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Completion Times for Computerized Tomography Tests and Walkout Rates in the Emergency Department

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This is to certify that the doctoral study by

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Abstract

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MA, Ashford University, 2018

BS, Valencia University, 2017

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

The efficiency of the emergency department (ED) is important in the provision of quality patient care, which includes avoiding long wait times for tests and treatments. EDs may be overcrowded and understaffed, leading to increased wait times for tests. One of the areas overwhelmed by increased ED cases concerns the number of requests for computerized tomography (CT) scans, which may result in patients leaving the ED before care is completed. The three research questions for this quantitative study focused on the age of patients and CT scan walkout rates, completion time and CT scan walkout rates, and the number of CT tests requested and walkout rates. The independent variable was CT scans ordered in the ED. The dependent variables were the completion times for all patients, completion times based on age, and walkout rates. After the appropriate approvals, the dataset was obtained from a large medical center. The final dataset included 54,549 scan records, which originated in the ED during 2014 through 2019. A *z* test of proportion and chi-square test, together with a logistical regression analysis, were conducted to determine possible associations and statistical significance that addressed the research questions. The Donabedian model provided the foundation for this study and focused on how to improve quality, structure, and processes in the ED. Results from all three research questions showed a weak but relevant relationship and indicated the potential for a deeper study into why patients leave before their ED treatment was complete. This study may promote positive social change by providing healthcare administrators with an understanding of the significance surrounding CT scans being ordered and patients leaving before having them performed.

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Dedication

This study is dedicated to my family and friends who provided me with encouragement and emotional support to enable me to complete my doctorate degree. Specifically, I would like to thank my mother, Kathy Williams. Her genuine love, caring actions, and pure strength has pushed me at times when I wanted to give up. Her belief in me propelled me to pursue my dreams. My sons, Jaden Gilliam, Waivion Rumph, and Willie Rumph III. They have been my knights in shining armor, providing unconditional love and understanding while mommy continued to achieve higher education. There are no amount of words to express our beautiful journey as a team. Lastly, all of my friends and colleagues that have touched my journey in one way or another and provided support whenever it was needed. The completion of my doctoral research is a representation of the love, support, understanding, and encouragement from everyone that has been involved in my life.

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Section 1: Foundation of the Study and Literature Review

Hospital emergency departments (EDs) experience many challenges in patient care as they manage community patients who require emergency care for a variety of medical problems which include accidents, flare-ups of chronic illnesses, respiratory conditions, and new acute illnesses such as strokes (Sousa et al., 2018; Warner et al., 2015). Staff are required to work swiftly and strategically to address challenges they face in their line of work. Overcrowding in the ED affects wait times for urgent tests, which may necessitate transfer to other facilities and putting the patient at risk (Warner et al., 2015). In cases of disaster, for example, most health facilities are overwhelmed with patients who require screening and various tests such as computerized tomography (CT) scans to quickly determine the appropriate medical treatment and avoid the risk of deterioration and possible death (Warner et al., 2015). Overcrowding, staffing issues, and disorganization may affect whether patients receive screening tests, including CT scans, in a timely manner (Rouhollah et al., 2018).

CT scans are a crucial part of patient care, and the completion of this test is affected by staffing, patient needs, administrative concerns, and the fiscal health of the organization (Rouhollah et al., 2018). Hospitals struggle with staffing and funding of operations in the ED due to overall expenses, decreased insurance reimbursement, and uninsured patients (Sousa et al., 2018). Additionally, because of ED limitations due to patient flow many patients leave the ED before their tests and treatments have been resolved and this places the patient and hospital at risk. Therefore, addressing challenges

encountered from these hurdles is important for streamlining services, reducing the rate of walkouts, and improving access to CT scans (Sousa et al., 2018).

Problem Statement

EDs in the United States are one place where all patients can have access to a full range of services irrespective of the severity of their condition and even if they cannot pay for their care (Suriyawongpaisal et al., 2019). Presently, the ED is the primary source of care for many people in the country due to a lack of insurance or access to care (Perotte et al., 2018). As a result, the costs of running EDs, which may include employee wages, administration expenses, and the use of equipment, have continued to increase (Xiao & Lateef, 2020). One practice that contributes to the increased costs is the overutilization of resources and staffing needs (Xiao & Lateef, 2020). For example, nurses and technicians may work long hours due to the overflow of patients in the ED, and this problem may be attributed to the increase in the number of patients who visit the ED (Xiao & Lateef, 2020).

Overutilization of resources and staff shortages affect quality of care and administrative costs in hospitals and for these reasons resources in the ED should be analyzed regularly (Perotte et al., 2018). An example of overutilization is the use of CT scans in the ED, which has increased in the recent past primarily due to head injuries (Xiao & Lateef, 2020). Studies have shown a direct relationship between general wait times for ED procedures and the rate of walkouts (Perotte et al., 2018). This study focused on patient walkouts in the ED and the utilization of CT scans. Lin et al. (2018) report that a lack of patient resources in the ED may increase mortality rates and decrease

the quality of care delivered to patients and contribute to other critical complications including patient walkouts before evaluation and treatment have been completed.

The outcome of this research could benefit administrators by highlighting the need to improve efficiency and patient care by reducing the time from the initial CT scan order to completion of the procedure with the goal of reducing the rate of walkouts. There are studies that reflect on the problem of wait times but none that demonstrates a direct relationship between wait times pertaining to CT scans and ED walkouts. This study addressed this literature gap by analyzing ED and CT data within a large community hospital located in Florida. The results may enable administrators to better understand the vital role of care delivery between departments and how this affects quality, fiscal health, and patient satisfaction.

Purpose of the Study

The purpose of this quantitative study was to determine whether there was a correlation between completion times for CT tests and walkout rates in the ED. It is important for hospital administrators to work efficiently to reduce the possibility of patient walkouts before treatment and evaluation are completed as this could compromise the quality of care delivered to patients (Lundquist, 2017). EDs in the United States are often crowded, which results in concerns about the need to improve overall patient flow (Myers & Parikh, 2019).

The lengthy period of turnaround times for imaging tests, especially in the case of CT scans, is a significant reason for the delays that occur both in disposition and treatment (Xiao & Lateef, 2020). According to a recent study by Matchar et al. (2017),

10,063 CT scans were ordered in an ED during a period of 8 months. During this period, the average length of time to receive a CT final report from the radiologist was 6 hours with a median time of 4.2 hours (Matchar et al., 2017). The frequent use of CT scans is beneficial to patients but only if they do not leave because of wait times. Therefore, this study determined whether there was a correlation between turnaround times for CT tests and walkout rates in the ED (Lin et al., 2018). The independent variable is CT scans ordered in the ED, and the dependent variables are the completion times for all patients, completion times based on age, and walkout rates. The data were obtained from a hospital in a large metropolitan area in Florida.

Research Questions and Hypotheses

RQ 1: Is there a relationship between CT tests based on age categories (i.e., 20–35; 36–50; 51-65; over 65) and walkout rates in the ED?

$H_0$1: There is not a relationship between CT tests based on age categories (i.e., 20–35; 36–50; 51-65; over 65) and walkout rates in the ED.

$H_1$1: There is a relationship between CT tests based on age categories (i.e., 20–35; 36–50; 51–65; over 65) and walkout rates in the ED.

RQ 2: Is there a relationship between the CT scan completion time and the age categories (i.e., 20–35; 36–50; 51-65; over 65) of the patients?

$H_0$2: There is not a relationship between the CT scans completion time and the age categories (i.e., 20–35; 36–50; 51–65; over 65) of the patients.

$H_1$2: There is a relationship between the CT scan completion time and the age categories (i.e., 20–35; 36–50; 51–65; over 65) of the patient.

RQ 3: Is there a relationship between the number of CT scans performed in the ED per week and the walkout rates in the ED?

$H_0$3: There is not a relationship between the number of CT scans performed in the ED per week and the walkout rates in the ED.

$H_1$3: There is a relationship between the number of CT scans performed in the ED per week and the walkout rates in the ED.

Theoretical Foundation for the Study

The framework for this study is the Donabedian model, which focuses on outcome, process, and structure as ways to evaluate the quality of healthcare and also examine how to improve the services a healthcare organization offers (Moore et al., 2015). *Process* refers to the transactions between the providers and patients concerning the development of quality initiatives that improve the delivery of care (Ibn El Haj et al., 2013). *Outcomes* relate to the improvements realized when patient quality is demonstrated. *Structure* refers to the context through which healthcare delivery is conducted, such as the equipment, financing, staff, quality initiatives, and the overall functioning of healthcare settings (Ibn El Haj et al., 2013).

