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Impact of Perceived Computed Tomography Radiation Risk and Benefit on Healthcare Decision-Making

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Abstract

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Patient-centered care is focused on healthcare consumers becoming more involved in their own health care decision-making. Research is needed to examine how those decisions are made in different settings. The purpose of this concurrent transformative design mixed method study was to evaluate how the perceived health risks and benefits of Computed Tomography (CT) influenced decision-making to accept or reject a hypothetical CT recommendation. One hundred thirty-four participants read 1 of 8 vignettes on how either "high" or "low" susceptibility to cancer risk, severity of exposure to radiation, and diagnostic benefits affected their decision-making. Using the health belief model as a framework, a Likert scale assessed participants' willingness to accept a proposed CT scan in a non-emergency setting. The majority of respondents accepted the recommendation. A factorial ANOVA was used to examine main and interaction effects. The perceived severity of radiation exposure and the interaction between susceptibility to cancer risk and diagnostic benefit significantly predicted scan acceptance. A Grounded Theory qualitative analysis identified wanting a diagnosis and trusting doctor's recommendation as common themes. The quantitative and qualitative data were relatively consistent, including perceived severity being identified as a significant predictor of acceptance and as an emergent qualitative theme. This research may be used to influence positive social change by informing researchers about healthcare decision-makers, leading to an increase in patient involvement in healthcare decision-making. Understanding the factors weighed in patients' decision-making may reform physician-patient dialogue and increase patient confidence in individual health care promotion.

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Chapter 1: Introduction to the Study

A medical recommendation that holds a possible cancer risk from exposure to low dose imaging radiation may create concern and fear, depending on how that risk is interpreted. It is crucial to understand patient perceptions about health care risks and benefits, especially when a decision involves a potential health risk. There have been increasing efforts to reform the healthcare system and improve quality of care for millions of healthcare consuming individuals (Blumenthal, Abrams, & Nuzum, 2015). This reform has led to the introduction of new patient-centered policies by healthcare maintenance organizations, which have necessitated a shift that places increased decision-making responsibility on the patient (Barry & Edgman-Levitan, 2012; Reyna, Nelson, Han, & Dieckmann, 2009). As described by Barry and Edgman (2012), patient-centered care shifts attention away from caring for disease and focuses more on the context of patient and family needs. The objective of this shift is to promote patient and family involvement in improving their healthcare quality and safety. Due to this shift, researchers need to focus on the process of healthcare decision-making by patients in order to better understand how to make these decisions and what elements are necessary to consider.

There are several factors that may be considered by healthcare consumers when a Computerized Tomography (CT) scan has been recommended. In this mixed survey study, I explore the impact these factors have using the health belief model (HBM) as a guide. A CT scan is a noninvasive diagnostic health care tool that uses X-rays and computers to produce three dimensional images of specific organs and cross sections of

the body (Brenner & Hall, 2007; Mettler, Bhargavan & Faulkner, 2009). The images are available for the prescribing physician in a short period of time, the application of CT technology is user-friendly to the patient, and the operational procedure takes relatively little time for the imaging professional. A CT is often a more valuable exam than conventional X-ray imaging (Alzimami, 2014; Ogbole, 2010; Prasarn et al., 2012).

This research intends to add literature about patient-centered decision-making by examining how patients understand the benefits and risks of a recommended CT scan as a diagnostic procedure. A patient-centered health care partnership puts the interest of the patient first, and no decision about the patient, is made without the patient (Berwick, 2009). Pioneering work on patient-centered care was initiated by Harvey Picker (Gerteis et al., 1993). Over the past few decades, research interest in shared medical decision-making continues to expand with increased attention on shared medical decision-making models (Clayman et al., 2017; Dauer et al., 2011; Fried, 2016). However, only one published article has focused on awareness and perception of ionizing radiation from medical imaging tests. Evans et al. (2015) targeted community events at six Vermont locations, and found that respondents did have enough confidence in their knowledge to make decisions about medical imaging, and that they preferred health professionals to make that decision for them.

Theories of decision-making emphasize the importance of emotions in health behaviors. The commonsense model postulates that the decision-making process includes not only the health risk but also the emotional response of the decision maker (Leventhal et al., 1992). Emotions play a significant role in the decision to engage in

preventive health behavior. This study examines the perceived susceptibility to cancer risk and the perceived severity of that risk on a person's decision-making ability to accept a recommended CT scan.

Decision choices are driven by emotional responses to an anticipated consequence (Mellers & McGaw, 2001; Mellers, Schartz, & Ritov, 1999). Caverly et al. (2013) conducted a survey study to examine communication between health care providers and their patients about the risks associated with CT scans. The study found that only 35% of patients who went through CT scans discussed the associated risks with any healthcare professional. Understanding what factors patients consider in decision-making, as well as how those factors are weighed, may benefit understanding of medical decision-making.

The aim of this study was to assess the impact of patient perception of risks and benefits described in the HBM (Zhang et al., 2013). The HBM model was applied to a hypothetical nonemergency setting to evaluate participants decision-making. The participants had to accept or reject a CT recommendation, based on their perception of possible risks (susceptibility of cancer from the scans and severity of potential damage from getting the CT scan) and benefits (obtaining an accurate diagnosis). This research may help to further develop decision-making models in health care and may contribute to current literature by furthering understanding of decision-making models. Given the unique setting of this study, it may provide evidence for health psychologists on the value of assessing emotions during decision-making. It may also assist in promoting and assisting care givers in developing an evidence-based guide in support of psychosocial

services, that may help to reduce care-related anxiety, improve the decision-making process, and align care with patient needs.

This study uses mixed methods. In the quantitative component, participants were asked to rate their willingness to accept or reject a physician recommended CT scan based on descriptions of risks and benefits of the exam. The qualitative component was designed to understand how participants made their decision to accept or reject the CT scan. This was accomplished by asking participants what the most important factors were in their decision-making process. The two components of the study are linked, by using the HBM model, to assist in determining which factors are most important in the patient decision-making process.

Previous studies that focused on decision-making regarding diagnostic imaging procedures have mostly been conducted with patients in the emergency department (Lee et al., 2004; Smith-Bindman, 2012; Takakuwa et al., 2010). The findings from previous research may not be generalizable to nonemergency settings, as only one-third of all CT scans are prescribed by emergency department (ED) physicians (Larson et al., 2011). Researchers have reported that trauma patients in the ED prioritize a diagnosis over the risks of imaging radiation (Caverly et al., 2013; Takakuwa et al., 2010). However, there is a gap in literature regarding how patients perceive imaging studies outside of the ED. Research is needed to understand factors considered in other settings. Therefore, the focus of this study was on patient centered decision-making in non-ED settings. The outcome may help to inform the decision-making process of individuals who are weighing the risks and benefits of diagnostic assessments and treatments. The findings

may also contribute to literature that places emphasis on individual perception and emotional reaction regarding medical decision-making (Clayman et al., 2017).

In the first chapter, I discuss the background of research in this area, including the influence of the ED on healthcare decision-making. I address the gap in the research literature, the purpose of the study, and the significance of the research. I also list the research questions and discuss the psychological constructs of shared decision-making.

Background

Decision-making regarding risk analysis is associated with experiential thinking (Slovic, Peters, Finucane, & MacGregor, 2012). Slovic et al. (2012) cite affect heuristics as the central focus of experiential thinking, but it is insufficient to rely only on affective components in making judgments and decisions. Considerations from rational and analytic forms of thinking are also important in the decision-making process. Perceptions about information rather than the information itself are more powerful in determining decision-making.

The Centers for Medicare and Medicaid Services (CMS) is an important arm of the Department of Health and Human Services (HHM) and is responsible for serving more than 100 million healthcare beneficiaries (CMS, 2016). The organization has four consortia to effectively administer the strategic action plans of the agency (CMS, 2016). In the last 5 years, CMS has emphasized the importance of patient-centered care in assuring responsiveness to patient preferences and needs, and ensuring patient values guide health care decision-making (CMA, 2016). Reuben and Tinetti (2012) noted that changes in the health care delivery system and in organizations such as CMS, are

increasingly linking health care providers' payment to patient-centered outcomes. CMS has adopted objectives to achieve better individual health care, improve health for the population, and lower costs.

Healthcare decisions are necessary during situations involving pain, uncertainty, discomfort, fear, and anxiety which contribute to elevated emotions (Takakuwa et al., 2010). In studies conducted by Youssef et al. (2014) and Takakuwa et al. (2010), most ED patients wanted physicians to discuss the risks and benefits of CT scans with them. In the ED, the environment creates an *automatic factor* that predisposes patients' emotions to focus primarily on the presenting trauma and not on their knowledge of potential harm from imaging radiation (Takakuwa et al., 2010). Emotional factors appear to be more strongly weighed than a cognitive assessment of facts when making decisions in this setting. Few published studies have focused on patient perceptions of the risks and benefits of CT scans, and no published research has investigated how those perceived risks and benefits may influence healthcare decision-making outside of the ED when there is no presenting trauma. Current research has focused on decision-making regarding diagnostic imaging procedures in ED trauma patients (Lee et al., 2004; Smith-Bindman, 2012; Takakuwa et al., 2010; Youssef et al., 2014). These studies demonstrate awareness about patient knowledge and attitude, but not on decision-making related to the risks of imaging radiation or benefits of the exam.

Although the health risk of imaging radiation is well-documented, the extent to which it is a cancer threat (Brenner & Hall, 2007; Pearce et al., 2012), the perceptions of patients about radiation imaging risks, and how those perceptions influence patient

healthcare decision-making has received little attention outside the ED (Repplinger, 2016). Evans et al. (2015) conducted an exploratory study to assess the knowledge and perceptions of ionizing radiation in individuals recruited from community events at six locations in Vermont. Only 8% of the 169 participants expressed confidence in their knowledge about ionizing radiation. Given this perception of a lack of information, the decision-making process regarding CT imaging may be more influenced by emotions and feelings than by the knowledge of benefits and risks (Takakuwa et al., 2010).

The goal of the quantitative survey conducted in this study was to understand how patients weigh specific factors in decision-making. By using vignettes to propose various situations that manipulate those factors, participants provided response to a recommended CT scan. It is important to understand how these decisions are made, and if they differ from decisions made in an emergency setting.

Psychological Constructs and Health Decisions

There are several psychological constructs involved with health decisions, including mood, perceived risk, affect, and heuristics that may influence health decisions. Faessler et al. (2016) reviewed studies that investigated psychological distress in adults presenting to the ED for somatic complaints. They reported that 4% to 47 % of these patients reported significant anxiety and/or depression. Anxiety has been cited in creating a mental noise that blocks out logic and reason (Dauer et al, 2011). Patient interpretation of risk relies on more than facts alone (Covello, 2010). The risk-as-feelings hypothesis proposes that the presenting emotional experience at the point of decision making often drives the decision rather than a cognitive assessment of risks

(Loewenstein, Weber, Hsee, & Welch, 2001). The choice of whether to accept or reject a CT scan in the ED may be influenced by anxiety. Informing a patient about the potential risks of CTs ionizing radiation may increase stress when the presenting health risk is in the ED.

Concern and uncertainty regarding future outcomes and potential side effects are other factors that influence risk perception (Lerner et al., 2015). When faced with a decision about accepting a medical recommendation, attitudes and beliefs are influenced by emotions (Lerner et al., 2015). The decision-maker health care environment may impact choices in patient-centered healthcare decision-making.

Radiation Health and Risk Perception

Assessing the factors that contribute to patients' willingness to accept or decline CT imaging when presented with the risks and benefits can be valuable research for patient-centered care and decision-making. Diagnostic and therapeutic radiation has several health benefits (Brenner & Hricak, 2010; Lehnert & Bree, 2010), but also exposes the patient to low dose ionizing radiation. Although exposure from CT radiation is small, it is statistically significant (National Council on Radiation Protection and Measurements [NCRP], 2013). Thus, understanding the influence of perceived health risks and benefits of this procedure on individual healthcare decision-making is highly valuable.

Everyone is exposed to natural radiation from sources such as ultraviolet sunrays in the atmosphere and radioactive content in the soil beneath the earth's surface (Shahbazi-Gahrouei et al., 2013). In addition to natural background radiation, the health care profession is a major contributor to manmade radiation (Brenner & Hall, 2007).

Although the radiation dose from natural sources has remained unchanged over time, the average ionizing radiation exposure from CT imaging in the United States increased more than six-fold from 1980 to 2006 (NCRP, 2013). In 2010, more than 80 million CT scans were performed in the United States compared to approximately three million in 1980 (Armao & Smith, 2014). Considering that CT scanning involves acquiring multiple images it delivers a higher dose of radiation than X-rays (Baerlocher & Detsky, 2010; Linet et al., 2012). The cumulative effects of multiple doses over time are associated with increased lifetime risk of cancer (Alert, 2011; Berrington de González, 2009; Smith-Bindman, 2009, 2012). In efforts to promote patient-centered care, it is necessary to assess how patients view ionization radiation risks against its diagnostic benefits.

