender differences in CAUTI risk also

suggests that infection control procedures and catheter management should be equally emphasized for all patients, irrespective of gender. However, further investigation into other potential gender-specific factors contributing to CAUTI risk is warranted.

This study's findings also carry significant implications for social justice in healthcare. Notably, the association between older age (e.g., 55 years and above) and an increased CAUTI risk raises concerns about health disparities among different age groups. Older patients, especially those from marginalized or underprivileged communities, may face higher risks, indicating potential inequalities in healthcare access and resources (Buffel et al., 2023). Additionally, the observation that non-hospitalized patients have a lower CAUTI risk than hospitalized individuals draws attention to potential disparities in access to care. This suggests that non-hospitalized patients may have better access to non-invasive treatment options or early discharge, shedding light on healthcare access discrepancies for different patient groups (Nhean et al., 2023).

This study's focus on infection control practices and their impact on CAUTI risk also emphasizes the need to address variations in implementing these measures across healthcare facilities. Disparities in resources and training could lead to differences in infection control outcomes, potentially resulting in inequities in CAUTI incidence and patient outcomes (Chen et al., 2021). Policymakers and healthcare providers can use these implications to develop interventions that prioritize resources and target preventive measures equitably, ensuring that all patient groups receive the highest standard of care. By addressing health disparities, promoting equitable access to care, and enhancing infection control practices, we can progress toward a more just and inclusive healthcare

system that prioritizes the health and well-being of all individuals, irrespective of age, gender, or social background.

Limitations

Queirós et al. (2017) defined limitations of a study as potential shortcomings, weaknesses, or constraints that may affect the design, execution, and interpretation of research findings. One limitation of this study was related to the accuracy of the collected data. Since different hospitals had varying definitions and protocols for recording variables, inconsistencies within the dataset could exist. For example, infection control procedures differed across hospitals, making it challenging to analyze the data uniformly. However, to address this issue, efforts were made to carefully examine the data and identify any potential variations in the approach to infection control procedures among hospitals. All records were thoroughly checked to mitigate this limitation to ensure that essential variables, including patient type, gender, length of catheter use, and infection control procedures, were accurately identified and standardized for analysis. Despite these efforts, it is essential to acknowledge that some inherent difficulties may have persisted in the data analysis process due to the heterogeneity of the collected information from various healthcare facilities.

This study's retrospective nature could also have introduced certain limitations. McKeever (2021) reported that these quantitative designs can be more prone to recall bias, incomplete records, and uncontrolled data collection processes. Additionally, the potential confinement of the study to a single healthcare facility may have restricted the generalizability of the findings to other settings with distinct patient populations and

practices (Fryer et al., 2018). The challenge of accounting for all confounding variables might also lead to bias, impeding the establishment of transparent cause-and-effect relationships. Acknowledging these limitations openly was paramount, as it allows for an informed interpretation of the outcomes and can guide future research endeavors in this critical area.

Recommendations for Future Research

Several recommendations can be made for future research based on the identified limitations and essential insights gained from this study. First, to overcome the retrospective nature of this study, future researchers could consider conducting prospective cohort studies. By collecting data in real time and following patients over a defined period, future researchers can reduce the potential for recall bias and incomplete records, enhancing the reliability of the findings (Albahri et al., 2023). Second, multi-center studies should be conducted involving diverse healthcare facilities with varying patient populations and infection control practices to enhance the generalizability of results. This approach can provide a more comprehensive understanding of CAUTI risk factors across different settings, thereby improving the applicability of findings to a broader context.

Future researchers should also prioritize the comprehensive identification and control of confounding variables. Utilizing advanced statistical methods, such as propensity score matching or regression analysis, can help mitigate the influence of these variables and strengthen the study's ability to establish meaningful associations between potential risk factors and CAUTI (Prasad et al., 2020). Additionally, experimental studies

or interventional trials could be undertaken better to understand the mechanisms behind CAUTI in COVID-19 patients. By manipulating specific infection control procedures or patient management strategies, future researchers can assess their direct impact on CAUTI rates and identify the most effective preventive measures (Dhar et al., 2021).

Furthermore, given the dynamic nature of the COVID-19 pandemic, long-term studies tracking CAUTI trends over multiple waves or outbreaks could provide valuable insights into how infection control practices evolve and their impact on CAUTI incidence. Finally, to address the limitations related to data accuracy, future research should invest in standardized data collection protocols across healthcare facilities. Collaborative efforts to develop uniform definitions and recording methods for variables such as infection control procedures will enhance the reliability and comparability of data across studies (Serio et al., 2022).

Conclusion

In conclusion, this study has yielded valuable insights into the risk factors associated with CAUTI among hospitalized patients. By exploring patient type, age, gender, nurse-driven catheter removal, and urinary catheter care during placement, the findings have contributed to the existing literature on CAUTI prevention and shed light on crucial aspects of infection control practices in healthcare settings. Notably, this study has revealed that patient type significantly influences CAUTI risk, with non-hospitalized patients displaying a lower likelihood of infection than those hospitalized for COVID-19. This observation highlights the potential benefits of non-invasive treatment options or early hospital discharge, easing the burden on healthcare resources and improving patient

outcomes. Moreover, the association between older age (55 years and above) and an increased risk of CAUTI underscores the importance of targeted preventive measures and attentive monitoring in geriatric care settings. Older patients with urinary catheters require specialized attention to mitigate the impact of CAUTI on their health and well-being.

In contrast, this study did not find any significant gender-based association with CAUTI risk, aligning with some previous literature. This finding underscores the importance of equitable infection prevention protocols, ensuring uniform and effective care for all patient groups, regardless of gender. Furthermore, the study's failure to establish a significant association between nurse-driven timely removal of urinary catheters and CAUTI risk highlights the need for continuous research and improvement in catheter management practices. Implementing evidence-based catheter insertion and removal guidelines will enhance infection control measures.

As with any study, some limitations should be acknowledged, including potential inaccuracies in data collection and the retrospective nature of the research. However, these limitations also present opportunities for future investigations to refine the understanding of CAUTI risk factors and improve infection control strategies. Overall, the results of this study underscore the significance of evidence-based approaches in CAUTI prevention and emphasize the continuous need for research and improvement in catheter management practices. By addressing identified risk factors and implementing targeted preventive measures, healthcare providers can work towards reducing CAUTI rates and enhancing patient safety and outcomes in hospital settings. This research serves

as a valuable contribution to the growing body of knowledge in the field of CAUTI prevention. It lays the foundation for further research endeavors to refine infection control practices and promote patient-centric care in healthcare facilities. Therefore, policymakers and healthcare providers can use findings from research to develop targeted interventions for equitable care, mitigating health disparities, and fostering a just and inclusive public health system for all, regardless of age, gender, or social background.

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