The Donabedian model was appropriate for this study as the model directly related to the need to improve quality, structure, and processes concerning the relationship between the completion of the CT tests and the walkout rates in the ED, which this study examined. The Donabedian model has been used in several studies that demonstrate the model's effectiveness. Ancker et al. (2012) described the role of outcome, process, and structure in a study that examined a hospital's implementation of

an IT system to improve functions between the IT and biomedical departments and the positive results that occurred. Martinez et al. (2018) used the structure, process, outcome methods to study ways to improve hospital flow by integrating the electronic medical record and various communication methods to enhance quality improvements throughout inpatient services. The same types of administrative and organizational issues described in these studies using the Donabedian model formed the theoretical foundation for this study. Donabedian's model of outcome, process, and structure directly related to the variables of this study concerning wait times for the completion CT scans for designated age groups and ED walkouts. By determining whether there was a relationship between the variables, new processes and structure could be developed to improve outcomes.

Nature of Study

This study included secondary data and a quantitative correlational research design that determined whether there was a relationship between the completion times of CT tests and walkout rates in the ED. The data were obtained from the ED and the CT data of a large community hospital located in Florida where the target patient records are kept. The secondary data included information pertaining to the variables concerning CT tests ordered, wait times, age groupings, those who completed their care, and those who walked out before treatment was finalized. In the assessment of these data, since there are three research questions and multiple variables, a regression analysis was effective in providing a detailed analysis using SPSS. Also, regression analysis helped examine the different factors that may significantly impact the completion rates of CT tests and the walkout rates in the ED (Gunst, 2018). Through this analysis, the proper statistical tests

were conducted based on the relationships between the independent and dependent variables.

Literature Review Strategies

Understanding how to improve care in the ED is an important health care quality initiative. This section provides a better understanding of these issues through a review of the literature about patient walkouts in the ED and patient flow related to completion of CT tests. The articles in the literature review reflected these topics and highlighted research regarding ED care, quality, and administrative concerns. Scholarly articles were found using a variety of Walden University library databases and search engines. A systematic review using Google Search, CINAHL Plus, Medline, ProQuest, and PubMed were the primary sources. The key search words related to the variable of the study included *wait times for CT tests, CT tests, ED walk-out issues, relationships of age and ED walk-out rates,* and *ED staffing.*

Literature Review Related to Key Variables and/or Concepts

The literature review focused on studies related to the independent variable concerning CT scans ordered in the ED and the dependent variables, which included the completion times for all patients, completion times based on age, and walkout rates. ED patients who require CT tests are usually those who need immediate attention in order to begin treatments and reduce risks that could endanger a patients' safety (Razavi & Meysamie, 2019). Therefore, coordination in CT scan tests is vital to improve efficiency and well-being of patients through prompt testing, and this literature review explored these issues.

Explanation of CT Scans

Waheed et al. (2018) described a CT scan as a combination of X-ray images obtained from various views around a person's body and use of computer processing to form cross-sectional images of the soft tissues, blood vessels, and bones. A CT scan has several uses, though it is specifically suitable for quick assessment of individuals who might have internal injuries from various accidents or any kind of trauma (Makaju et al., 2018). Through visualization of various parts of the body, CT scans are used to diagnose injuries and diseases and to create medical and surgical plans based on the results. CT scans are also used for screening patients and preventive medicine, for instance, CT colonography for individuals with a high colon cancer risk (Makaju et al., 2018).

According to Jamjoom et al. (2018), application of the CT scanners has risen in the past decades due to increased efficiency and fewer side effects. According to Nishizawa et al. (2018), there are several studies being done in ED settings to determine additional applications for the use of CT scans. Studies indicate that the frequency of CT scans may be due to the increased availability or a better understanding of tests that can be provided (Nishizasa, et al., 2018). Moreover, third-generation CT scanners have better imaging and resolution quality, resulting in the trend towards noninvasive tests. With better imaging quality and technology, CT scans have turned out to be a crucial part of diagnostic process (Vicente et al., 2019). Also, Vicente et al. (2019) stated that CT scans are used more frequently to rule out problems and avoid future medical or potential legal problems, and this has contributed to an exponential upsurge in scan rates. Tertiary referral centers and trauma centers often have CT scanners in their EDs, and this has

decreased the time needed to obtain a definitive diagnosis, therefore enhancing patient outcomes. Nevertheless, Jamjoom et al. (2018) maintained that the increasing number of scans may expose patients to unnecessary radiation and contribute to higher healthcare costs.

Despite the benefits of CT scan, there are concerns that radiation may increase the risk of cancer. Based on the findings of Gallamini et al. (2018), during a CT scan, a person becomes temporarily exposed to ionizing radiation. The radiation from a CT scan is greater than what a patient receives during a routine X-ray since the CT scan collects more comprehensive information; however, research has indicated there is little risk to patients (Gallamini et al., 2018).

CT Completion Times for ED Patients

According to Cleverley et al. (2018), many patients remain in ED departments for a lengthy period of time, which increases their risk for adverse outcomes. The average time a patient is in the ED is 5.6 hours, and this is often due to the need for tests, including CT scans. Other reasons for a lengthy ED stay are high patient volume, shortage of beds, and a lack of staff (Cleverley et al., 2018). Cleverley et al. (2018) stated that physicians and surgeons usually recommend completion duration using criteria based on level of injury and arrival time.

Driesen et al. (2018) conducted a study about ED length of time and stated that it is frequently affected by administrative factors within the organization. According to the study, the factors concern the transfer of knowledge, culture, management priorities, protocols, and external organizational factors. According to Driesen et al. (2018), the

external factors are failures of the organizations that are situational, which, according to the study, may be difficult for the organization to correct. These issues may be due to the need for a specialist, lack of CT technicians, need for more radiologists, inexperienced staff, and inexperienced leadership and management. The hospital culture affects the completion time within the ED during CT scans. For instance, the healthcare culture may require that a patient is first assessed by a medical student before resident medical staff, and lastly examined by a health specialist. Such protocols and culture may lead to long waiting times before a CT scan is performed (Driesen et al., 2018).

Clinical factors that cause ED delays may include directives from patient supervisors to change the mode of treatment, which postpones the CT procedure to later hours (Driesen et al., 2018). Also, legal issues that require informed consent, as well as the billing system in the hospital, can delay the CT scan procedures, thus affecting the time it takes within the ED before a successful scan is completed (Driesen et al., 2018).

CT scan timing and contrast enhancement affects the completion time during a CT scan (Bae, 2010). According to Bae (2010), the scan timing is influenced by the nature of the disease, type of organ involved, and the patient's physical characteristics**.** The patient characteristics that affect the scan timing during CT procedures are body mass, surface area, mass index, and weight as well as the height of the patient. According to Bae, large patients will take longer scanning time than small patients. The phenomenon is attributed to the blood volume as the dilution rate is longer in large patients because they have larger vascular and parenchymal systems; therefore, the contrast medium injected into the body is rapidly diluted. Consequently, the

concentration of the contrast medium is quickly reduced, affecting the image produced, thus more of the contrast medium is used (Bae, 2010). Furthermore, iodine is usually adjusted proportionally to the patient's body characteristics, which affects the scanning time. All of these factors are related to the patient's sex, age, and height.

According to Bae (2010), long CT scans durations require a prolonged injection period, which affects the completion time for a CT scan. Clinically, the injection duration is determined by the involved organ as well as the body size of the patient. Delicate organs such as the heart require a small amount of contrast medium as well as short scanning time, whereas organs such as limbs are relatively large, requiring a large amount of contrast medium as well as longer scanning time. Therefore, the CT scan completion time is affected by several factors, such as patient characteristics, the organ involved, and the contrast medium (Bae, 2010).

CT Completion Times for ED Patients Based on Age

According to Li et al. (2011), age affects the CT scan procedures and completion times in the ED. The age of a patient is directly related to body mass index, weight, height, and vascular system development as well as the neural system. According to Li et al., age determines the chest diameter of a patient and the overall body size and often the patient's age is correlated with the patient's body size. The study results showed through a regression analysis that both transverse and anteroposterior thoracic thickness are correlated to age, which affects the CT scan length of time (Li et al., 2011). Therefore, older patients would require more completion time than younger patients. Additionally, the CT scan images are clearer in pediatric patients as compared to adult patients. This

discrepancy is attributed to the tissue-weighing factor. Li et al. also mentioned that there is limited research on the effects of age on the CT scan and its completion time and recommended additional research with this focus.

Another viewpoint related to age was provided by Morris et al. (2000), who stated that age does not affect the completion times for CT scans in the ED. The study was conducted with a total of 1207 patients and results indicated that education, sex, age, and race did not affect CT completion times. Morris et al. stated that CT scan delays and duration of CT scans for ED patients are the results of types of illness such as acute stroke as well as the nature of the patients' arrival. Patients who arrived in an ambulance took a shorter time to enroll and schedule for lengthy procedures. This study had limitations due to being conducted in a short time-period of 36 hours.