Problem Statement

The problem addressed in this study is that it is not known to what extent the impact of perceived health risks and benefits from CT ionizing radiation on decision-making regarding diagnostic CT scans recommendation in a nonemergency setting. Previous studies investigating healthcare decision-making regarding imaging have been conducted in hospital EDs (Lee et al., 2004; Smith-Bindman, 2012; Takakuwa et al., 2010). Few researchers have focused on how patients make medical decisions about types of imaging scans (Lown et al., 2009) and no literature has focused on what influences healthcare decision-making outside of the ED.

There is limited literature regarding what factors influence decision-making in patients who are considering recommendations for procedures such as CT scans. Lack of patient knowledge or confidence in that knowledge may play a part when patients

delegate decision-making responsibility to their physician (Evans et al., 2015). An ability to understand the benefits and potential health risks is vital in managing patient perceptions, attitudes, concerns, apprehension, and fears regarding CTs ionizing radiation. This study addresses the gap in literature.

Purpose of the Study

The purpose of this mixed method study is to assess the extent to which the risks and benefits of a physician recommended CT scan in a non-ED setting affects willingness to accept undergoing the scan. This study sought to promote patient involvement in healthcare decision-making by assessing the influence of perception on the decision-making process. Facts about risk and benefits are not enough to make healthcare decisions. The aim of the qualitative component of the study is to understand the major emerging themes participants considered as factors in their decision-making process.

The concept of risk perception is used to understand respondents' values, emotions, and beliefs. The perception associated with risk is not simply about communicating or understanding risk. The perception associated with risk involves communication between patients and providers, perceived understanding of risks and benefits, knowledge, and emotions. A combination of facts, feelings, instincts and the situation at the point of decision-making are all a part of the decision-making process (Ropeik, 2008). To contribute to existing knowledge regarding the use of CT imaging, decision-making behavior in a non-ED setting was studied, participants had more time to consider their options and anxiety is not a factor. By presenting individuals with vignette describing perceptions about the risks and benefits regarding the proposed CT scan, they

may be better able to think about those perceptions and explain their decision in a way that will help contribute to the understanding of how patients make healthcare decisions. According to the American Psychological Association (APA), health psychologists apply biological, social, and psychological science in promoting health, enhancing illness deterrence practices, and improving health care systems. This study aims to contribute to the mission of health psychology by focusing on the connection between beliefs affecting healthcare delivery system and patient-centered healthcare decision-making.

In the quantitative component of the study, independent variables, perceived health risks and benefits related to CT ionizing radiation, were manipulated in vignettes, and acceptance of the recommended diagnostic CT procedure was the dependent variable. The relation among these variables was assessed in a general population sample. Independent variables were manipulated to examine the influence of low versus high perceived severity and susceptibility to cancer as well as high versus low benefit of the CT scan on the decision to accept or reject the recommendation of the CT (which will be assessed on a Likert scale). Demographic information was collected for descriptive purposes and for exploratory secondary analysis.

The qualitative component focuses on the process of decision-making by asking participants to explain the most important factors that led to their decision. A grounded theory approach was used to identify the most common factors provided by participants. The qualitative and quantitative components of this study were conducted concurrently and are linked by the theoretical construct of the HBM.

Research Questions

Research Question 1: Is degree of perceived severity of CTs ionizing radiation significantly associated with the rating of willingness to accept CT imaging recommendation in a sample of health care recipients, outside the hospital setting?

Null Hypothesis ($H_0$1): The degree of perceived severity of CTs ionizing radiation has no significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Alternative Hypothesis (H_a1): The degree of perceived severity of CTs ionizing radiation has a significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Research Question 2: Is degree of perceived susceptibility to CT health risk significantly associated with the rating of willingness to accept CT imaging recommendation in a sample of health care recipients, outside the hospital setting?

Null Hypothesis ($H_0$2): The degree of perceived susceptibility to CT health risk has no significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Alternative Hypothesis (H_a2): The degree of perceived susceptibility to CT health risk has a significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Research Question 3: Is degree of perceived benefits of CT imaging significantly associated with rating of willingness to accept CT imaging in a sample of health care recipients, outside the hospital setting?

Null Hypothesis ($H_0$3): The degree of perceived benefits of CT imaging has no significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Alternative Hypothesis (H_a3): The degree of perceived benefits of CT imaging has a significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Research Question 4: Is degree of interactive effect among the three independent variables significantly associated with the ratings of willingness to accept recommended CT imaging in a sample of health care recipients outside the hospital setting?

Null Hypothesis ($H_0$4): The degree of interactive effect among the three independent variables has no significant association with the ratings of willingness to accept recommended CT imaging in a sample of health care recipients outside the hospital setting?

Alternative Hypothesis (H_a4): The degree of interactive effect among the three independent variables has a significant association with the ratings of willingness to accept recommended CT imaging in a sample of health care recipients outside the hospital setting?

Research Question 5(Qualitative): What are the most important factors that individuals weigh in deciding to accept or reject a hypothetically recommended CT scan in a non-ED setting?

Theoretical Framework

The HBM is the most commonly used theory in addressing health education and health promotion (Glanz & Bishop, 2010; Janz & Becker, 1984; Krawczyk et al., 2012). It is a conceptual framework based on the premise that an individual's health beliefs mediate their personal health behavior. Hochbaum (1958), as cited in Steckler et al. (2010), described the original use of the HBM in the 1950s as a healthcare initiative to explain public utilization of a tuberculosis screening program provided by the U.S. Public Health Service. Perceived severity, perceived susceptibility, perceived benefit, and perceived barriers to care are the four main constructs of the original model. The variable of perceived severity is addressed in this study by evaluating personal beliefs about the potential impact of CTs ionizing radiation on health. Perceived susceptibility is addressed by evaluating the perceived personal risk of developing cancer the individual is likely to experience as a result of the scan (Jones et al., 2015). The variable of perceived benefit was evaluated by analyzing patient perception of the diagnostic accuracy of the CT scan. Last, perceived barriers addresses the individual's assessment of the obstacles that need to be overcome to implement a new behavior necessary to prevent disease occurrence (Jones et al., 2015). In this study, I did not assess barriers, because access to healthcare, insurance reimbursement, and access to CT scans were assumed in all vignettes. In the qualitative component, the grounded theory approach was used and a concurrent transformative design to assess how individuals weighed potential cancer risks and diagnostic benefits of CT scans in making the decision about whether to accept a recommended outpatient CT scan.

According to Karsperson et al. (1988), the social amplification of risk framework (SARF) states that risk perception is predicted by a person's psychological state (i.e., attitude, belief), social state, and cultural perception. The mixed study design used the SARF approach on a general sample population to gain insight on the risks and emotions involved in health care decision-making. This knowledge will be valuable to health psychologists in understanding the values, preferences, and attitudes that contribute to patient decision making.

Two additional constructs; self-efficacy and cues to action, were added to the HBM as modifying variables (Stretcher & Rosenstock , 1988; see Figure 1). Self-efficacy is the tendency to believe in one's ability to do what is necessary. Cues to action refer to events or actions that would motivate the individual and cause behavioral change. These variables were not manipulated because self-efficacy, or the ability to take the CT scan, as well as cues to action, or the recommendation by the physician to have the CT scans, were both assumed.

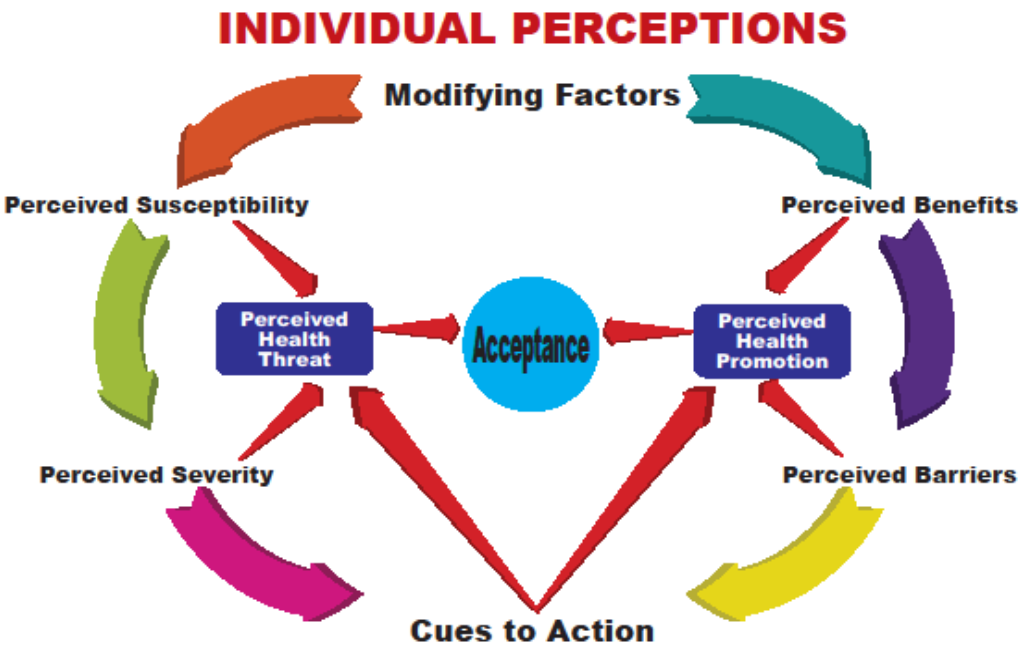

Figure 1. The health belief model (HBM) constructs and individual perceptions. From "The Health Belief Model," by V. Stretcher, & I.M. Rosenstock, in N. K. Glanz, F. M. Lewis, & B.K. Rimer (Eds.), 1997, Health Behavior and Health Education: Theory, Research and Practice (2nd ed.). Copyright 1997 by Jossey-Bass. Reprinted with permission (see Appendix A).

The HBM has been previous used to increase breast self-examination practices in women (Graham, 2002; Rao, 2010). It has also been used to motivate individuals to undergo colorectal cancer screening (Hay et al., 2003), reduce tanning risk in college students (Lamanna, 2004), explain patient safety (Bishop et al., 2014), explain surgical methods to address obesity (Armstrong et al., 2009), and foster communication in research (Jones et al., 2015). The HBM has also been used in several previous studies regarding decision-making (Rosenstock et al., 1988; Zhang et al., 2013). The model provides a suitable theoretical framework for this study, as several constructs of the

theory can be manipulated to assess changes in decision-making based on the level of each construct.

In summary, the HBM constructs of perceived severity, susceptibility, and benefits, were used as the independent variables in this study to assess the impact of these variables on participant decisions regarding the likelihood that they would accept or reject a recommended CT scan (see Glanz & Bishop, 2010). Vignettes were used to manipulate the independent variables. A mixed method approach was used. The quantitative component assessed willingness to accept the CT imaging recommendation, and the qualitative component addressed the issue of how that decision was made. This research may assist in extending the HBM to assess concerns associated with the potential future development of cancer risk.

Nature of the Study

A concurrent transformative approach was used in this mixed method design. More emphasis was given to the quantitative component, as the goal was to address a cause and effect relationship between risk perception and acceptance of a medical recommendation for a CT scan. Data collection and analysis for both components of the design were conducted concurrently. The qualitative grounded theory component analyzed open-ended text data to evaluate respondent descriptions of their decision-making process.

Eight different vignettes were used to describe scenarios of perceived high or low severity, susceptibility, and benefit. Participants anonymously responded via an online survey and randomly assigned to one of eight vignettes. A 5-point Likert scale ranging

from “would definitely accept” to “would definitely reject” was used to obtain participants willingness to accept a recommended CT scan. A three-way nonparametric ANOVA was conducted to determine the relative contribution of the independent variables on the dependent variable. The vignettes questions were followed by an open-ended qualitative question that asked participants to describe the two most important factors that shaped their decision to accept or reject the recommended CT scan in the vignettes.

Definitions

Barriers: Individuals’ consideration of events that may pose obstruction or hindrance to participating in the recommended CT scan. The ability to overcome barriers seems to have a positive influence on acceptance of a new health behavior or recommendation (Glanz et al., 2002).

Computed tomography scan: A helical or spiral equipment using X-rays and computers used for acquiring three-dimensional images of organs and body structures through the entire length of the human body (Brenner, 2010).

Health beliefs: A fundamental concept that health behavior is determined by psychological constructs such as perceived benefit, severity, and susceptibility to disease (Rosenstock, 1988).

Health care decision: A process of making a choice between two or more alternatives taken with the intent to improve overall health situation (Levenson, 2010).
Healthcare recipient: An individual who stands to benefit from health care provision and intervention (Porter, 2010).

Health status: An assessment of the individual, community and population health measured with the adequate instrument to provide comprehensive health awareness (Barry et al., 2007).