Age is a factor that determines the time a patient takes before having a CT scan in the ED. According to Mills et al. (2010), age, sex, and the health condition of the patient are used when determining which patients are a priority for needing a CT scan. Newborn babies have preferences over other patients, whereas patients over 65 years are given priority over young adults. These decisions are frequently based on the body immunity system of the patients. Newborn babies have a relatively undeveloped immune system as compared to young adults and teenagers. Additionally, with an increase in age, the body's immune system declines; thus, older patients should be given priority (Mills et al., 2010).

CT Scans and Walkout Rates in the ED

According to Artenstein et al. (2017), the walkout rate is a key indicator of reduced efficiency in the ED. Artenstein et al. further suggested that walkout rates among

patients show that the turnaround time for CT scans is efficient or inefficient. Daily census in the ED and the hospital census affects walkout rates for ED CT scans. Typically, if patients spend more than 4 hours in the ED, they are more likely to walk out before their treatments and care have been completed. Artenstein et al. (2017) recommend the development of an interdisciplinary plan managed by various ED healthcare professionals. The purpose is to ensure that patients are examined, treated, and discharged or admitted (Systermans & Devitt, 2014). The team considers the right bed, right patient, and the right time in deciding on prioritizing the patients to be attended (Artenstein et al., 2017). Li et al. (2016) affirmed the importance of timeliness when attending to ED patients and emphasized that the preferred length for stay in the ED should be short but thorough. Healthcare professionals should transfer patients to the safest environments within the shortest time possible (Li et al., 2016).

Delays in the ED are linked to poor patient prognosis and reduced patient satisfaction (Lin et al., 2016). As a result, the total time spent between getting diagnostics and discharge or admission influences the completion time for CT tests among patients visiting the ED unit. On the other hand, CT completion time decreases and improves when there are improvements in ED processes (Lin et al., 2016). Conversely, lengthy turnaround times of procedures increase the possibility that the patient will leave the ED against medical advice. Overcrowding in the ED decreases patient flow, and without a plan to streamline care, delays will result in patient walk outs before the CT scan results are available (Systermans & Devitt, 2014).

According to Li et al. (2016), many inefficiencies in the ED are caused by the arrival time of the patient. When patients arrive in the evening, there may be few radiologists on standby, which results in delays and more time for physicians and nurses to liaise with specialists and their supervisors. The time of the ED arrival, as well as the urgency of tests and medical attention due to high acuity patients may result in a higher incidence of patient walkouts (Li et al., 2016). Patients with urgent clinical needs are likely to get priority when they visit the ED for imaging tests. Notably, patients who visit hospitals in the evening have fewer CT scans ordered as compared to those who visit during day shifts. This is influenced by staffing and overcrowding as evenings are the busiest times in EDs (Li et al., 2016).

Systermans and Devitt (2014) suggested that increasing the number of CT scans for diagnostic purposes will improve turnaround times. An adequate number of machines enhances efficiency and reduces the turnaround time needed for radiologists to report results. An increase in efficiency will improve patient satisfaction, improve CT completion times, and reduce ED walkouts (Systermans & Devitt, 2014).

Staffing in the ED

As stated by Salway et al. (2017), EDs in the United States have problems with overcrowding and an insufficient supply of medical equipment and services needed for patient care. Among these ED problems, staffing is a prevalent challenge and may result in an overflow of patients that are seeking immediate medical attention due to accidents, critical health conditions, or complicated cardiac health concerns. As a result, ED staff are often subjected to long working hours and stressful workloads (Salway et al., 2017).

Handel et al. (2011) associated the timeliness of the emergency services to most walkouts by patients that may require immediate care when they are not admitted within the shortest time, thereby, resulting in their families or caregivers often deciding to seek medical attention elsewhere. At times, walkouts occur because patient referrals are made when EDs have reached capacity which indicates the importance of managing staffing and availability of equipment, particularly CT scans, which are a frequently used test (Handel et al., 2011). Handel et al. further stated that CT testing units should be expanded to handle more people and their capacity and staff enhanced. This would provide EDs that experience a high rate of walkouts opportunities to reduce them by achieving a better workflow (Handel et al., 2011).

Age-Related Issues and Walkouts

In a study conducted by Mohsin et al. (2018), results showed that walkout rates from EDs were higher among young patients compared to aged patients who demonstrated patience during the wait time to see a doctor and receive treatment. An indicator of this issue relates to the fear of death attributed to patients seeking medical attention from other emergency centers when not attended to within 20 minutes after arriving at the hospital. The younger generation has been criticized for lacking enough patience; however, this could provide an opportunity for the health industry to improve their services and position their research and development departments in a patient-centric way (Sousa et al., 2018).

Similarly, according to Mohsin et al. (2018), age as an indicator of wait time was also influenced by other factors such as socioeconomic factors. For example, aged

patients that come from lower-middle-class families exhibited more patience in the waiting areas compared to those from higher middle-income ones. This indicator also affected their expectations about how they would be respected, assessed, and treated by the emergency medical team. Additionally, education contributed to care expectations in that illiterate patients or patients with a low education level expected less attention compared to other patients with a higher level of education. Mohsin et al. stated that these issues should be studied further considering there may be other clinical factors that influence patients' decisions.

Gaps in Literature

Implementing measures to enhance completion times for CT tests and predicting which patients should have priority are important elements related to walkout rates in the ED and more research is needed to understand and improve these issues. There are studies that reflect on the problem of wait times but none that demonstrates a direct relationship between wait times pertaining to CT scans and ED walkouts. This study addressed this literature gap by analyzing ED and CT data within a large community hospital located in Florida. The results may enable administrators to better understand the vital role of care delivery between departments and how this affects quality, fiscal health, and patient satisfaction. This research may provide information that could lead to the development of best practices related to completion of CT tests and reduced patient walkouts (Lundquist, 2017). These goals may help administrators realize progressive trends towards improvements in quality care, revenue, and positive community relationships.

Literature Review Summary

The research studies in this section describe many reasons for lengthy stays in EDs and how this contributes to delays in CT tests, adverse events, and patient walkout rates. Some of the contributing factors for delays in CT tests include nursing and physician staffing shortages, insufficient CT staff and equipment, delays in processes, lack of training, and organizational deficiencies due to leadership and protocols that may be confusing or inefficient. For instance, accidents and other critical health conditions require immediate health attention compared to other emergency services and there may be a dilemma on who to administer emergency services to first, which includes the ordering of CT scans on a priority basis.

Research studies are necessary to better understand the needs of patients seeking emergency health services. This study could help ED administrators adequately prepare for the needs of vulnerable ED patients. This research study sought to better understand what affects completion times for CT scans which could improve processes for EDs, their operations, and their challenges by addressing the literature gap. Results of this study could potentially provide information that decreases completion times for CT scans, enhances patient care, and potentially reduces patient walkout rates.

Definition of Terms

CT scan: This test is defined a cross-sectional image of the body using a rotating X-ray machine and computers. This test provides more detailed information than a standard X-ray that shows images in 2D and is frequently used to determine diagnoses before treatments can occur (Bjerken, 2017).

Emergency department: ED is defined as the acute care division of a hospital that provides care to patients without prior appointment. The department is equipped to manage a broad spectrum of injuries and illnesses (Rouhollah et al., 2018).

Walkouts for ED patients: This is defined as the premature exiting of patients before care and tests have been completed and treatment plans can be determined. Walkouts often occur because of wait times, disorganization, and staffing (Warner et al., 2015).

Turnaround times for CT imaging tests: This is defined as the length of time it takes after a physician places an order for a CT test - to the completion of the CT test (Mataloni et al., 2018).

Assumptions

There are several assumptions related to the focus of this study. One assumption is that CT scans are frequently used in EDs to determine diagnoses and treatment of patients (Warner et al., 2015). A second assumption is that patient walkouts affect the completion of CT scans. Another assumption concerns the secondary data to be used in this study is accurately coded in relation to diagnoses, completion of CT scan, or incomplete CT scan due to walkouts by patients. A final assumption is that the age designation in the patient's medical record is accurate.

Limitations

The research is based only on completion rates of CT tests as the cause of patient walkout rates in the ED. This may reduce the accuracy of the findings as other factors may have caused the increase in walkout rates, such as patient attitudes towards the care

received, the competence of the providers, and the cost of the health care services that the health care organization offers. Using regression analysis may be restrictive to linear relationships, and thus other possible factors that may lead to the increased walkout rates may not be determined (Gunst, 2018). Focusing on a for-profit community hospital as the source of the data also limits the accuracy of the study since non-profit hospitals may have different patient populations. In addition, the collection of data from patients and staff may lack accuracy as some of them might provide false or incorrect information, which may affect the findings of the study.