Ionizing Radiation: A form of X-rays used in CT scans with sufficient energy to directly or indirectly damage DNA molecule by setting off an electron from an atom (Brenner & Hall, 2007).

Severity: The extent of potential radiation effect when the body or target organ of the body receives multiple CT scan procedures (Cwikel et al., 2010).

Susceptibility: Individuals' judgment or tendency to believe that their chances of cancer risk in the future may have increased as a result of ionizing radiation from CT scans (Einstein, 2012).

Assumptions and Limitations

It was assumed that respondents read and understood the vignettes and were honest in providing answers. It was also assumed that respondents were honest in completing the demographics questions. A limitation of this study was the inability to control the environment in which the questionnaire was completed, as it was administered online and the respondents were anonymous. The study was also limited in that it was posted on an online website to invite higher education participants and was mostly available to a sample of online respondents with higher education. Although participation was open to individuals of any educational level, generalizability was limited to a population assumed to be more educated than the general population and enrolled in online education or have attained higher education. These factors may limit

generalizing findings to mostly individuals with at least a high school degree and may include a disproportionate number of graduate degree students. The sample included individuals who have varied experiences with health care professionals and CT scans, and had variable levels of self-reported health status. These variables were assessed in a demographics survey and considered in the analysis to determine whether they demonstrate a significant association with the dependent variables during the preliminary analysis; however, the characteristics of the sample may still present a limitation regarding the generalizability of the findings.

Significance

Cognitive and affective constructs mediate all medical decision-making (Slovic et al., 2005). Researchers such as Dauer et al. (2011), Shyu & Sodickson (2016), and Timins (2011), have addressed communicating the benefits and risks of medical radiation to patients from the perspective of prescribing physicians and imaging care providers. Therefore, the focus of this study was on the general public's beliefs, attitudes, values, and preference on healthcare decision-making associated with low dose ionizing radiation from CT scans.

The desired patient-centered care is one in which the health psychologist collaborates with other health care professionals about how to access patient understanding of risks and benefits, anxiety, and worry. The mixed method approach was used in this study to explore, assess, and understand the factors respondents expressed concern about (i.e., what they weigh as most important) about the constructs of perceived radiation risk /benefits, anxiety, worry, and attitude to reach a health care

decision. The research may contribute to the existing literature on beliefs, attitudes, and risk perceptions of health care recipients about health care decision-making by providing evidence-based data to assess existing decision-making models. The findings may benefit health psychology practice and healthcare providers with evidence that indicates how perceived health risks and benefits affect patient-centered decision-making.

Knowledge and understanding about the role of affective and cognitive constructs in medical decision-making may benefit from this research. The information gained from the study may enhance knowledge that leads to facilitated shared decision-making between patients and their healthcare providers, including psychologists. The outcome of this study may inform a collaborative approach between the ED physician, radiologist, health psychologist, and the patient (Shyu & Sodickson, 2016).

Summary

Advances in computer technology, clinical applications, and ease of operations have contributed to growing CT scan usage despite efforts to reduce radiation dose received (Yu et. al., 2009; UNSCEAR, 2010). This mixed methods study was designed to address the unknown regarding perceptions of health risk severity, susceptibility to health risk, and perceived health benefits of CT scans on healthcare decision-making, as well as assess and understand what factors individuals perceive as important factors impacting their decision. The outcome of this research may benefit patient-centered healthcare delivery, the physician-patient relationship, the patients, their families, healthcare providers, as well as the public in general with empirical evidence.

In Chapter 2, a review of the research literature that informed the development of this study will be conducted. Additionally, research regarding patient attitudes and beliefs about perceived risks related to ionizing radiation from CT scans and the influence of health information disclosure on health care recipients will be presented. This literature review is the foundation for Chapter 3, where the details of the study will be discussed.

Chapter 2: Literature Review

Researchers investigating healthcare decision-making have reported that, prior to 1980, patients had limited involvement in healthcare and abdicated decision-making almost entirely to the healthcare providers (Evans et al., 2015; Hamann et al., 2012; Laidsaar-Powell et al., 2013; McDonald et al., 2014; Price-Haywood et al., 2010; Ruiz-Moral, 2010; Timins, 2010). After the 1980s, there has been a change to increase patient participation as healthcare organizations are making policy changes to encourage patient responsibility in decision-making (Reyna et al., 2009; Tapp et al., 2014). The Institute of Medicine (2001) introduced the concept of patient-centered care in 2001. This care model is designed to focus attention on patient needs, values, and preferences during the healthcare decision-making process. Patient-centered care promotes physician-patient decision-making and helps to close the nonparticipation gap of patients in their own health care (Charles et al., 1997; McDonald et al., 2014).

In a more recent patient-centered study, Vitzthum, Kitts, Swanson, Hanley and Krishnaraj, (2020) reported an increase in patient-centered approach through increased access to patient medical records and imaging result availability through electronic health records. In a similar study, Cook (2020) sought to improve patient-centered care in cardiothoracic imaging through increasing direct interaction with patients. To improve patient-centered care in imaging, Royuela et al. (2019) implemented a computerized support system for assisting decision-making when adult patients present with nontraumatic headaches to the ED. The support system used electronic data findings in

developing a risk factor shortlist to order cranial CT scans. The impact of the implementation found a decrease in CT request rate.

Previous studies on healthcare decision-making have addressed patient knowledge and physician input. For example, Busey, Soine, Yager, Choi, & Shuman . (2013) and Evans et al. (2015) focused on patient knowledge about health risks. Lam et al. (2015), Shyu & Sodickson (2016), and Thornton et al. (2015) studied the communication of health risks by prescribing physicians. Adding to previous research, the purpose of this mixed method design study was to assess the impact of perceived health risks and benefits associated with CT scans ionizing radiation on healthcare decision-making outside the ED. Information about the influence of beliefs and attitudes about the risks and benefits associated with decision-making outside the ED represents a significant gap in literature. Online participants response sought to address this gap by assessing how risk perception, beliefs, and attitude influence the decision-making process in a setting outside the ED.

The literature search consisted of searching for key terms in PsycArticles, EBSCO, and PSYCinfo. Key terms included: *acceptance of prescribed CT scan, impact of perceived risk on ionizing radiation from computed tomography,* and *impact of perceived risk on CT scan acceptance.* SAGE was also used to search key words including: *ionizing radiation*, *radiation experts,* and *risk perception in peer-reviewed publications*. Other key terms searched included *radiation knowledge*, *healthcare knowledge,* and *decision-making*. The focus was on literature published in peer-reviewed journals within the past 10 years. Reference lists from identified articles were used as an

additional source. The preliminary literature review identified 120 articles. Ninety of these articles had relevant information, with 60 articles containing useful material that was used in the literature review.

In this chapter, a literature review regarding health risk perception and the HBM in preventive and diagnostic health studies will be presented. The literature reviewed covered the HBM from its inception in the early 1950s, the revision and revisitation of the theory through the 1970s and 1980, and concluded with recent research on the model. The physician-patient relationship regarding health care decision-making, including the current focus on getting patients more involved in their own healthcare decision-making process will also be discussed. A review on ionizing radiation perception in the general public as well as empirical information regarding potential risks of repeat scans was conducted and lastly, research findings in support of understanding perceptions about healthcare risks and benefits will be presented.

Theoretical Foundation

The theoretical framework for this study was based on the HBM. The HBM was developed in the early 1950s by the United States Public Health agency to conduct medical screening services (Hochbaum, 1958). This theory is based on the tenet that behavior is primarily a function of the value associated with a goal and the importance of the action required to accomplish the desired goal. Apart from the HBM, the trans-theoretical model, (Prochaska & DiClemente, 1982), the theory of planned behavior, (Beck & Ajzen, 1991), and the dual process theory (Leventhal et al., 1983) are also models that can be employed to assess the association of psychological variables in

healthcare decision-making. The HBM is a major theoretical framework used widely to explain, predict, and intervene in health behavior and health promotion (Janz & Becker, 1984; and Zhang et al., 2013). Although the HBM is not the only theoretical framework available to explain health behavior, it has been widely used as a model. Assari (2011) noted that a PubMed literature search on HBM in April 2011 found approximately 3,800 articles focused on this model and indicated that the HBM was used more frequently than any other healthcare behavior theory.

Researchers have found the HBM versatile in predicting a variety of health behaviors, ranging from the flu shot to healthy eating behavior, physical inactivity (e.g., Orji, Mandryk, & Vassileva, 2012; Peng, 2009), and applications in surgery (Armstrong et al., 2009). It has also been used to examine beliefs about technology security concerns (Davinson, & Sillence, 2014). Its application in health psychology includes research on adherence to medical regimens (e.g., Jones et al., 2014). Other research such by Kim et al., (2012) investigated eating behaviors in Korea, and Shahrabani and Benzion (2012), studied flu immunization in Israel; this demonstrates that the HBM has global applications. The HBM embraces psychological and behavioral factors in decision making and integrates constructs including the severity of a health concern, the susceptibility to a health condition, the benefits of a health decision, and the barriers standing in the way of the desired health decision making (Glanz et al., 2002). In 1988, the constructs self-efficacy and cues to action were added to the four original constructs (Rosenstock et al., 1988).

Despite the application of the HBM in a variety of domains (Armstrong et al., 2009; Davinson, & Sillence, 2014; Orji et al., 2012; Peng, 2009), it has limitations. Norman and Brain (2005) reported that the HBM had small behavior predictive ability in a study designed to investigate its use in encouraging breast self-examination. The authors identified problems including small effect size, as well as a lack of a clear approach in combining the variables (perceived severity, benefits of self-examination, and self- efficacy). In addition, Fisher (1977) described the motivational impact of the HBM as inadequate in a study focusing on the decision to accept or decline contraceptives. The responsiveness of the HBM appears to differ within various health behavior conditions. The study assessed the impact of three of the HBM constructs (perceived susceptibility, perceived severity, and perceived benefits) when presented with a health care decision to accept or reject a recommended CT scan. The constructs were manipulated individually via vignettes to mitigate the limitations of the model. The influence of each of the factors of the HBM that were examined in this research could be assessed individually.

Additional limitations of the HBM include that it fails to depict a clear relation between variables in some research, and it lacks a clear rule to combine the variables. This latter limitation may also provide flexibility and increase the application of the model (Orji et al., 2012, pp. 8). The more important limitation is its low predictive effectiveness. The model has been extended with cue to action and self-efficacy added as additional constructs (Rosenstock et al., 1988). Other researchers have adapted different

context to extend the HBM, for example, Orji et al. (2012) conducted a study that applied the HBM to eating disorders in adults.

Many researchers have used the HBM as a conceptual framework to examine the relationship between health risks and health behaviors. Gutierrez and Long (2011) reported that the HBM is accurate in predicting behavior in diabetic patients. Asci and Sahin (2011) used the HBM to investigate beliefs, attitudes, and behaviors of mothers who brought their daughters to the hospital for breast health. Results showed that after three months, the application of the HBM scale increased the rate of breast self-examination from 39.2% to 78.4%. The HBM has also been used to investigate college students' nutritional beliefs (Kim et al., 2012). In this study, HBM was used to predict the influence of perception on healthcare decision-making. Furthermore, The HBM was used to manipulate different potential predictive factors and assess respondent willingness to accept a physician recommended CT scan.

Tilaki and Auladi (2014) investigated the application of the HBM to breast cancer preventative screening. The researchers reported that women who believed themselves to be at low cancer risk were less likely to engage in preventive screening behavior. The HBM has been used to examine non-compliance with HPV vaccine (Donadiki et al., 2014) as well as to examine user perception about safety and security of technology (Davinson & Sillence, 2014). Researchers have used the model to investigate beliefs and attitudes about obesity (McConnon et al., 2013). Carpenter (2010) suggested when individuals perceive that the health outcome is severe, they are susceptible to the outcome, that the benefits of reducing the negative health outcomes as high, and that

there is low barrier implementation, they are more likely to make a positive healthcare decision.

The HBM was preferred as the framework for this study because it offers constructs ideally suited to operationalize the independent variables in a clear manner. I used vignettes to manipulate three of its constructs to assess the impact of perceived health risk and benefits to evaluate willingness to accept or decline a recommended CT scan. There are currently no published studies that employed the HBM to assess willingness to accept recommended CT imaging.

Public Perception Regarding Low Dose Ionizing Radiation

The purpose and usage of ionizing radiation predicts public attitudes, beliefs, and values associated with acceptance of imaging procedure (Evans et al., 2015; Freudenberg & Beyer, 2011). A study of 1,168 participants indicated low confidence in the health care received when a medical evaluation was limited to patient's history report and physical examination. Patients' confidence level increased when a CT scan was part of the medical evaluation process (Bauman et al, 2011). These types of satisfactory feelings influence healthcare decision-making (Ludwig & Turner, 2002). Patients seem to be more confident with medical evaluation when CT scan is included in their evaluation, even though they may have a limited understanding about CT scan radiation health risks. More than half of 300 participants who presented with back pain in a study aimed to investigate patients' belief indicated imaging was necessary for best health care outcome. The influence of satisfactory feelings about imaging appears to predict imaging overuse (Jenkins et al., 2016). This imaging belief supports Freudenberg and Beyer (2011) who

suggested that patient perception does not appear to pose a negative influence on radiation use.

The general public's attitudes and beliefs about ionizing radiation can be attributed to fear of an unknown outcome, lack of trust in information provided by authorities, or both as a result of distorted perceptions (Dauer et al., 2011). The word *radiation* creates an uneasy feeling and fear, as it is perceived as an unknown health hazard (Balter, 2011). Fear of the unknown can influence public perception and acceptance of hazards including radiation (Fischhoff et al., 1978; Slovic et al., 2005). Perceptions about low dose imaging radiation are related to patients trust in medical professionals as reliable sources for information regarding health risks and benefits. The perceived benefit-risk ratio is higher when patients have favorable feelings about imaging, and lower when feelings toward imaging are not favorable (Slovic, 2005).

The general public and radiation safety specialists do not perceive the health risks associated with ionizing radiation sources in the same way. In a landmark study, Fischhoff et al. (1978), reported that non-imaging experts perceived nuclear energy as an unacceptable high-risk and regarded X-ray as an acceptable low risk. In contrast, imaging experts regarded both nuclear energy and X-rays as acceptable moderate health risk. Difference in perception between the public and imaging experts have not changed decades later. Ludwig and Turner (2002) examined general public knowledge, beliefs, and attitudes regarding different sources of radiation with a survey of 200 participants. Less than 50% agreed with imaging experts that exposure to radiation sources presents a

risk. The authors noted that survey results supported limited accurate radiation knowledge in the general public.

Perceptions about radiation exposure risks are not based on accurate information and knowledge, but on beliefs and attitudes (Ludwig & Tuner, 2002). There is an indication that beliefs and attitudes about medical imaging radiation have not changed since the Ficshhoff et al. (1978) study, (i.e., there is a favorable perception of medical imaging), but there is no consensus among researchers about the relation between low-level ionizing radiation dose and cancer health risk. Some experts have asserted that the health risks associated with low dose ionizing radiation (typically less than 100 mSv in a CT), may lead to stochastic health effects including late cancer development (Brenner & Hall, 2012; Huda, 2015).

In contrast, the American Association of Physicists in Medicine stated that risks of medical imaging at low doses may be too low to be detectable (Hendee, 2013; McCollough, 2016). Scientific bodies including the International Commission on Radiologic Protection (ICRP, 2007), the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR, 2007), and the Biological Effects on Ionizing Radiation Committee (BEIR, 2006) have used estimates derived from high doses (i.e., Hiroshima nuclear bomb exposure) to interpret biological effects at low dose levels (i.e., CT medical imaging exposure). Dose estimates have used risk projection models, which are derived mainly from studies of survivors of the atomic bombs in Japan (BEIR, 2006).

A large pediatric cohort study in Britain conducted between 1985 and 2002 evaluated 178,604 children who received CT scans with no previous cancer diagnosis

(Pearce et al., 2012). A follow up analysis of the cohort group after 10 to 23 years revealed statistically significant cancer increase with CT exposure. Seventy-four out of the 178,604 patients developed leukemia and 135 out of 176,587 patients developed brain tumors. Researchers noted a positive association between CT scan radiation and leukemia. Children less than 10-years-old undergoing their first CT scan, it was estimated that one excess incident of leukemia and one excess incident of brain tumors can be predicted per 10,000 CT scans. The trend of positive association between CT radiation and health risk in children was also identified by Mehyar et al. (2019). The authors reviewed seven studies from 1968 to 2018. The analysis found positive risk central nervous system tumors in all cohorts. These findings provide a connection between imaging radiation dose and cancer development (Pearce et al., 2012).

According to Einstein (2012), this finding ought to minimize the controversy surrounding perceived reality of CT risks. There seems to be other empirical evidence to support the assertion that exposure to low dose ionizing radiation may predict delayed cancer risk. Hong, Han, Jung, and Kim (2019) found that 12 million youths in South Korea exposed to low dose diagnostic radiation had more cancer incidents, including mouth, breast, thyroid, lymphoid, and pharynx, than non-exposed persons. The study conducted with participants' ages 0 to 19 years found association between low dose radiation exposure and increased cancer risks. This finding is a valuable consideration to inform decision-making regarding low dose ionizing radiation associated with diagnostic CT scan. The public attitudes and beliefs towards the radiation risks of CT scan are not clear. This research aimed to understanding how beliefs and attitudes affect healthcare

decision-making. The outcome may help health care professionals understand how the patient-centered health care approach works in order to further foster trust within the physician-patient shared decision-making process (Chawla & Arora, 2013).

Ionizing Radiation Knowledge and Health Risk

There is a gap in literature regarding how patients prioritize and perceive information when presented with a health care decision. Bridging this gap may help understand how individuals make health care decisions about different procedures in different settings. In efforts to promote patient-centered care, it is important to assess how patients prioritize their perceptions of ionization radiation risks against potential diagnostic benefits. This information may assist the development of an understanding of individual healthcare decision-making. According to Dauer et al. (2011), two barriers appear to impede the general public's knowledge and ability to understand medical ionizing radiation. One is a lack of understanding of the units commonly used with radiation dose measurement. The other is a lack of understanding about radiation dose and biological damage associated with the dose (Dauer et al., 2011).

Busey et al. (2013) examined patient knowledge about imaging radiation. The major finding showed that 90% of the 325 respondents indicated knowledge about imaging health risk was important to them. Sixty-nine percent relied on their healthcare provider for health knowledge, 84% acknowledged that they were told the reasons for having imaging test, and 34% were not aware that they were exposed to radiation (Busey et al., 2013).

Evans et al. (2015) assessed public perception about ionizing radiation with a twenty-point questionnaire to examine health risks knowledge associated with imaging tests. They reported that only 20% of the sample was aware that magnetic resonance imaging and ultrasounds are not sources of ionizing radiation, and only 8% indicated they had confidence in their knowledge of ionizing radiation. The rest had confidence in the healthcare professional knowledge (Evans et al. 2015). There is a notable gap between the general public's assumptions regarding the knowledge of healthcare professionals and their actual knowledge regarding imaging ionizing radiation. Healthcare professionals prescribing CT scans are not as informed as the public assumes (Arslanoğlu et al., 2007; Baerlocher, & Detsky, 2010).

Several researchers have investigated patient knowledge and understanding of ionizing radiation associated with CT scan. However, in some studies, researchers evaluated knowledge and understanding after patients have undergone CT scan procedure (i.e., Hartwig, et al., 2013; McNierney et al., 2015; Youssef, et al., 2014; Zwank, 2014). In this study, a hypothetical scenario presented patients with perceptions of the risks and benefits of ionizing radiation and the impact of those perceptions, importantly, before expressing willingness to accept CT scan recommendation.

Perceived Susceptibility and Repeat CT Scans Overexposure

A CT scan is a noninvasive diagnostic imaging test. When used for diagnostic intervention, it is a simple procedure that utilizes advanced technology combining the specialized array of X-rays with sophisticated computers. This combination can produce a radiation dose comparable to eight months to three years of natural background

radiation exposure (Brenner & Hall, 2012). The simplicity of CT application promotes its overuse in numerous medical imaging procedures (Miglioretti et al., 2013; Miglioretti & Smith-Bindman, 2011). There is growing concern regarding overexposure from overuse (Brenner & Hall, 2007; Furlow, 2011; Rehani, 2012). Although the radiation dose from CT imaging is small, it is statistically significant and a potential health problem when more than 80 million individuals are exposed to ionizing radiation annually (Armao & Smith, 2014).

Sodickson (2009) reviewed more than 31,400 hospital inpatient cases and reported that 7% had received radiation doses from repeated CT scans large enough to increase their cancer risk by approximately 1%. Approximately 1,500 patients had undergone over 22 CT scans and 320 had experienced more than 38 scans. Fifteen percent of the cases had cumulative radiation doses equivalent to 1,000 X-ray exams and 4% had a lifetime dose comparable to 2,500 chest X-rays. It was estimated that 1% of the cases reviewed had health risks associated with CT imaging, and their cancer risk ranged from 2.7% to 12%. The author concluded that there is a clinically significant increase in cancer risk associated with multiple CT scans.

There is no published research investigating how perceptions of susceptibility to cancer with repeated CT scans impacts decision-making in accepting or rejecting a medically recommended CT. There is evidence that increased CT exposure increases susceptibility to cancer later (Mathews et al., 2013). Cumulative effects of multiple doses over time are associated with increased susceptibility to lifetime risk of cancer (Alert, 2011; Berrington de González et al., 2009; Smith-Bindman, 2009; Smith-Bindman et al.,

2012). With repeated CT exposure, there is a small but statistically significant cancer risk increase (Brenner & Hall, 2012). Avoiding unnecessary repeat CT scans may keep the benefit-to-risk ratio high (Bruner et al., 2009).

Research focused on susceptibility using the HBM is sparse even though Fulford, et al. (2013) discussed susceptibility as a crucial tool in healthcare decision-making. They conducted a decision-making study in a survey that included 1,345 women with fertility difficulty and who never received medical fertility treatment. Perceived susceptibility was assessed as the patient's judgment of the likelihood of experiencing infertility. Perceived susceptibility to infertility was found to influence the decision-making process to seek medical assistance (Fulford et al., 2013). In addition, the perception that smoking influenced susceptibility of infertility appeared to increase medical help decision-making in smokers with infertility problems.

There is limited information regarding how the general public perceives and prioritize the risks versus benefits of CT scans, and understanding this information may help medical professionals and future researchers limit the use of potentially unnecessary scans. If individuals perceive the risk of cancer to be higher with repeated scans, this may decrease the likelihood that they would accept the recommendation of a scan. This information is likely weighed with other risks and benefits. This study was designed to manipulate the perceptions of several variables that may influence healthcare decision-making in order to determine how much individual perceptions such as perceived susceptibility impact the decision to accept or reject a recommended CT scan.

Perceived Benefits and Risks of CT Imaging

Takakuwa et al. (2010) asked 383 patients who had undergone a CT scan questions regarding the scan. Seventy-nine percent correctly estimated the risk of cancer from chest X-ray and 83% correctly identified the estimated risk of cancer from CT scans. Approximately one-third correctly indicated that a chest X-ray is associated with less radiation than CT. Seventy-four percent of sample indicated the benefit of enabling their physician to diagnose with CT scans was more important to them than concerns about the risks of radiation.

Lee et al. (2004) reported that approximately 75% of radiologists and ED physicians significantly underestimated the radiation dose from CT scan. Fifty-three percent of the radiologists and 91% of ED physicians were not able to distinguish the difference in radiation dose between an abdominal-pelvic CT scan and a chest X-ray (Lee et. al., 2004). Additionally, only five out of 76 patients received information from ED physicians about CT risks, benefits, and dose (Lee et. al., 2004). Patients tend to trust that their physician is knowledgeable, and therefore go along with recommendations, especially in the ED when presenting with trauma (Evans et al., 2015). In general, research indicates that patients tend to assess the benefits of CT as more important than the risks; however, most of this research has been conducted in the ED and with patients who are vulnerable. There is no similar research that has been conducted with patient populations outside ED setting.

Psychological Constructs and Decision-Making

Dauer et al. (2011) argued that emotions and uncertainties are equally, if not more important, than facts and knowledge when it comes to healthcare decisions. Characteristics such as benefits, doubts, and emotions play important roles in determining perception and acceptance of risk associated with any healthcare decision. A crucial influence in healthcare decision-making is not necessarily the information itself, but the patient's perception about the information (Dauer et al., 2011). The authors asserted that other factors that may influence patient understanding about radiation health risk are anxiety, fear of the unknown, and competence to make the right decision now to avoid future regrets.

Slovic (2005) noted that cognitive and affective responses are involved in predicting healthcare decision-making. According to Slovic, decisions that hinge on logic and reason are made from cognitive consideration while emotional factors are responsible for behavioral control during moments of fear, pain, and anxiety. Anxiety can be an impediment that may alter an individual's information processing abilities and consequently lead to emotional rather than logical decision-making (Hartley & Phelps, 2012). The perception associated with risk is not just about communicating or understanding the risk, but a combination of facts, feelings, instincts and the prevalent situation of risk (Ropeik, 2008).