Scope and Delimitations

The scope of this study concerns whether there was a relationship between walkout rates, and length of time for completion of CT scans in a hospital ED. The setting for this study was based in a community hospital in in a large metropolitan city in Florida. The secondary data were obtained through an established data-base located in the CT and ED departments and all information was de-identified. Although the purpose of this study was an established problem in relation to issues in ED departments, the results may not be generalized to other areas of the country as Florida has a diverse population. Also, the hospital is for-profit and this differs from the majority of hospitals that are non-profit.

Significance

According to Wong et al. (2017), EDs across the country are often overcrowded, and nearly all EDs indicate they operate above their staffing capacity. Although management and ED leaders are responsible for overseeing the best performance of these

services, this research study brings to the forefront the issue of wait times for CT scans and whether this contributes to patient walkouts before treatment and evaluation have been completed. Information received from this study could provide a better understanding of the various dimensions of quality healthcare services. Results could also significantly contribute to the measures taken to improve patient flow in EDs.

According to Lundquist (2017), there is a need for health professionals to introduce unique and evidence-based methods that can assist in reducing the number of ED walkouts. Lundquist also indicated that at times EDs are filled with critical patients who, in many cases, are not monitored or reassessed after triage. Such scenarios create anxiety, decrease patient satisfaction, increase hospital liabilities, reduce service quality, and the overall safety of the patients (Suriyawongpaisal et al., 2019). There is research related to ED overcrowding and wait times for a variety of services but there is a lack of research that pertains to the relationship between wait times for the completion CT scans concerning, age groups, and ED walkouts (Lundquist, 2017). This study addressed this literature gap by analyzing ED and CT data within a large hospital. In general, this research may provide information that could lead to the development of best practices related to completion of CT tests and reduced patient walkouts (Lundquist, 2017). These goals may help administrators realize progressive trends towards improvements in quality care, revenue, and positive community relationships.

Summary and Conclusions

EDs play a significant role in health care and general patient care; however, overcrowding reduces efficiency. Most EDs operate above their staffing capacity and the

issue of the wait times for CT tests has affected the delivery of patient care (Warner et al., 2015). Due to the inadequate staffing in these departments or delayed times in acquiring a CT scan, many requests cannot be completed promptly. This study addressed the issues of wait times for CT scans. The independent variable is CT scans ordered in the ED. The dependent variables are the completion times for all patients, completion times based on age, and walkout rates. Patient assessments and tests using CT scanners have risen in recent decades as the machines have become more efficient with fewer side effects (Makaju et al., 2018). There is a need for health professionals to introduce unique and evidence-based methods to reduce the number of ED walkouts and this study may contribute to improvements in care by providing processes that reduce wait times for CT tests.

Section 1 provided information about the study related to ED walkout rates and the relationship to completion times for CT scans. The literature review provided information from studies that relate to the problem, purpose, and variables. Section 2 provides information about the research design, methodology, population, and statistical analysis.

Section 2: Research Design and Data Collection

The purpose of this study was to find the correlation between the walkout rates and the completion time of CT scans. There are diverse challenges in EDs as the number of patients who require-care continues to increase. EDs cope with many different types of medical problems, including respiratory conditions, chronic illnesses and other acute diseases such as stroke. Due to the high number of patients, EDs are overcrowded and this has increased the wait time and patients' vulnerability (Bobrovitz et al., 2017). Most services in EDs are urgent, and with continuous delays, risks to patients increases. In cases of a disaster or increases in medical problems, most medical facilities are overcrowded with patients who require urgent treatments or CT scans. Overcrowding and staffing issues determine the wait times for patients who require treatment and tests, and an indefinite delay may lead to patient risk or even death. The keywords related to the variables are ED staffing, CT tests wait time, walkout rates in ED, and the relationship between age and walkout issues. The data was retrieved from a community hospital in Miami, Florida.

Research Design and Rationale

The focus of this study concerns the CT scans in EDs as the independent variable. The overall completion time is the dependent variable. The completion time based on age is the covariate. The completion time in the ED is the moderator variable, with the walkout rates being the mediator variable. The data were analyzed to determine how much variance in the dependent variable is shared with the independent, covariant, and moderator variables.

This study used a research design that evaluated the correlation between the four variables. The research questions concerned the relationship between the CT test completion times and the walkout rates and their association based on age differences. This study was quantitative research based on the correlations between the CT scans and the walkout rates. The research was guided by research questions and hypotheses built on knowledge that featured the association of various variables (Badu et al., 2019). The correlation was the ideal way of determining if there were existing associations between the variables.

The dependent variable in this context was the walkout rates in the ED. The independent variables included the average CT scan time and the average number of CT scans. The data was analyzed to determine how much variance in the dependent variable was shared in the independent variables. The correlation design was a significant methodology that deploys when the available data is evaluated with more than two variables and their possible associations.

Methodology

Target Population

The target population features patients scheduled for CT scans in the ED, with several of them completing the tests and others leaving the ED before the tests could be completed. The patient data were obtained from a moderate size medical center in Miami, Florida. The facility accommodates a diverse population, which includes Black, Latino, White, and Haitian patients. The medical center contains many medical resources, including stroke care, radiology, outpatient lab and emergency room care. The patients

were distinguished by gender and age from the years 2014–2019 for both the cancellation of tests based on walkouts and completed exams.

The ED administrators keep a record of patient appointments in the electronic medical record, which also includes the department's scheduling system. This system helps departments identify the number of patients who completed scheduled tests and exams and the patients that failed to complete tests due to different issues (Knowles et al., 2017). The estimated number of patients who completed their test was 49,463 from 2014 to 2019, and the estimated number of cancelled tests was 5,538 from 2014 to 2019.

Sampling and Sampling Procedures

The initial number of patient appointments in the ED was unrealistic to consider as some patients left before being registered due to overcrowding or delay. Therefore, the analysis featured patients who were registered. The data covered 6 years from 2014 to 2019 and were grouped by order procedure type, patients' name, encounter medical record number (MRN), patients' age and gender, order date and time, exam completion date, and the duration of completion.

Inclusion

The inclusion criteria for this study were patients who registered and had CT tests ordered between 2014 and 2019. The prescheduled ED appointment for the study featured all patients who have clear information for their age and health problem (Dalila et al., 2018). This determined the analysis record based on the number of successfully finished exams and the ones that were cancelled for various reasons.

Exclusion

Patient visits that were seen by specialty physicians, other radiology exams, outpatient lab, chronic care management, nurse visits, and immediate walk-in care were excluded. Moreover, patients with no birthday listed (their age) and those who failed to register were also excluded. This means that patients who were not prescheduled with registration, which compromises their identity, insurance, and complete demographic section, were excluded. For various reasons surrounding ethical standards, minors under the age of 18 were excluded from this study (Yang et al., 2018).

Table 1

Population Considered for This Study

Inclusion Criteria		
Physicians	Demographics	Scheduling
Internal medicine, emergency departments officers	Complete credentials Older than 18 years	Sampling from 2014-2019 for scheduled patients
Exclusion Criteria		
Physicians	Demographics	Scheduling
Nephrology, cardiology and pediatrics	Incomplete credentials Younger than 18 (minors)	No prescheduled appointments
Medical Group Information		
Non-Physicians	Physicians	Patient was seen
Radiology, outpatient lab, chronic care management, nurse visits, an immediate walk-in care	Nephrology, cardiology and pediatrics, internal medicine and family practice	Average of 20,000 patients take the examination, with half of them completing the tests annually.
A sampling of Secondary Data		
Cluster Sampling	Before Exclusion-Estimated visits	After Exclusion-Estimated Visits
From 2017-2019	Before exclusion, the total number of patients who visited the emergency departments and registered was 74,261	After exclusion, the estimated patients that sat for the exam and gave clear credentials were 55,001

Note. The secondary data for this study was obtained from the emergency department scheduling system.

Sample Size Estimation and Power Analysis

By using quantitative correlational analysis, the aim was to reveal if there was an association between the variable data. Ideally, correlational analysis is practical if there is a sufficient sample size. I determined the smallest sample size and analyzed the values using G*Power (Version 3.1.9.4) software for Windows. The estimate was then done to determine the size of the sample before the secondary data will be collected. From the analysis, the sample was 993.7000123 and alpha was 0.05.