A component of the physician-patient partnership is patient-centered communication (Ha & Longnecker, 2010), including physicians' respect for the patients' views, and clinician's confidence in the patient's ability to manage their illness by

making the patient a partner in the decision-making process (Pomey et al., 2015). Clarity of information is important, but information and education alone are incomplete and inadequate for healthcare decision-making. Health psychologists place emphasis on the impact of affective variables and personal risk perception to understand healthcare decisions. When it comes to healthcare and patient-centered care, there is need to understand the extent of presenting factors on decisions as well as which factors are most important. For example, the ED presents an environment where the setting increases the likelihood that patients will accept physician recommendations such as a CT scan (Griffey & Sodickson, 2009). Under these circumstances, patients' emotions and feelings appear to outweigh information or facts in making health care decisions (Takakuwa et al., 2010). According to Stiegler and Gaba (2015), these automatic factors affect the decision-making of healthcare providers as well as patients. This study assessed the impact of perception on healthcare decision-making when there is no ED automatic factor influence and sought to address the impact of the perception about the risks and benefits associated with low dose ionizing radiation on healthcare decision-making.

Emergency Departments and Patient Decision-Making

Many of the studies discussed in this review were conducted at an academic institution or an ED without generalization to the general public (i.e., Brenner & Hall, 2007; Takakuwa et al., 2010; Thompson et al., 2011). Considering the ED setting, patients in crisis may regard this location as *belonging* to the care provider and therefore defer decision-making to the physician (Lee et al., 2004). The ED presents patients in trauma with decisions to make when they are more concerned about their treatment than

health risks (Takakuwa et al., 2010). Decision-making in the ED ranges from simple observation method to traumatic healthcare response (Schonfeld et al., 2013).

Most patient visits to the ED involve traumatic health emergencies (Takakuwa et al., 2010). Their immediate priority is taking care of the presenting health problem rather than the threat of future cancer development (Takakuwa et al., 2010). In this setting, the physician is primarily responsible for healthcare decision-making (Metler et al., 2009). This research was conducted to fill a gap when the physical setting does not present a health trauma as in the ED, where the health care decision making is physician driven rather than patient centered.

The studies discussed in this chapter focused on views and perceptions about ionizing radiation from CT imaging. Researchers agree that CT scans present a small health risk (Schauer, & Linton, 2009; Smith-Bindman, 2009). Some believe that no actual risk exists compared to the benefits (Hendee & O'Connor, 2012). Others contend that even a small dose is statistically significant and may increase the threat of cancer development (Shah et al., 2012; Smith-Bindman, 2009). The application of the HBM to investigate the process of decision-making may help develop understanding about how individuals make healthcare choices.

Summary

The general public views ionizing radiation in medical use as having low susceptibility to health risk (Slovic, 2012; Einstein, 2012). The public attitude about medical benefits appears to be inversely related to the perceived health risks associated with radiation-producing healthcare intervention such as a CT scan (Alhakami & Slovic,

1994; Finucane et al., 2000). Based on the premise that individuals will prefer making a decision that promotes health behavior, the HBM has been applied in smoking prevention and health promotion behavior such as taking medication.

This quantitative design study was unique from other HBM applications because three of its constructs were manipulated to assess willingness to accept or decline a healthcare recommendation. This study sought to add to literature by assessing the influence of psychological constructs and the public's perception of CTs benefits and health risks on decision-making to accept a recommended health care intervention. In chapter three the methods used and a rationale for the design will be provided. Population selection, ethical consideration, and analysis plan will also be described.

Chapter 3: Research Method

The purpose of this mixed experimental study was to assess the impact of perceived cancer health risk and diagnostic benefit on the willingness to accept a physician recommended CT scan in a hypothetical outpatient setting. The study explored the influence of the constructs perceived susceptibility to cancer risk, perceived severity of that risk, and perceived benefits of the procedure on the decision to accept or decline a CT scan. The qualitative component of the study asked participants to describe the two most important factors that influenced their decision-making process. In this chapter, the methods used in the study as well as the rationale for the design are described. Additionally, the patient population, selection criteria, instruments to be used, analysis plan, and ethical considerations will be presented.

Research Design and Rationale

This mixed concurrent transformative method was designed to have a quantitative component for collecting data and a qualitative component emphasizing descriptive data derived from a grounded theory. The quantitative component included a 2x2x2 factorial design with three factors, (susceptibility, severity, and benefits), each with two levels (low and high). Eight different combinations of factors and levels were possible. Each participant read and responded to one out of the eight total vignettes manipulating the independent variables (see Appendix B) with a rating of their acceptance of a recommended CT scan (the dependent variable).

The qualitative component of the mixed design used the grounded theory to explore factors participants deem most important in making their health care decisions.

Each participant was asked to identify the two most important factors used in decision making for each vignette. The rationale for combining quantitative and qualitative methods was that the quantitative component assessed the decision, and the qualitative component assessed how that decision was made. The grounded theory used subjective assessment to analyze and understand what factors respondents prioritized most in CT scan health risk/benefit decision-making. Quantitative and qualitative components were evaluated and integrated with the HBM as the theoretical lens.

A vignette is a brief description of a situation, event, or person presented in a simple noncontentious style to elicit respondents' judgment. Vignettes are increasingly used in research as a flexible assessment tool to determine participants' response (Auspurg et al., 2009), including the influence of age and education on participants' response (Sauer et al., 2011). Quantitative vignettes have been used extensively in social science studies (Dulmer, 2007; Jasso, 2006; Rossi & Anderson, 1982). Quantitative vignette studies have increased in various fields of application, including education, sociology, psychology, and decision-making (Dulmer, 2007; Evans et al., 2015). The use of vignettes provides a simplified and flexible way to manipulate independent variables in order to examine the influence of each of those variables on the dependent variable. In addition, web-based surveys have been used in studies focusing on evaluating health risk assessment (Cottrell & McKenzie, 2005) and to collect health risk assessment relating to health status and health risks.

A true experimental quantitative vignette study consists of two components: a vignette designed to manipulate the independent variables and a questionnaire designed

to measure the dependent variables. The flexibility of vignettes makes it possible to use with mixed and between-subjects designs. Administering the experimental survey concurrently with a qualitative grounded theory inquiry into participant views will allow access into understanding the decision-making process. The quantitative component provided an objective assessment regarding how decision-making changed depending on the factors that were manipulated, while the qualitative component will access the participants' personal assessments regarding how the decision was made. The HBM guided each of the study components and the data gathered from each part of the study was analyzed to assess consistency between the quantitative and qualitative data.

Factorial Design

The three independent variables that were manipulated are: perceived severity of ionizing radiation, perceived susceptibility to radiation health risk, and perceived benefits of CT scans. The dependent variable was rated on a two-level scale (high and low) as willingness to accept the recommended CT scan. The 2x2x2 factorial design produced the following eight options (see Appendix B): (a) high severity, high susceptibility, high benefit; (b) high severity, low susceptibility, high benefit; (c) high severity, low susceptibility, low benefit; (d) high severity, high susceptibility, low benefit; (e) low severity, low susceptibility, low benefit; (f) low severity, high susceptibility, high benefit; (g) low severity, high susceptibility, low benefit; (h) low severity, low susceptibility, high benefit.

Methodology

Population and Sample Recruitment

Following IRB approval, data collection was started on January 13, 2019 and conducted via an online survey that was completed by April 18, 2019. Participants who met the eligibility requirement were recruited via an external online survey site from a population of online university with international enrollment and an academic institution in the Midwest. Participants were 18 years and older and included men and women of varying ethnicities and educational levels. Considering that recruitment was conducted from a university participant pool, participants education level was above that of the general public. The data was collected anonymously, and IP addresses were not recorded. The descriptive data collected included: age, sex, education levels, a rating of health self-assessment and an indication of whether they are healthcare providers (see Appendix C).

Sample Size

Gravetter and Wallnau (2004) emphasized the importance of obtaining enough participants to determine whether a significant association exists between the independent variables and the dependent variable. The study was designed to use convenience sampling. Three statistical components are necessary to ensure that a study has enough participants to determine a relationship between the variables. Type I error, α, was a predetermined value that was set at 0.05. Power is denoted as (1 - ß), where ß is the risk of committing Type II error. The effect size is an indication of the magnitude of the

statistical test (vignettes) that will determine the existence of a relation between the independent variables and the dependent variable.

G*Power 3.1.7 was used to determine the appropriate sample size. A moderate effect size was predicted, given the findings of Miller and Doyney (1999) and Grilo et al. (2005) who both found moderate effect sizes in studies examining the role of perception in healthcare decision-making. Using a moderate effect size ($f^2 = 0.25$), an α level of 0.05, a power of 0.80, and a numerator *df* of 7 (determined by the inclusion of the main effects and interactions), and eight groups. Approximately 15 participants read each vignette for a total of 120 responses, needed to have sufficient power for the analyses. To account for 10% attrition to accommodate invalid or incomplete data, a total of 134 participants were recruited.

Procedures for Recruitment, Participation, and Data Collection

Participants read a brief statement describing the study, posted on the participant pool website of an online university (see Appendix D). Permission was granted by the IRB to invite voluntary participants who meet the eligibility requirement from an academic institution in the Midwest to participate in the study. Those interested in the posted study were directed to participate online via a website hosted by survey monkey that included a detailed description of the voluntary nature of the study, anonymity, and their right to discontinue the study at any time. Individuals who consented to continue with the survey are directed to the demographics questionnaire. Each participant was assigned one vignette in order to maintain the assumption of independence across groups.

Participants were asked to respond to one question regarding acceptance of the CT scan that is recommended in each vignette. IP addresses were not collected.

Instrumentation

Demographics Questionnaire

The demographics questionnaire (see Appendix C) was designed to collect information regarding age, sex, level of education, race, employment as a health care provider, interaction with primary health care physician, and self-rated health status. It was estimated to take less than 10 minutes to complete the survey. The data obtained here was used to describe the study sample.

Vignettes

Each respondent was randomly assigned one vignette that described an individual with chest pain with an unknown cause. The vignettes (see Appendix B) described eight hypothetical scenarios. In each vignette, the physician recommended a CT scan to diagnose the cause of the pain. Each vignette included a description of the perceptions of the patient, manipulated to reflect high or low levels of each of the three independent variables. Participants were asked to rate their degree of willingness to accept the CT scan recommendation if they were the vignette patient. The rating was based on a 5-point Likert scale (see Appendix E). Participants were then asked to describe the two factors that weighed most heavily in making their decision to accept or reject the CT scan recommendation (see Appendix F).

Perceived severity of ionizing radiation was manipulated by extent of the radiation dose received, or the use of repeat or multiple scans for *high severity* conditions.

Perceived susceptibility was manipulated by describing the individual as needing a higher number of scans. In the *high severity* condition, the individual was concerned that the exposure to radiation from the multiple scans made them more susceptible to a delayed long-term risk of radiation damage. This information was adapted from published radiological data (Fazel et al., 2009), and was reviewed by expert in the field.

I used vignette to manipulate low and high CT benefit to assess the extent of perceived useful of the CT scan as a useful diagnostic tool. The high benefit group was assigned vignettes describing a 95% likelihood of diagnostic accuracy, and those in the low benefit group receive vignettes where the diagnostic accuracy is 30%. I used 5-point Likert scale to rate acceptance of the CT scan (see Appendix E). Participants were asked to rate the degree to which they would be likely to accept a recommended CT scan if they were the individual described in each vignette. The anchors of the scale are "definitely accept" or "definitely reject" the recommendation. The middle rating represents a neutral attitude, with no strong feelings about having a CT scan.

Vignette Validity Check

I asked three individuals with graduate degrees in clinical psychology and psychiatry to review the vignettes and indicate whether they reflected high or low levels of the independent variables. Reviewed ratings were consistent with the intended HBM construct manipulation and comments and feedback from the reviewers was used to edit the vignettes for clarity.

Data Analysis Plan

In the quantitative phase of the mixed concurrent transformative approach, data was downloaded from the survey site into SPSS version 22.0 for Windows. Before conducting the analysis, the data was inspected for completeness, missing data, compliance with the assumption of the analysis plan, and outliers. Incomplete cases were removed from the database. A Kolmogorov Smirnov (KS) test was used to assess the assumption of normality of data. Additionally, equality of variance was assessed with a Levene's test. A nonparametric data analysis approach was used.

Descriptive statistics were used to describe the sample demographics and for descriptive purposes. Frequencies and percentages were calculated for nominal data while means and standard deviations were calculated for continuous data (Howell, 2010). Post hoc analyses were conducted to determine whether level of education or prior CT experience predicted CT acceptance.

To examine the research questions and hypotheses, an ANOVA was conducted to assess differences in the willingness to accept the CT recommendation by (a) degree of perceived severity of CT; (b) perception of susceptibility of CT health risk; and (c) perceived benefits of CT imaging. An ANOVA was selected because the goal was to assess the main and interactive effects of the three categorical factors on the dependent variable ordinal data. There are three main effects of the ANOVA (severity, susceptibility, and benefit), and eight interaction effects, which represent any combination of the three variables at each level, as follows: (a) high severity, high susceptibility, high benefit; (b) high severity, low susceptibility, high benefit; (c) high

severity, low susceptibility, low benefit; (d) high severity, high susceptibility, low benefit; (e) low severity, low susceptibility, low benefit; (f) low severity, high susceptibility, high benefit; (g) low severity, high susceptibility, low benefit; and (f) low severity, low susceptibility, high benefit.

ANOVA was also used to analyze the mean difference between the three independent variables on the dependent variable. ANOVA was preferred as there are more than two groups in the proposed study, and ANOVA will allow for comparison of groups as well as interaction effects. The ANOVA outcome was used to determine any association of the *F*-ratio with the p-value, and to assess whether a significant difference among the groups existed. There was no significant difference among the groups, and Bonferroni and Tukey post-hoc test was not performed in identifying variable(s) contributing towards possible group differences. The use of ANOVA requires meeting its three assumptions:

1. Observations within each sample must be independent (i.e., one participant observation must not be related to another). To ensure that assumptions of independence across groups are not violated, by design, only one vignette question was assigned to a participant.
2. The data must be normally distributed (i.e., the dependent variable has a normal distribution for all three independent category variable). A Kolmogorov Smirnov (KS) test to test normality was used. This assumption was not met, but the assumption is robust to violations when the sample size exceeds 50 cases.

3. The population from which the samples are taken must have equal variances (i.e., the value of each group in the independent variables has equal size and the variances on the dependent variable are similar, otherwise known as homogeneity of variance). A Levene's test was conducted to assess equality of variance.

The assumptions were met (see Chapter 4). In addition, to assess the degree of association, the mean of participants in the high and low severity group, in the high and low susceptible group, and in the high and low benefit group was compared. The research question pertaining to interactive effects sought to assess effects among perceived severity, susceptibility, and benefits that impact willingness to accept a recommended CT imaging in a sample of healthcare recipients outside the hospital setting?

The qualitative phase of the mixed concurrent transformative design used grounded theory method to analyze open-ended descriptive data. Grounded theory is a significant systematic dual inquiry research method used increasingly by researchers to collect and analyze data (Lewis-Beck et al., 2004). Grounded theory has been used to explain a phenomenon and/or examine an experience. In this study it was used to explain healthcare decision making regarding CT acceptance. The data analysis plan used participants' response to obtain a descriptive data.

To achieve this goal, data was analyzed from the qualitative survey response. Thematic analysis (TA) was used as a systematic six-step approach that involves the search for emerging themes. To complete the first step of TA, descriptive responses were transcribed, reviewed, and read thoroughly. In the second step, the survey transcripts

were read line-by-line and assigned descriptive initial codes. In Step 3, all the significant passages were reviewed and searched for themes. The similarities and differences between the codes were explored and similar codes were placed into the same preliminary categories, which will become the initial themes. After the coded passages were placed together into thematic categories, all of the themes and codes within each category were reviewed to ensure their fit within the theme for the fourth step. In Step 5, the themes were defined, named and a title that described the content of the theme was created. In Step 6, the results of the qualitative data analysis were written. Finally, emerging consistency in the quantitative data regarding the most important factors weighed in deciding to accept or reject a recommended CT scan was investigated.

Research Questions

Research Question 1: Is degree of perceived severity of CTs ionizing radiation significantly associated with the rating of willingness to accept CT imaging recommendation in a sample of health care recipients, outside the hospital setting?

Null Hypothesis ($H_0$1): The degree of perceived severity of CTs ionizing radiation has no significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Alternative Hypothesis (H_a1): The degree of perceived severity of CTs ionizing radiation has a significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Research Question 2: Is degree of perceived susceptibility to CT health risk significantly associated with the rating of willingness to accept CT imaging recommendation in a sample of health care recipients, outside the hospital setting?

Null Hypothesis ($H_0$2): The degree of perceived susceptibility to CT health risk has no significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Alternative Hypothesis (H_a2): The degree of perceived susceptibility to CT health risk has a significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Research Question 3: Is degree of perceived benefits of CT imaging significantly associated with rating of willingness to accept CT imaging in a sample of health care recipients, outside the hospital setting?

Null Hypothesis ($H_0$3): The degree of perceived benefits of CT imaging has no significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Alternative Hypothesis (H_a3): The degree of perceived benefits of CT imaging has a significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Research Question 4: Is degree of interactive effect among the three independent variables significantly associated with the ratings of willingness to accept recommended CT imaging in a sample of health care recipients outside the hospital setting?

Null Hypothesis ($H_0$4): The degree of interactive effect among the three independent variables has no significant association with the ratings of willingness to accept recommended CT imaging in a sample of health care recipients outside the hospital setting?

Alternative Hypothesis (H_a4): The degree of interactive effect among the three independent variables has a significant association with the ratings of willingness to accept recommended CT imaging in a sample of health care recipients outside the hospital setting?

Research Question 5(Qualitative): What are the most important factors that individuals weigh in deciding to accept or reject a hypothetically recommended CT scan in a non-ED setting?

Threats to Validity

Validity has been defined as the capability of the survey instrument to measure what it is designed to measure (Barry et al., 2007). The essence of validity was the ability of items on the survey questionnaire to effectively evaluate the constructs in the proposed study. There are no instruments that have been tested and published that could be used in the proposed research. The vignettes were developed for this study. The vignettes underwent a face validity check before being utilized in the experimental study but were not tested for reliability or other types of validity.

Each participant was assigned one vignette to ensure active engagement in the survey and to minimize fatigue from reading too much information. Participation was

anonymous. Providing participants with anonymity may contribute to their willingness to be open and honest in their ratings, as honest response is important to internal validity.

Ethical Considerations

One of the ethical considerations in research involving human subjects is to prevent harm to participants. Individuals who agreed to participate were required to indicate consent before accessing the vignettes or survey questionnaires. Participants were informed that they can discontinue participation at any time. All information provided and results from the study are kept and managed securely, and no identifying information or IP addresses were collected. The vignettes and questions asked were not sensitive and psychological distress was a minimal risk. The risk to take part in the study was minimal, and there were no direct benefits. The database itself is password protected and kept on a password-protected computer. Participants who desired the results of the study can request them as part of information dissemination. Researcher contact information was available if participants had questions. Data will be destroyed 5 years after the publication of the research per scientific publishing requirements of the American Psychological Association.

Summary

This chapter described the design and research method for the study. The chapter discussed the rationale for the online survey questionnaire approach, and the use of vignettes. The chapter also described the qualitative question of this mixed method design, the vignettes that were designed to manipulate the independent variables, and the face validity check that was used to develop them. Additionally, the methods used to

recruit participants, the method used to manipulate and measure the research variables, the analysis plan, and the ethical consideration used to protect participants was discussed. In chapter four the results of data collected are presented and analyzed. Results are also presented in tables. The descriptive statistics of the participants' demographics is provided. Quantitative and qualitative results is presented and analyzed. Findings on post hoc analysis are described.

Chapter 4: Results

The goal of this study was to examine the relation between risk perception and acceptance of a medical recommendation for a CT scan. In this chapter, the findings of the data analysis are presented. Descriptive statistics were used to describe the participant sample. Research questions and hypothesis are restated. An ANOVA was conducted to analyze the quantitative research questions, and the qualitative question was analyzed using a grounded theory approach. The results of the analyses are presented and synthesized.

The study was posted on an external website linked to an online university participant pool website. In addition to recruiting participants from the online pool, permission was granted by the IRB to invite voluntary response from participants at an academic institution in the Midwest who met the eligibility requirement. Respondents read a brief statement about the study and individuals interested in the study were directed to the website that included a detailed description of the voluntary nature of the study, anonymity, and their right to discontinue the study at any time. Individuals who consented to continue with the survey were then directed to the questionnaires.

Descriptive Statistics

Demographics

A total of 146 individuals responded to participate in the research and completed the demographic form. However, 12 participants did not answer the questionnaire item regarding acceptance of the CT scan and were excluded. The total number of participants included in the final analysis was 134. Overall, the participants were 65% female, 43%

were 34 years old or younger, 49% were African American, and 53% reported having either a graduate degree or a postgraduate degree (see Table 1).

Table 1

Participant Demographics

Demographic Variables	*n*	*%*
Gender		
Male	44	32.8
Female	87	64.9
Unknown	3	2.2
Age		
18-24	37	25.3
25-34	31	21.2
35-44	27	18.5
45-54	28	19.2
55-64	21	14.4
65+	1	0.7
Unknown	1	0.7
Race		
White	46	31.5
African American	72	49.3
Latino	7	4.8
Asian or Asian American	13	8.9
Native Hawaiian or other Pacific Islander	2	1.4
Other	5	3.4
Unknown	1	0.7
Education		
High school diploma	34	23.3
Bachelor's degree	37	25.3
Graduate degree	39	26.7
Post-graduate degree	36	24.7

Note. Due to rounding errors, percentages may not equal 100%.

Other items listed in the demographic form asked about history of employment in the healthcare industry, health status, and experience with CT scans. Most participants

(65%) had not been employed as a healthcare provider. The majority (87%) reported that their current health status was *good* or *very good*. Most (88%) had a primary healthcare provider. More than half (53%) had never had a CT scan.

Independent Variables

The distribution of vignettes was random, and the total number of participants who received each vignette ranged from 15 to 20. Participants provided response to each of the three main effects. Each independent variable was assessed at two levels. (see Table 2).

Table 2

Participants Who Received Each Type of Vignette

Independent Variables	*n*	*%*
Degree of severity		
High	68	50.7
Low	66	49.3
Degree of susceptibility		
High	67	50.00
Low	67	50.00
Degree of benefit		
High	68	50.00
Low	68	50.00
Vignette number		
1	18	13.4
2	16	12.0
3	15	11.0
4	20	15.0
5	16	12.0
6	17	13.4
7	17	13.0
8	15	11.2

Note. Due to rounding errors, percentages may not equal 100%.

Acceptance of Recommendation

Of the 134 participants, the majority indicated that they would *probably* or *definitely accept* the recommendation for a CT scan (n = 50, 37.3%; n = 55, 41%) after reading the vignette. Only a few respondents (n = 7, 5.6%) indicated that they would *definitely not* accept a CT scan, or that they would *probably reject* the recommendation (n = 10, 7.5%). Twelve respondents (9.0%) indicated that they *are not sure and do not feel one way or the other*.

Research Questions

Research Question 1: Is degree of perceived severity of CTs ionizing radiation significantly associated with the rating of willingness to accept CT imaging recommendation in a sample of health care recipients, outside the hospital setting?

Null Hypothesis ($H_0$1): The degree of perceived severity of CTs ionizing radiation has no significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Alternative Hypothesis (H_a1): The degree of perceived severity of CTs ionizing radiation has a significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Research Question 2: Is degree of perceived susceptibility to CT health risk significantly associated with the rating of willingness to accept CT imaging recommendation in a sample of health care recipients, outside the hospital setting?

Null Hypothesis ($H_0$2): The degree of perceived susceptibility to CT health risk has no significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Alternative Hypothesis (H_a2): The degree of perceived susceptibility to CT health risk has a significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Research Question 3: Is degree of perceived benefits of CT imaging significantly associated with rating of willingness to accept CT imaging in a sample of health care recipients, outside the hospital setting?

Null Hypothesis ($H_0$3): The degree of perceived benefits of CT imaging has no significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Alternative Hypothesis (H_a3): The degree of perceived benefits of CT imaging has a significant association with ratings of willingness to accept recommended CT imaging in a sample of health care recipients.

Research Question 4: Is degree of interactive effect among the three independent variables significantly associated with the ratings of willingness to accept recommended CT imaging in a sample of health care recipients outside the hospital setting?

Null Hypothesis ($H_0$4): The degree of interactive effect among the three independent variables has no significant association with the ratings of willingness to accept recommended CT imaging in a sample of health care recipients outside the hospital setting?

Alternative Hypothesis (H_a4): The degree of interactive effect among the three independent variables has a significant association with the ratings of willingness to accept recommended CT imaging in a sample of health care recipients outside the hospital setting?

Research Question 5(Qualitative): What are the most important factors that individuals weigh in deciding to accept or reject a hypothetically recommended CT scan in a non-ED setting?

Quantitative Results

To address Research Questions 1 through 4, a factorial ANOVA was proposed to assess main effects and interactions. Acceptance of a recommended CT scan was treated as the continuous level dependent variable. Perceived severity, perceived susceptibility, and perceived benefits were included as independent grouping variables, each with two levels: low and high. Three main effects and four interaction terms were examined for the analysis.

Prior to conducting the analysis, the assumptions of normality and homogeneity of variance were tested. Levene's test was conducted to assess the homogeneity of variance assumption. The assumption was met for severity ($p = 0.689$), susceptibility ($p = 0.349$), and benefit ($p = 0.795$). The assumption of normality was not met for the acceptance of recommended CT imaging ($p < 0.001$). However, the assumption is robust to violations when the sample size exceeds 50 cases (Stevens, 2012); thus, given the large sample size, the planned ANOVA was conducted.