Table 2

*Sample Size Calculation Using G*Power*

Input:	Tail	Two
	Effect size	0.1
	α err probability	0.05
	power (1-β err probability)	0.7
Output:	DF	990
	Total Sample Size	993
	Actual Power	0.7000123

Therefore, the retrieved size from this data sample was n = 41,841 visits within the 6 years. The actual sample size was moderately higher than the estimated sample size using the G*Power analysis parameters.

Constructs, Data Approval, and Ethical Standards

Organizational Approval

The secondary data that was used in this research was obtained from the ED electronic registration system which is part of a large medical organization in Miami. I adhered to the Institutional Review Board (IRB) procedures and policies of the organization. A request for the secondary data was done by sending a formal application submission request for the facilities link. I was given an identification number that was submitted on January 3, 2020. I used the formal IRB as my samples were patients who had been examined in the EDs in previous years. My study was categorized as only

needing de-identified data, and my request to use the data was granted and I was issued an approval number 03-01-20-0467532.

The acquired data set contained historical de-identified patient data, including six years of raw data via an encrypted email spreadsheet of patients diagnosed in the EDs and given clear credentials and demography. The data were appropriate for this study as they provided the ideal values of patients who turned down the examination and the ones who completed the tests. The data included all the relevant information that was used to answer the research questions concerning the walkout rates and the completion times based on age and gender.

Walden University Approval

In addition to the approval required by my organization, an approval to use the data and perform my study was obtained from Walden University's IRB. Once my proposal was approved, I completed Forms A and B and submitted them to the IRB department. Included with this request was the approval letter from my organization and my CITI certificate.

Operationalization

EDs experience many challenges due to the number of patients who require emergency care and time limitations concerning tests and treatments. The purpose of this study was to find the correlation between the walkout rates and the completion time of CT scans. The CT scans in the EDs were the independent variables. The overall completion time was the dependent variable.

The research was based on the ED's retention time, which means that the number of CT scans did not depend on any other activities. The completion time based on age was the covariate and was related to the overall completion time, which was the dependent variable. Additionally, the completion time depends entirely on the staff, the CT scans, and the patient population. The dependent variable was the walkout rates in the ED. The independent variables included the average CT scan time, the number of CT scans per week, and the staffing hours of work per week. The completion time based on age was related to the overall walkout rates, which was the dependent variable.

Research Questions

RQ 1: Is there a relationship between CT tests based on age categories (i.e., 20–35; 36–50; 51–65; over 65) and walkout rates in the ED?

$H_0$1: There is not a relationship between CT tests based on age categories (i.e., 20–35; 36–50; 51–65; over 65) and walkout rates in the ED.

$H_1$1: There is a relationship between CT tests based on age categories (i.e., 20–35; 36–50; 51–65; over 65) and walkout rates in the ED.

RQ 2: Is there a relationship between the CT scan completion time and the age categories (i.e., 20–35; 36–50; 51–65; over 65) of the patients?

$H_0$2: There is not a relationship between the CT scans completion time and the age categories (i.e., 20–35; 36–50; 51–65; over 65) of the patients.

$H_1$2: There is a relationship between the CT scan completion time and the age categories (i.e., 20–35; 36–50; 51–65; over 65) of the patient.

RQ 3: Is there a relationship between the number of CT scans performed in the ED per week and the walkout rates in the ED?

$H_0$3: There is not a relationship between the number of CT scans performed in the ED per week and the walkout rates in the ED.

$H_1$3: There is a relationship between the number of CT scans performed in the ED per week and the walkout rates in the ED.

Data Analysis

A descriptive analysis was conducted to determine the percentage and frequency of erroneous and outlier data related to the variables. These data were then reviewed to determine missing data and inconsistencies in order to determine whether encounters should be retained or excluded.

In addition to the descriptive analysis, more in-depth analysis was performed to determine if there are, or are not, statistically significant outcomes in relation to walkout rates and CT wait times. A *z* test of proportion and chi-square test–together with a logistical regression analysis–was conducted to determine possible associations and statistical significance that address the research questions.

Threats to Validity

According to Ford and Scandura (2018), some situations can threaten a study's external and internal validity. According to Aghamohammadi et al. (2020), validity is a measure of quality in quantitative research. Santos et al. (2020) contended that some threats to internal validity might refer to the factors outside the treatment that could account for the results acquired in the evaluation. Nascimento (2018) asserted that threats

to external validity compromise confidence in stating whether the results of the study are relevant compared to other groups or if they can be generalized to different settings. For this study, a threat to validity related to the possibility that patients would provide false or incorrect information or employees entering information in the electronic medical record data base would make errors.

Ethical Procedures

The secondary data were stored securely and saved as an encrypted document on my hard drive. The data contained de-identified patient information which cannot be connected to any individual. The secondary data will be deleted from my computer after 5 years, which is the required amount of time to save research data. Approval for using the data was obtained from my organization's IRB and approval was also obtained from the Walden University IRB.

Summary

The objective of this study was to provide information about possible reasons for high walkout rates in EDs and whether wait times for CTs scans were a factor. The results of this study may lead to more effective utilization of space and time in the EDs. This may reduce ED walkout rates and help organizations focus on process and policies that improve quality.

This section described the study design, ethical considerations, sampling techniques, target population, threats to validity and secondary data analysis and management. In Section 3, I present the results and findings of the study.

Section 3: Presentation of Results and Findings

The purpose of this quantitative study was to investigate different contributors to walkout rates in the ED. The contributors included patient age, scan time, and scan load (number of scans conducted within a week). CT scan walkouts are an important topic to investigate given the crowded nature of many EDs, which adds to wait times and patient walkouts. This study included secondary data, and a quantitative correlational research design was used to determine whether there was evidence for a relationship between the completion times of CT tests and walkout rates in the ED. The data were obtained from ED and CT data of a large community hospital Florida where the target patient records are kept. The secondary data included information on the variables concerning CT tests ordered, wait times, age groupings, those who completed their care, and those who walked out before treatment was finalized.

To investigate the specific possible relationships that may exist between these independent variables and CT scan walkouts as the dependent variable the following research questions and hypotheses were created:

RQ 1: Is there a relationship between CT tests based on age categories (i.e., 20–35; 36–50; 51–65; over 65) and walkout rates in the ED?

$H_0$1: There is not a relationship between CT tests based on age categories (i.e., 20–35; 36–50; 51–65; over 65) and walkout rates in the ED.

$H_1$1: There is a relationship between CT tests based on age categories (i.e., 20–35; 36–50; 51–65; over 65) and walkout rates in the ED.

RQ 2: Is there a relationship between the CT scan completion time and the age categories (i.e., 20–35; 36–50; 51–65; over 65) of the patients?

$H_0$2: There is not a relationship between the CT scans completion time and the age categories (i.e., 20–35; 36–50; 51–65; over 65) of the patients.

$H_1$2: There is a relationship between the CT scan completion time and the age categories (i.e., 20–35; 36–50; 51–65; over 65) of the patient.

RQ 3: Is there a relationship between the number of CT scans performed in the ED per week and the walkout rates in the ED?

$H_0$3: There is not a relationship between the number of CT scans performed in the ED per week and the walkout rates in the ED.

$H_1$3: There is a relationship between the number of CT scans performed in the ED per week and the walkout rates in the ED.

Data Collection of Secondary Data

This section provides details about the process for collecting the secondary data used in the analysis. The process includes how the data were collected, the time frame involved, discrepancies, and descriptive statistics.

Obtaining Data, Time Frame, and Discrepancies of the Data Set

Obtaining Data

After receiving IRB approval (03-01-20-0467532) from Walden University, I analyzed deidentified data using IBM SPSS version 21. Data were obtained from an ED electronic registration system that is a smaller part of a large medical organization in

Miami, Florida. Six years of data were obtained for the years 2014 through 2019 for a total of 55,001 records.

Data Filters – Exclusions

While examining the data, some cases were found to include out-of-sequence dates and times for certain events–such as CT scans being conducted before they were ordered. These cases, then, had negative time durations for the variables being used in the study. To address this issue, any case with a negative value among the durations provided was removed from all analysis. This measure led to the exclusion of 452 scan records.

Data Filters – Inclusions

No specific inclusion criteria were used besides having valid duration scores and outcomes. The final dataset moving into analysis was composed of 54,549 scan records.

Descriptive Statistics

For each complete week between 01/01/2014 and 12/31/2019, new values were recorded for each of the study variables. The first and last weeks of this range were excluded from analysis, as they did not contain 7 days, meaning the final data in the weekly set range from 01/05/2014 to 12/28/2019. The final data set consists of scan data from 312 complete weeks.