The results of the ANOVA for severity were significant, [$F(1, 126) = 7.43$, $p = 0.007$], indicating significant differences in acceptance in recommended CT imaging by severity (see Table 3). Individuals were more likely to accept the recommended CT scans if the severity of possible consequences, or the chance of developing cancer as a result of radiation exposure, was low. This led to a rejection of the first null hypothesis.

Table 3

CT Scan Acceptance Rate by Severity

Variable	*n*	*M*	*SD*
Classification of severity			
Low severity	66	4.26	1.01
High severity	68	3.78	1.20

The results of the ANOVA for susceptibility were not statistically significant, [$F(1, 126) = 1.60$, $p = 0.209$], indicating there was no difference in acceptance of the recommended CT imaging by susceptibility. Individuals tended to be more likely to accept the CT scan if they perceived themselves as less susceptible to cancer, but this difference was not statistically significant (see Table 4). Therefore, I failed to reject the null hypothesis for the second research question.

Table 4

CT Scan Acceptance Rate by Susceptibility

Variable	*n*	*M*	*SD*
Classification of susceptibility			
Low susceptibility	67	4.12	1.19
High susceptibility	67	3.91	1.07

The results of the ANOVA for benefit were also not statistically significant, [$F(1, 126) = 0.82$, $p = 0.366$], indicating that there was not a significant difference in acceptance of the recommended CT imaging by benefit (see Table 5). Individuals who read the vignette describing a high degree of benefit in diagnosing the cause of the pain tended to be more likely to accept the CT scan recommendation, but this finding was not statistically significant. Therefore, I failed to reject the null hypothesis for the third research question.

Table 5

CT Scan Acceptance Rate by Benefit

Variable	*n*	*M*	*SD*
Classification of benefit			
Low benefit	68	3.94	1.14
High benefit	68	4.09	1.12

Possible interaction effects between the independent variables were also investigated via separate ANOVAs. The analysis of the severity and susceptibility interaction was not statistically significant, [$F(1, 126) = 1.54$, $p = 0.217$]. The result

indicates that severity did not interact with susceptibility in impacting acceptance of the CT scan (see Table 6). The severity and benefit interaction was also not statistically significant, [$F(1, 126) = 0.05$, $p = 0.826$], indicating that severity did not interact with benefit in impacting the acceptance of the CT scan (see Table 7).

Table 6

CT Scan Acceptance Rate by Severity and Susceptibility

Variables	*n*	*M*	*SD*
Degree of severity and susceptibility			
Low severity – Low susceptibility	31	4.26	1.21
Low severity – High susceptibility	35	4.26	0.82
High severity – Low susceptibility	36	4.00	1.17
High severity – High susceptibility	32	3.53	1.19

Table 7

CT Scan Acceptance Rate by Severity and Benefit

Variables	*n*	*M*	*SD*
Degree of severity and benefit			
Low severity – Low benefit	33	4.18	0.95
Low severity – High benefit	33	4.33	1.08
High severity – Low benefit	35	3.71	1.27
High severity – High benefit	33	3.85	1.12

The ANOVA investigating the interaction between susceptibility and benefit interaction was statistically significant [$F(1, 126) = 7.54$, $p = 0.007$] indicating that

susceptibility and benefit interacted with each other in impacting the decision to accept the recommended CT (see Table 8). Individuals who read the vignette describing a high degree of severity at a low CT scan benefit are less likely to accept the CT scan recommendation than those who read vignette describing low severity with high benefit. Thus, the interaction of susceptibility and benefit had a significant impact on acceptance of a recommended CT scan.

Table 8

CT Scan Acceptance Rate by Susceptibility and Benefit

Variables	*n*	*M*	*SD*
Degree of susceptibility and benefit			
Low susceptibility – Low benefit	36	4.28	1.03
Low susceptibility – High benefit	31	3.94	1.34
High susceptibility – Low benefit	32	3.56	1.16
High susceptibility – High benefit	35	4.23	0.88

The results of the ANOVA for the three-way interaction of severity, susceptibility, and benefit was not statistically significant, [$F(1, 126) = 0.60$, $p = 0.440$]. The three independent variables did not interact together to impact the acceptance of the recommended CT scan (see Table 9). Therefore, I failed to reject the fourth null hypothesis. Overall findings are presented in Table 10.

Table 9

CT Scan Acceptance Rate by Severity, Susceptibility, and Benefit

Variables	*n*	*M*	*SD*
Degree of severity and susceptibility and benefit			
Vignette 1: High severity – High susceptibility – High benefit	17	3.94	0.90
Vignette 2: High severity – Low susceptibility – High benefit	16	3.75	1.34
Vignette 3: High severity – High susceptibility – Low benefit	15	3.07	1.33
Vignette 4: High severity – Low susceptibility – Low benefit	20	4.20	1.01
Vignette 5: Low severity – Low susceptibility – Low benefit	16	4.38	1.09
Vignette 6: Low severity – High susceptibility – High benefit	18	4.50	0.79
Vignette 7: Low severity – High susceptibility – Low benefit	17	4.00	0.79
Vignette 8: Low severity – Low susceptibility – High benefit	15	4.13	1.36

Table 10

Statistical Summary of the Results

Variables	*SS*	*df*	*F*	*p*	η_p^2
Severity	8.73	1	7.43	0.007	0.06
Susceptibility	1.88	1	1.60	0.209	0.01
Benefit	0.97	1	0.82	0.366	0.01
Severity and susceptibility	1.81	1	1.54	0.217	0.01
Severity and benefit	0.06	1	0.05	0.826	0.00
Susceptibility and benefit	8.87	1	7.54	0.007	0.06
Severity and susceptibility and benefit	0.71	1	0.60	0.440	0.00
Residuals	148.06	126			

Post Hoc Analysis

An exploratory analysis was conducted in order to examine possible predictive associations between the demographic variables and the dependent variable. An ordinal logistic regression was used to test for a possible predictive relationship between the independent variables of education level, experience with a CT scan, and employed as healthcare provider and the dependent variable was CT scan acceptance. Due to the categorical nature of education level, high school was treated as the reference group. The results of the ordinal logistic regression model for education and previous experience with CT scan were not significant, $\chi 2(4) = 2.11$, $p = 0.716$.There was an overall goodness of fit statistic with all of the variables entered ($R^2 = 0.017$), indicated that there was not a significant relationship between these two predictor variables and CT acceptance (see Table 11).

Table 11

Education Level and Experience with a CT Scan Predicting CT Acceptance

Variable	Estimate	*SE*	Wald(1)	*p*
Education level (reference: high school)				
Bachelors	-0.55	0.47	1.37	0.242
Graduate	-0.09	0.45	0.04	0.849
Postgraduate	-0.27	0.47	0.34	0.560
Pervious CT	-0.18	0.32	0.32	0.574

Results of the ordinal logistic regression model revealed that for participants who were employed as healthcare providers there was a significant association with CT scan

acceptance. The results of the logistic regression model were significant, $\chi^2(1) = 5.63$, $p = 0.018$, Nagelkerke $R^2 = 0.044$, suggesting that there is a significant relationship between being employed as a healthcare provider and CT acceptance (see Table 12). Participants who were employed as healthcare providers had a lower acceptance rate of CT scans in comparison to those were not employed as healthcare providers. The coefficient of determination, R^2, suggests that approximately 4.4% of the variance in CT acceptance can be explained by employment as a healthcare provider.

Table 12

Employment as a Healthcare Provider Predicting CT Scan Acceptance

Variable	Estimate	*SE*	Wald(1)	*p*
Employed as a healthcare provider	0.80	0.34	5.63	.018

Note. Results: $\chi^2(1) = 5.63$, $p = .018$, Nagelkerke $R^2 = 0.044$

Summary of Quantitative Results

The goal of the quantitative component of this study was to access the impact of participant perception of risk versus benefit on the willingness to accept a physician recommended CT scan. Overall, 38% (*n*=55) of participants *strongly accepted* the recommendation of a CT scan compared to 5% (*n*=7) who *definitely did not accept* the recommendation. These findings indicate that perceived severity influenced the acceptance rate of a CT scan, the null hypothesis for Research Question 1 was rejected. The severity of the influence of radiation did predict the CT scan acceptance rate. The more severe the perceived impact of radiation was, the less participants accepted the recommendation. The main effects of susceptibility and benefit were not significant. This led to accepting null hypotheses for Research Questions 2 and 3. The degree to

which the individuals perceived themselves to be susceptible to the impact of radiation or the extent to which they perceived the CT to benefit them diagnostically, did not appear to impact their decisions regarding CT acceptance.

The interaction of all three main effects did not have any impact on willingness to accept the recommended CT scan. This finding indicates that the combined effects of perceived severity, perceived susceptibility, and perceived benefits did not influence participants' response. The combined effect did not attain statistical significance, indicating all three factors together seem to have less impact on acceptance rating compared to each main factor considered alone.

Qualitative Results

The purpose of the qualitative analysis component of this study was to examine how participants described what influenced their decision regarding willingness to accept the recommended CT scan. Grounded theory was used to identify themes in the responses to the two open-ended questions regarding what influenced the decisions of the participants. A total of 146 participants responded to the survey. However, 12 participants were excluded for not completing the questionnaire. Therefore, the final sample included 134 participants. Eight participants choose not to provide a qualitative descriptive response, but all answered the quantitative Likert scale questionnaire.

The TA six-step systematic approach was used to read thoroughly, review, and transcribe the descriptive responses. Next, initial codes were assigned to comments in the data set and identified similarities and differences into categories which became the initial thematic themes. Themes in each category were checked, and a title for the theme

content was developed. Last, using the grounded theory method approach to analyze open-ended descriptive data, emerging consistencies were identified and listed, as important response factors weighed by participants to accept a recommended CT scan. The majority of individuals had made the decision to accept the CT scan, with ratings of "4" or "5." This limited the qualitative analysis to focus on factors considered by individuals who accepted the CT scan recommendation and those who did not.

Theme 1: Getting a Diagnosis

The most frequent reason cited by participants (n = 29, 25% of the sample) for their response was an indication that getting a diagnosis for the medical complaint was important. These participants explained that getting a diagnosis would reveal the cause of and eliminate associated pain. One participant wrote, "I want to be diagnosed." Another participant commented, "diagnosing and treating the pain and any underlying cause is much more important to me than any small chance of developing cancer later in life." Only two respondents who described this as a reason for their rating were not sure about accepting the CT scan, and all the other participants who cited this theme accepted the recommendation.

Theme 2: Wanting to Follow Doctor's Recommendation

Participants had trust and respect in experience and opinion of the doctor and 18% (n = 21) or participants made the decision to accept the CT scan because a doctor recommended it. All of the individuals who cited this theme had accepted the recommendation. One participant's response was, "I respect the opinion of my doctor,"

and another explained that they accepted the CT scan, “simply because it was recommended by the doctor.”

Theme 3: Severity of Health Concern

In addition to getting a diagnosis and recommendation made by a doctor, another category of response considered the severity of health concern as well as the pain and suffering associated with it (*n*=14, 12%). All the respondents who endorsed this theme had accepted the recommendation. Comments that represented this theme included, “Chest pain is usually very bad and indicative of something dangerous…better to risk the CT scan and know for sure what's causing it,” and “The most important factor is the chest pain and the concern that it might be a heart condition that could lead to a fatal heart attack.”

Theme 4: Belief in CT Diagnostic Accuracy

Belief in CT accuracy was also considered by 8% (*n*=9) of the participants as an important factor that contributed to their decision. Eight of the nine respondents had accepted the recommendation based on this theme. One respondent did not accept and explained, “I believe one CT is enough not three.” One individual who accepted the CT wrote, “It is the only [way] you can see what is happening in your body.” Another participant wrote, “CT scan will be successfully diagnostic.”

Theme 5: Radiation Exposure Risk

The comments of 8% (*n*=9) of the participants mentioned potential cancer risk as a factor for their health care decision response. These participants were divided on their acceptance scores. Two of those nine participants declined the recommendation, one

respondent was unsure, and six accepted the CT. One participant, who had not accepted the recommendation, wrote, "I am concerned that even this low dose of radiation on multiple occasions over time will increase susceptibility of developing cancer later in life." In contrast, another respondent who had accepted the recommendation wrote that they were "not particularly concerned about the exposure to radiation during this procedure."

Theme 6: Preference for a Test Other Than CT

One set of comments was mentioned by 6% (*n*=8) of the participants' who had a preference to perform a diagnostic test other than a CT scan. One participant was unsure, but none of the participants who endorsed this theme accepted the recommendation. They noted that there might be other ways to diagnose chest pain, and wrote comments such as, "there might be other options regarding diagnosing the chest pain." Another respondent wrote that they "would have to know if alternative (MRI) would be indicated."