Demographics and descriptive statistics of the final sample for individual scans are provided in Table 3. More than half of the 54,549 records were from female patients (56.29%). The mean age of the patients was 50.72. The majority (89.83%) of participants completed their CT scan. The average CT scan time for scans that were completed was 65 seconds (*SD* = 0.53s), while for those who had walked out was 107 seconds (*SD* =

294s). Summary statistics for individual scan level data can be found in Table 3, and weekly data in Table 5. A brief description of the variables included in this study is presented in Table 4.

Table 3

Demographics and Descriptive Statistics of Final Sample for Individual Scans

	Completed scan		Walkout	
Categorical variables	*N*	Valid %	*N*	Valid %
Total sample	48,921	89.83%	5,538	10.17%
Gender				
Female	27,356	55.92%	3,298	59.55%
Male	21,565	44.08%	2,240	40.45%
Age group				
20 – 35	12,137	25.29%	1,432	26.61%
36 – 50	12,059	25.13%	1,285	23.88%
51 - 65	12,304	25.64%	1,296	24.08%
66+	11,488	23.94%	1,369	25.44%
Interval variables	Mean	*SD*	Mean	*SD*
Age	50.74	19.35	50.52	20.25
Order to outcome duration	1:05:50	0:53:43	1:55:02	6:23:40

Note. Percentage listed for Total Sample of percent of total. Percentage listed with Gender is percent within Completed Scan/ Walkout Group. Outcome refers to completion of scan or walkout, depending on group.

Table 4

Descriptions of the Variables

Variable	Level of measurement	Variable type	Description
Scan outcome	Nominal	-	A binary variable representing whether or not the ordered scan was completed.
Gender	Nominal	-	The gender of the patient undergoing the scan.
Age	Ordinal	Independent	Age of the patient undergoing the scan.
Order to outcome duration	Interval	Independent	This variable records the duration between the order of the scan to its outcome. Specifically, the order to completed duration for those with completed scans, and the order to walk out duration for those who walked out.
Ordered scans	Scale	Independent	The total number of scans that were ordered within each week.
Completed scans	Scale		The total number of scans that were completed within each calendar week.
Walkouts	Scale	Dependent	The total number of scans that were not completed (i.e., walkouts) within each calendar week.
Walkout rate	Scale	Dependent	The proportion of walkouts within each week, or the quotient of total walkouts to total ordered scans.

Table 5 reports the descriptive statistics for the study variables. The number of scans ordered within each week had a mean of 174.00 (*SD* = 32.55), the number of scans completed each week had a mean of 156.31 (*SD* = 29.00), the number of scans that were not completed each week had a mean of 17.70 (*SD* = 6.31), and the average proportion of scans that were not completed within each week had a mean of 10.10% (*SD* = 2.87%).

Table 5

Descriptive Statistics of Final Sample for Week-Level Data

Variable	*M*	*SD*
Ordered scans	174.00	32.55
Completed scans	156.31	29.00
Walkouts	17.70	6.31
Walkout rate	10.10%	2.87%

Note. $n = 312$.

Study Results

After data were collected, some minor recoding was needed to address the research questions as written. It is noted where such recording occurred and will be explained to make the test statistics and results interpretable. I employed a mixture of parametric and nonparametric tests where appropriate as the variables used to address the research questions included binomial, ordinal, and ratio data.

Logistic Regression Analysis for RQ 1

RQ 1: Is there a relationship between CT tests based on age categories (i.e., 20–35; 36–50; 51–65; over 65) and walkout rates in the ED?

Patient age was recoded into the specified ordinal age groups and then broken down into four categorical dummy variables. A binomial logistic regression model was then created to use these groups to predict scan result (0 = walkout, 1 = scan completed). For purposes of interpretation, scan results were coded so higher values indicate completed scans and positive relationships between age groups and the outcome indicate higher completion rates.

Most of the remaining assumptions of the bivariate logistic regression were met. A review of the data and methodology was sufficient to confirm that the dependent variable was bivariate and the observations (ordered scan outcomes) were independent. A post hoc analysis revealed the power (1-β) to be 1.00, even with a minimal effect size of .001. This means the sample size is sufficiently large, but may be overpowered, so statistically significant results may be found even in the case of nonmeaningful effect. Although the regression model and all predictors reached statistical significance, $\chi^2(4) = 34.40$, $p < .001$, the overall prediction of the age groups showed little-to-no overall effect on scan completion or walkout result (Cox & Snell and Nagelkerke $R^2 = .001$).

There is statistically significant evidence to reject the null hypothesis in the case of RQ 1. There is evidence of a relationship between patient age and walkout. It may also be useful to note the near-identical mean and standard deviation of ages observed between those with completed scans and those who walked out in Table 3. A summary of the logistic regression analysis can be found in Table 6 and 7.

Table 6

Overall Performance of Logistic Model and Prediction

Observed	Predicted		Percentage correct
	Walkout	Scan completed	
Walkout	0	5,538	0.00%
Scan completed	0	48,921	100.00%
Overall percentage			89.83%
χ^2	34.40		
df	4		
p	< .001		
Cox & Snell R^2	.001		
Nagelkerke R^2	.001		

Note. n = 54,459.

Table 7

Logistic Regression Predicting Scan Completion From Age Group

Predictor	*B*	*SE B*	Wald	*df*	*p*	Exp(B)
Age 20–35	-0.35	.09	14.71	1	< .001	0.71
Ace 36–50	-0.45	.09	24.33	1	< .001	0.64
Age 51–65	-0.46	.09	25.62	1	< .001	0.63
Age 66+	-0.34	.09	13.82	1	< .001	0.71
Constant	3.39	.27	162.51	1	< .001	29.62

Note. n = 54,459.

Regression Analysis for RQ 2

RQ 2: Is there a relationship between the CT scan completion time and the age-group of the patients?

No aggregation or further manipulation of the data was needed to perform this analysis. I evaluated a linear regression model predicting scan time from patient age-group. The same categorical dummy variables from RQ 1 were used. Additionally, it must be mentioned that only patients with a completed scan could be used because instances where a patient walked out of the scan do not have a complete scan time.

I evaluated the assumptions of multiple regression analysis prior to analysis. Multivariate normality was observed based on graphical analysis of a histogram of residual values. Because all predictor variables were categorical, it is inaccurate to say a linear relationship existed between the predictors and outcome, but that is to be expected in this form of analysis. Additionally, multicollinearity was present because of the nature of dummy variables, but again, this is to be expected with this form of analysis. Homoscedasticity is also difficult to evaluate with categorical predictors, but seemed to be acceptable, given the sample size, based on a P-P plot of standardized residuals.

The linear regression model reached statistical significance, $F(4, 48{,}916) = 12.44$, $p < .001$, but again overall prediction was low, and the model only managed to explain 0.10% of variance in scan time. No patient age-groups were statistically significant predictors. The highest-magnitude relationship to scan time was extremely weak ($\beta = -.02$). Directly interpreting the coefficients (*B*) across all age groups indicates that predictions only vary by a total of 237.37 seconds with an overall average scan time of

over an hour. There is statistically significant evidence to reject the null hypothesis in case of RQ 2. A summary of regression analysis can be found in Table 8.

Table 8

Linear Regression Predicting Scan Time From Age

Predictors	*B*	*SE B*	β	*t*	*p*
Age 20–35	67.42	109.45	.01	0.62	.54
Age 36–50	97.68	109.48	.01	0.89	.37
Age 51–65	-106.32	109.40	-.01	-0.97	.33
Age 66+	-139.69	109.67	-.02	-1.27	.20
Constant	3969.45	105.47		37.64	.00
F	12.44				
df	4, 48916				
p	< .001				
R^2	.001				

Note. n = 48,920.

Regression Analysis for RQ 3

RQ 3: Is there a relationship between the number of CT scans performed in the ED per week and the walkout rates in the ED?

Aggregated data were used for analysis. The data collected across 6 years (1/1/2014 to 12/31/2019) were collected into calendar weeks, for which each week, a total number of participants was taken, along with a walkout rate. The first (12/29/2013 to 1/4/2014) and last week (12/29/2019 to 1/4/2020) in the dataset were then excluded from final analysis as they did not have data for all days of the week, which would slightly bias analysis. It bears mentioning that I used walkout rate in lieu of the total

number of walkouts because it was thought the total number of scans is inherently related to the number of walkouts, and so the percentage (rate) of those who walked out would be a better test variable for the research. A linear regression model predicting walkout rate from total scans ordered was then evaluated.

Assumptions were evaluated prior to analysis. Examinations of a histogram and P-P plot of standardized residuals were acceptable for stablishing normality of error and homoscedasticity. Additionally, the relationship between scans ordered and walkout rate appeared to be roughly linear based on examination of a scatterplot.

Analysis revealed a weak but significant relationship between the number of scans ordered and walkout rate within each week, $F(1, 310) = 6.25$, $p = .01$, but only accounted for 2% of variance. The direct relationship between ordered scans and walkout rate was positive and weak ($\beta = .14$), however, a direct investigation of the coefficient shows the relationship is almost null. The observed coefficient did not have significant figures until taken out to the 4th decimal point ($B = .00012$). Directly interpreted, 100 additional scans would need to be ordered, to increase the walkout rate by 1%.

There was statistically sufficient evidence to reject the null hypothesis, and state there is a relationship between the number of CT scans performed, and walkout rate within weeks, although it must be acknowledged this relationship is weak. A summary of these results can be found in Table 9.

Table 9

Linear Regression Predicting Walkout Rate From Total Scans

Predictors	*B*	*SE B*	β	*t*	*p*
Ordered scans	.00	.00	.14	2.50	.01
Constant	.08	.01		9.03	< .001
F	6.25				
df	1,310				
p	.01				
R^2	.02				

Note. n = 312. Data aggregated by calendar week.

Summary

Section 3 presented the full findings of this study which addressed the three questions. The results of evaluating the first research question using logistic regression analysis provided support to reject the null hypothesis that there is no significant relationship between CT tests based on age categories and walkout rates in the ED. The results demonstrated that age was a significant predictor of walkout rates. Furthermore, the results of examining Research Question 2 using multiple regression analysis provided sufficient evidence to reject the null hypothesis that there is no significant relationship between the CT scan completion time and the age-group of the patients. It was found that age accounted for about 0.10% of the variation in CT scan completion time. Research Question 3 was evaluated using linear regression analysis. The result of the analysis provided evidence to reject the null hypothesis that there is no significant relationship between the number of CT scans performed in the ED per week and the walkout rates in

the ED. These results revealed that the number of CT scans completed within each week explained about 2% of the variation in walkout rates.

Section 4 includes an interpretation of these results, as well as a review of this study's limitations. Recommendations and implications for future research into this topic was also enumerated in the next section.

Section 4: Application to Professional Practice and Implications for Social Change

In the United States, EDs are the one place where all patients can have access to a wide range of services, irrespective of condition, regardless of their financial viability or medical insurance (Perotte et al., 2018; Suriyawongpaisal, et al., 2019). As a result, the costs of running EDs have continued to increase (Xiao & Lateef, 2020). Unfortunately, the overutilization of resources and staff shortages affect quality of care and administrative costs in hospitals (Perotte et al., 2018). Furthermore, EDs in the United States are often crowded, which results in concerns about the need to improve overall patient flow (Myers & Parikh, 2019). It is important for hospital administrators to work efficiently to reduce the possibility of patient walkouts before treatment and evaluation are completed as this could compromise the quality of care delivered to patients (Lundquist, 2017).

Implementing measures to enhance completion times for CT tests and predicting which patients should have priority are important elements related to walkout rates in the ED and more research was needed to understand and improve these issues. Previous studies reflected on the problem of wait times, but none demonstrated a direct relationship between waiting times pertaining to CT scans and ED walkouts. As such, the purpose of this quantitative study was to determine whether there was a correlation between completion times for CT tests and walkout rates in the ED. The theoretical framework for this study was the Donabedian model, which focuses on outcome, process, and structure as ways to evaluate the quality of healthcare and also examine how to improve the services a healthcare organization offers (Moore et al., 2015). This model

was well suited for this research, because by determining whether there is a relationship between the variables, new processes and structure can be developed to improve outcomes.

Six years' worth of data were obtained from an ED electronic registration system, which was a part of a large medical organization in Miami, Florida (55,001 records). Any case with a negative value among the durations provided was removed from all analysis. This measure led to the exclusion of 452 scan records. The final sample of 54,549 was primarily female (56.29%), and an average of 50.72 years old, while the majority of participants completed their CT scan (89.83%). Variation of the above-listed demographic statistics between whether or not the scan was completed or resulted in a walkout was minor. However, the average duration for a completed CT being ordered to being completed (M = 1:05:50, SD = 0:53:43) was much lower than the average duration of a walkout CT being ordered to cancelled (M = 1:47:42, SD = 4:53:49). It is not known whether this difference directly associated with the decision to walk out or a result of potential differences in how paperwork is kept for the two scenarios, however, it does provide insight into the possible scenarios surrounding walkouts, as well as the possibility that walkouts were a result of abnormal occurrences when compared to the average time for CT completion.

RQ 1: Is there a relationship between CT tests based on age categories (i.e., 20–35; 36–50; 51–65; over 65) and walkout rates in the ED?

$H_0$1: There is not a relationship between CT tests based on age categories (i.e., 20–35; 36–50; 51-65; over 65) and walkout rates in the ED.

$H_1$1: There is a relationship between CT tests based on age categories (i.e., 20–35; 36–50; 51–65; over 65) and walkout rates in the ED.

Although the regression model and all predictors reached statistical significance, $\chi^2(4) = 34.40$, $p < .001$, the overall prediction of the age groups showed little to no overall effect on scan completion or walkout result. It is possible that the significance of the results was due to the overpowered sample size. The model was able to correctly predict walkouts for 0 of 5538 walkout instances. There is evidence of a relationship between patient age and walkout, although weak. There was statistically significant evidence to reject the null hypothesis in the case of RQ 1; however, it should not be applied beyond its scope based on the abovementioned conclusions.

RQ 2: Is there a relationship between the CT scan completion time (scale) and the age of the patients (ordinal or scale)?

$H_0$2: There is not a relationship between the CT scans completion time and the age of the patients.

$H_1$2: There is a relationship between the CT scan completion time and the age of the patient.

The linear regression model reached statistical significance, $F(4, 48{,}916) = 12.44$, $p < .001$, but again overall prediction was low, and the model only managed to explain 0.10% of variance in scan time. The highest magnitude relationship to scan time was weak ($\beta = -.02$). There is statistically significant evidence to reject the null hypothesis in the case of RQ 2. However, no patient age-groups were statistically significant predictors.

RQ 3: Is there a relationship between the number of CT scans performed in the ED per week and the walkout rates in the ED?

$H_0$3: There is not a relationship between the number of CT scans performed in the ED per week and the walkout rates in the ED.

$H_1$3: There is a relationship between the number of CT scans performed in the ED per week and the walkout rates in the ED.

Analysis revealed a weak but significant relationship between the number of scans ordered and walkout rate within each week, $F(1, 310) = 6.25$, $p = .01$, but only accounted for 2% of variance. The direct relationship between ordered scans and walkout rate was positive and weak ($\beta = .14$), however, a direct investigation shows the relationship is almost null. Directly interpreted, 100 additional scans would need to be ordered to increase the walkout rate by 1%. There is statistically sufficient evidence to reject the null hypothesis and state that there is a relationship between number of CT scans performed and walkout rate within weeks, although it must be acknowledged this relationship is weak. The rest of this section will provide an interpretation of the findings, a discussion on the limitations of the study, recommendations for future research, implications for professional practice and social change, and some final thoughts.

Interpretation of the Findings

Findings for RQ 1

The null hypothesis for the first RQ was rejected, indicating that there was a relationship between the average scan times of CT tests based on age categories (child, adult, seniors) and walkout rates in the ED. Although the literature contradicts this

statement, it also provides other reasoning for age influencing CT scan times. Morris et al. (2000) posited that age did not affect the completion times for CT scans in the ED, nor did sex or race. The researchers concluded that types of illness and administrative procedures more likely had an influencing on waiting time. Taken into account that the relationship determined in this research was weak, however positive, it may not necessarily be in direct contradiction with the literature. It should also be noted that the samples utilized in the literature were significantly smaller than the sample size of the current research.

Alternatively, Mills et al. (2010) added that age, sex, and the health condition of the patient did influence the duration of CT scans as these factors were taken into account when determining which patients were a priority for needing a CT scan. Last, Mohsin et al. (2007) determined that walkout rates from EDs were higher among young patients compared to aged patients who demonstrated patience during the wait time to see a doctor and receive treatment. This could mean that even though waiting times are the same across ages, younger people may walk out sooner than aged patients. Furthermore, aged patients that come from lower-middle-class families exhibited more patience in the waiting areas compared to those from higher middle-income ones. As such, determining the relationship between age, CT scan procedure duration, and walkout incidents cannot be researched in isolation, and may vary across hospitals with different demographics and geographical areas, as well as different procedures. Furthermore, as younger people may be more impatient, and not the first priority, their walkout rates may be higher in comparison with those of other ages. Further in-depth research should be done to better

determine and understand the influencing factors present aside from the three mentioned variables.

Findings for RQ 2

The null hypothesis for the second RQ was rejected, indicating that there was a relationship between the CT scan completion time and the age of the patient. This result was in agreement with the literature as Li et al. (2011) also found that age affected the CT scan procedures and completion times in the EDs. The age of a patient is directly related to body mass index, weight, height, and vascular system development as well as the neural system. The researchers determined through a regression analysis that both transverse and anteroposterior thoracic thickness were correlated to age, which affected the CT scan length of time (Li et al., 2011). Therefore, older patients would require more completion time than younger patients. Additionally, the CT scan images are clearer in pediatric patients as compared to adult patients. These findings, together with the findings of RQ 1, may explain why the relationship between age, duration of CT scan, and walkouts was so weak, or even nonexisting according to Morris et al. (2000).

Hypothetically speaking, as the duration of a CT scan takes longer according to a patients age (based on transverse and anteroposterior thoracic thickness and clarity of images), yet older patients get priority over younger people, the duration of CT scan completion may not be as varied across age as predicted. As such, different walkout instances across ages may be more as a result of specific demographic and personality characteristics rather than age. For example, millennials are known for being impatient; however, if you take age out of the equation, it might mean that individuals with specific

personality types that include traits of being impatient may walk out more often, regardless of age or CT scan duration. Further research regarding these factors can be valuable, as it could absolve hospitals from the responsibility of making improvements to reduce walkouts (beyond reasonable requirements), as walkouts may simply occur as a result of impatience.

Findings for RQ 3

The null hypothesis for the second RQ was rejected, indicating that there was a relationship between the number of CT scans performed in the ED per week and the walkout rates in the ED, which was in agreement with the literature. According to Artenstein et al. (2017), the walkout rate is a key indicator of whether the turnaround time for CT scans is efficient or inefficient. Typically, if patients spend more than four hours in the ED, they are more likely to walk out of the ED before their treatments and care have been completed. Furthermore, Li et al. (2016) posited that many inefficiencies in the ED are caused by the arrival time of the patient. When patients arrive in the evening, there may be few radiologists on standby, which results in delays and more time for physicians and nurses to liaise with specialists and their supervisors. The time of the ED arrival, as well as the urgency of tests and medical attention due to high acuity patients may result in a higher incidence of patient walkouts (Li et al., 2016). Patients with urgent clinical needs are likely to get priority when they visit the ED for imaging tests. Notably, patients who visit hospitals in the evening have fewer CT scans ordered as compared to those who visit during day shifts. This is influenced by staffing and

overcrowding as evenings are the busiest times in EDs (Li et al., 2016). Essentially, staffing may not be the only limitation, there may also be a limitation of scanners.

Since all of the null hypotheses were rejected, it can be argued that improvements can be made as per the Donabedian model. The Donabedian's model of outcome, process, and structure directly relates to the variables of this study concerning wait times for the completion CT scans for designated age groups and ED walkouts. However, the weakness of the relationships, even though they were positive, should be taken into account when suggesting improvements or changes. For example, improvement in any sense will be an asset to an ED if it can ease the pressure on staff or speed up processes, but the financial implications of implementing changes may not be worth it in comparison with the ratio of walkouts. Also, since the study investigated the walkout ratios in a for-profit community hospital EDs, the impact of the walkouts should be investigated first to determine its influence on the hospital's income. A more convincing reason for expensive improvements in an ED may be mortality rates as a result of CT scan delays, or adverse effects as a result or incomplete care if patients walk out because of CT scan delays. These repercussions are worth investigating further to bring about positive change.

Limitations of the Study

As the findings of the study revealed, there were several limitations associated with this research study; however, several avenues for future research were uncovered. The research was based only on completion rates of CT tests as the cause of patient walkout rates in the ED. This may reduce the accuracy of the findings as other factors

may have caused the increase in walkout rates, such as patient attitudes towards the care received, the competence of the providers, and the cost of the health care services that the health care organization offers. This limitation was evident specifically for the first research question and further research is needed before that information can be used to implement change.

Using regression analysis was restrictive to the linear relationships, and thus other possible factors that may lead to the increased walkout rates was not determined (Gunst & Mason, 2018). Furthermore, focusing on a for-profit community hospital as the source of the data also limited the accuracy of the study since nonprofit hospitals may have different patient populations. As indicated in the existing literature, demographics and geographical location may have an influence on CT scan duration as well as walkout rates.

In addition, the collection of data from patients and staff may lack accuracy because some of them might provide false or incorrect information, which may affect the findings of the study. However, this would be impossible to determine and could possibly be the case for the majority of hospitals' historical records. Another limitation was not necessarily the sample size, but because the entire sample came from one source. Data from more hospitals may have provided more conclusive findings.

Recommendations

Since there are still several discrepancies in the existing literature, as well as in the findings of the current study, there are several recommendations for future research. First, a large-scale quantitative study that investigates the relationship between age, CT

scan procedure duration, walkout incidents, as well as personality traits can provide valuable data in determining to what extent the hospital is to blame. Such a study should include the data of several hospitals with contrasting demographic and geographical elements. Including several hospitals would provide robust data and could provide clarification on the current conflicting findings.

A qualitative study could provide insight as to why patients walk out before receiving the proper care. CT scan duration may not be the only or the main reason for patients walking out before receiving complete care. Interviewing walkouts after the fact may reveal interesting and new information. Again, it would be valuable to include walkouts from several hospitals in such a study.

An investigation into the impact of walkouts on the profit of a hospital would be the key to implementing change. A quantitative approach, or even a mixed-methods approach, could provide valuable data, and different for-profit hospitals could even be compared with regards to profit, patient turnaround time, mortality rates, and walkout ratios. Last, a thorough investigation on the effects of delayed care, slow patient turnaround time, and walkouts is needed to determine whether it influences mortality or has any other adverse effect on the health of patients who walk out. These repercussions are worth investigating further to bring about positive change.

Implications for Professional Practice and Social Change

The aim for healthcare research is always to uncover findings that can bring about positive change with regards to practice and society. However, as mentioned in previous sections, the relationships amongst variables that were uncovered were weak, and when

viewed in comparison with the existing literature, the findings are still inconclusive and contradicting. Therefore, more research into the time procedures like a CT scan take in relation to walkouts before treatment must be done to better understand why people walk out before their treatments are complete. The results of this project indicate that there is some, albeit weak, relationship between patients who walk out and the time their procedures from the ED take. It is thus recommended that more research be conducted into what causes a patient in the ED to walk out before their treatment is complete.

This research did confirm that there is a relationship, though weak, and that further research is called for to fully understand why patients walk out before their ED treatments are complete. Other recommendations from the literature include Artenstein et al. (2017) who recommended the development of an interdisciplinary plan managed by various ED healthcare professionals. The team considers the right bed, right patient, and the right time in deciding on prioritizing the patients to be attended (Artenstein et al., 2017). Li et al. affirms the importance of timeliness when attending to ED patients and emphasizes that the preferred length for stay in the ED should be short but thorough. Healthcare professionals should transfer patients to the safest environments within the shortest time possible (Li et al., 2016). These recommendations for best practices should be implemented, regardless of patient walkout rates, to provide the best possible care to all patients until further research helps clarify the cause of walkouts in relation to test times.

Systermans and Devitt (2014) suggested that increasing the number of CT scans for diagnostic purposes will improve turnaround times. An adequate number of machines

enhances efficiency and reduces the turnaround time needed for radiologists to report results. An increase in efficiency will improve patient satisfaction, improve CT completion times, and reduce ED walkouts (Systermans & Devitt, 2014). However, these suggestions may be expensive to implement, and therefore it is important to determine the correlation to adverse medical implications and mortality rates first. Furthermore, should data show that delayed care leads to higher mortality or other medical implications, change with regards to best practices can have a significant influence on society.

Conclusion

Studies have shown a direct relationship between general wait times for ED procedures and the rate of walkouts (Perotte et al., 2018). The purpose of this quantitative study was to determine if there was a correlation between completion times for CT tests and walkout rates in the ED. The three research questions investigated: 1. if there was a relationship between average scan times of CT tests based on age categories and walkout rates in the ED; 2. If there was a relationship between the CT scan completion time and the age of the patients; and 3. If there was a relationship between the number of CT scans performed in the ED per week and the walkout rates in the ED. Six years' worth of data were obtained from an ED electronic registration system. Logistic regression analysis and linear regression analyses were performed. The null hypotheses for all the research questions were rejected and the alternative hypotheses accepted; however, the correlations uncovered were weak and somewhat inconsistent with the existing literature (Mills et al., 2010; Morris et al., 2020). But Li et al. (2011) found there was an effect by

age, so the literature is divided and ultimately, more research is needed to fully understand this problem. Nevertheless, these findings support a strong basis for further investigation and provide several implications for future research and the development of best practices related to CT tests in the ED.

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