Theme 7: Participants' Experience with Health Care

Six percent of responses (*n*=7) were influenced by the participants' health care experience with CT scans in the past. All seven of the participants who had endorsed this theme had accepted the recommendation. One remarked, "so I've always had a positive experience with it…and that I have already had a number of these in the past." Another wrote, "to be honest, I've experienced this exact scenario, was prescribed an X-ray, and turned out to have life-threatening pneumonia. I cannot separate that getting the scan was right for me from this situation describing essentially the same decision tree."

Theme 8: Benefit Versus Risk

All the 4% (*n*=6) of participants who commented about risks versus benefit of getting the CT also indicated that they believed the benefit outweighed the risk. They all accepted the CT scan. One participant wrote, "I've undergone imaging (CT, X-ray, MRI) many times and it's pretty much always been useful for diagnosing the problem." Another participant expressed that, "comparing the risk of a heart attack, which is high considering the symptoms and initial diagnosis, to the risk of radiation exposure, which is low."

Other Factors

Other factors that weighed into the decision to accept or reject the CT scan did not fit into the above categories and did not occur frequently enough to be counted as a theme. Approximately 2% (*n*=4) of participants were influenced by fear of regret, insurance cost as out of pocket expenses, and loss of time off work for scan appointments. All four respondents had accepted the recommendation for the CT scan. One respondent expressed fear of regret and uncertainty, "I do not want to wonder what they would have found if I do not do it."

Summary of Qualitative Results

Key findings of the qualitative analysis included that many respondents did not assume active involvement in the healthcare decision-making process, but rather agreed to a CT because the doctor recommended it. Many respondents also expressed concern regarding the perceived severity of the potential medical issue as a main factor

influencing their acceptance a CT scan. Others were concerned about susceptibility to future radiation risk manifestation, or CT scan benefit.

Participants who had previously had at least one CT scan (n = 7) had all accepted the scan. All the respondents who had expressed a preference for other diagnostic test options such as MRI scans (n = 8) did not accept the CT scan. In addition, all the participants who commented on the benefits versus the risks of the CT scan indicated acceptance of the scan. Individuals who commented on the influence of radiation exposure risk were not consistent in their responses, with two respondents who cited this theme declining the recommendation and six accepting the recommendation.

Integrating the Quantitative and Qualitative Analyses

Data collection and analysis for the mixed method design of this study was conducted concurrently for the quantitative and qualitative components. The qualitative grounded theory component examined open-ended text data to organize the respondents' descriptions of their decision-making process into themes. Perceived severity is one of the three major tenets of the health belief model employed in this study. Severity of health concern was one of the emerging themes in the qualitative analysis that predicted participant response regarding health care decision-making. In response to Research Question 5, 12% (n=14) of participants cited severity of health concern as an emerging theme predicting decision to accept a recommended health decision. This finding from the analysis supports severity of health concern as an important factor weighed by participants. The quantitative analysis results indicated that the interaction of susceptibility and benefit was significant. However, susceptibility did not emerge as a

theme in the qualitative analysis, indicating a complicated relation between those two variables.

Summary

In the quantitative analysis, an ANOVA was used to test the research questions and hypothesis. The analysis indicated that perceived severity of the impact of radiation was the only independent variable that was significant in the acceptance of the recommended CT scan. Susceptibility and benefit did not significantly influence this decision.

The qualitative analysis revealed eight emerging themes describing categories of important factors weighed by participants. The most common response weighed by respondents was the need to get a diagnosis. Physician opinion or recommendation was highly regarded and accepted as a reason to comply with the recommendation since many respondents indicated trust in physicians. The two sets of data appear to be relatively consistent. The variable of severity was significantly related to the acceptance of the proposed CT scan, and this was supported by a theme that presented in the qualitative data. The variables of susceptibility and benefit demonstrated a more complicated relation to acceptance of the CT, with the interaction of the two variables predicting acceptance of the recommendation in the quantitative analysis, but only benefit occurring as a theme in the qualitative analysis. In Chapter 5, these findings will be discussed in more detail, and connections made to the literature and theoretical framework selected for the study. Limitations and recommendations for future studies will also be described.

Chapter 5: Discussion, Recommendations, and Conclusion

The purpose of this study was to examine the impact of perceived susceptibility to CT radiation risk, perceived severity of that risk, and perceived benefits of a diagnostic CT scan on the decision to accept a physician recommended CT scan. The goal was to determine what factors were prioritized by healthcare recipients in decision-making outside of the ED. A mixed method concurrent transformative design was used to address the research questions. The quantitative component was given more emphasis as the primary data to understand a cause/effect relation between benefit-risk perception and willingness accepting a CT scan recommendation. The qualitative grounded theory component sought to examine whether the open-ended text data supported the quantitative findings.

In this chapter, the results will be reviewed and interpreted. The relation of these findings to previous research and the HBM, as well as how the findings may inform future research will be discussed. Additionally, a discussion about the limitations of the study and recommendations for further research focused on increasing patient participation in the healthcare decision-making process will be included.

Interpretation of the Results

Previous research has reported increased efforts to encourage patients to participate more actively in their own health care instead of deferring decision-making to their physician (Evans et al., 2015; Hamann et al., 2012; Laidsaar-Powell et al., 2013; McDonald et al., 2014; Price-Haywood et al., 2010; Ruiz-Moral, 2010; and Timins, 2010). Research that focuses on individual decision-making regarding health care can

help understand this process and encourage individual involvement. This study examined the impact of perceived severity of CT scan ionizing radiation, the perceived susceptibility to delayed CT scan related cancer health risk, and the perceived benefit of CT scan diagnostic imaging on participants' willingness to accept a physician recommended CT scan.

Overall, 95% of participants accepted the recommendation for the scan. One possible explanation for the high acceptance rates of the CT recommendation was that participants considered feelings of uncertainty, worry, and fear about the presenting chest pain. Chest pain may be indicative of a serious undetermined health issue, this may have generated a sense of urgency to obtain a diagnosis rather than worry about a delayed radiation risk such as cancer.

The quantitative analysis demonstrated that perceived severity significantly predicted CT scan recommendation acceptance. Individuals who believed that their health risk severity from radiation exposure was high accepted the recommendation of a CT scan less than those who thought the risk severity was low. Neither the perception of susceptibility to future radiation health risk nor the perceived diagnostic benefit of a CT scan predicted willingness to accept the CT scan recommendation. This was consistent with the qualitative data, as 8% of participants made comments such as "diagnosing the current cause of pain is more important to me than the possibility of developing cancer later in life."

The quantitative data did not demonstrate a significant effect for the variables of susceptibility on decision making. This finding was further supported by the lack of

qualitative findings regarding susceptibility as a theme. In contrast, perceived benefit did not significantly influence outcomes in the quantitative analysis, but the qualitative analysis demonstrated that all participants who cited benefits versus risks as an emerging theme agreed that the benefits of a CT scan outweighed the risks. The quantitative analysis results indicated that the interaction of susceptibility and benefit reached significance. However, susceptibility did not emerge as a theme in the qualitative analysis, indicating a complicated relation between those two variables.

The quantitative analysis also indicated that the potential benefit of the CT scan (obtaining a diagnosis) was not in itself related to acceptance of the scan. The qualitative data analysis was inconsistent with this finding in that an emerging theme was "belief in CT diagnostic accuracy." Eight of nine participants (one was neutral) who cited this theme, accepted the recommendation for the CT scan because diagnostic accuracy was considered an important factor.

In the quantitative analysis, the interaction of susceptibility with diagnostic benefit was a significant predictor. When susceptibility to developing cancer was low, and the perceived diagnostic benefit of the CT was high, individuals accepted the CT scan more. The Likert scale used in the quantitative data analysis may have identified a more subtle relation between benefits and risks than the qualitative data reflected. The majority of participants rated themselves as likely to accept, but the difference between a 4 (*would probably accept*) and 5 (*would definitely accept*) on the Likert scale may have picked up subtle differences in concern about radiation effects without changing the actual decision to accept the recommendation.

According to Slovic et al. (2005), the perceived benefit-risk ratio is higher when patients have favorable feelings about imaging, and lower when feelings toward imaging are not favorable. In this study, participants perceived CT imaging as a useful diagnostic solution to pain with an unknown cause. Given these results, if individuals believed their risk of cancer was severe, the diagnostic benefits of the CT scan were not prioritized. However, they tended to take the potential benefit into account when considering the longer-term potential for a cancer diagnosis. This outcome would seem to support Slovic et al. (2005).

The qualitative component of this study sought to identify the most important factors that individuals considered in deciding to accept or reject a hypothetical recommended CT scan in case vignettes. Most respondents cited wanting a diagnosis as an important factor they weighed in making their decision. This finding is consistent with results from previous research by Caverly et al. (2013) and Takakuwa et al. (2010). They reported that patients preferred to know the diagnosis of the presenting trauma in the ED, even when imaging radiation is used. Takakuwa et al. (2010) reported that, "patients believed it is more important to diagnose their condition with CT than to worry about radiation" (p.1156).

Overall, the qualitative findings indicate that people tend to believe in the capability of CT scan diagnostic testing to identify the unknown cause of the presenting pain and address their uncertainty, fear, and worry regarding the symptom. This tended to be more of a consideration when the risk of cancer from CT scan radiation was low. Caverly et al. (2013) and Takakuwa et al. (2010) reported similar findings, patients

valued getting a clear diagnosis in the present moment over the possibility of future cancer as a result of radiation risk. In the present study, there were clear limits to the degree of risk participants were willing to take. Those that read the vignette where a history of multiple CT scans may have increased the severity of cancer risk due to radiation were less willing to take that risk than those that perceived a less severe health threat from reading vignettes with no previous CT scan history.

The commonsense model postulates that the healthcare decision-making process includes not only the health threat but also the emotional response of the decision maker (Leventhal et al., 1992). The ED setting was used in most previous studies of healthcare decision-making. The ED setting may have elicited a strong emotional response from the decision-maker, as emotional responses are generally heightened during an emergency (Caverly et al., 2013; Takakuwa et al., 2010; & Youssef et al., 2014). A hypothetical non-ED setting was used in this study to reduce the possible emotional impact of the ED setting. This change in setting did not appear to make a significant difference in the acceptance rate of a CT scan.

Patients tend to trust physicians' knowledge and opinions, and therefore follow their recommendations, especially in the ED when presenting with trauma (Takakuwa et al., 2010). Findings from the qualitative component of this study revealed that respondents strongly prioritized the CT being a doctor's recommendation. This suggests patients are likely to make health care decisions by relying on physician recommendation, regardless of the setting or the presence of trauma. This finding is also consistent with the findings of several other researchers (Evans et al., 2015; Hamann et

al., 2012; Laidsaar-Powell et al., 2013; McDonald et al., 2014; Price-Haywood et al., 2010; Ruiz-Moral, 2010; and Timins, 2010). Healthcare recipients place a good deal of trust in doctor recommendations when it comes to diagnostic testing, which can be misplaced in situations such as when practitioners own imaging equipment and benefit financially from the testing (Galewitz, 2010). The long-term goal of patient-centered care research is to discover ways to influence the way healthcare is provided by getting more patients to become involved in their own health care decision-making.

In the qualitative analysis, 5% of the participants expressed a desire for a diagnostic option other than a CT scan. Given the nature of this study, it was not possible to assess whether these individuals would inquire about alternative options. However, asking questions is an important step for patients to be part of the physician-patient dialogue, even if the patient's question is answered with an explanation of why CT is preferable to MRI given the symptoms. Taking the initiative to ask questions may enhance patient confidence in their ability to effectively participate in health care decision-making. Given that patients may have limited healthcare education they need to ask questions and feel confident about their ability to use the information they gather from the information-seeking process. Caverly et al. (2013) reported that approximately 65% of the participants in their CT scan decision study did not discuss associated risks with their healthcare professionals. Ideally, future and ongoing research will identify how to encourage this process.

Although the radiation dose from natural sources has remained unchanged over time, the average ionizing radiation exposure to the United States population from CT

imaging increased more than six-fold from 1980 to 2006 (NCRP, 2009; NCRP, 2013). More than 80 million CT scans were performed in the U. S. in 2010 compared to three million in 1980 (Armao & Smith, 2014). More than 81 million CT scans were conducted in 2014 (IMV Medical Information Division, 2014). Americans in general are aware of the increasing use of CT scans, but according to a study conducted by Evans et al. (2015) only 8% expressed confidence in their knowledge about CT imaging. This outcome indicates that the increase in CT scans conduced over the decades did not coincide with confidence in knowledge about CT imaging. The key finding in this study showed that most participants accepted the recommendation for a CT scan with little input of their own in the decision-making process. Active participation in health care decisions provides patients with an opportunity to increase their self-efficacy and minimize the decision-making administered solely by the prescribing health care.

The HBM has been widely used as a major theoretical framework to predict a variety of health beliefs and behaviors. Previous application include beliefs about nutrition, breast self-examination, and the flu shot (Asci & Sahin, 2011; Glanz & Bishop, 2010; Janz & Becker, 1984; Krawczyk, et al., 2012). This study employed the HBM to examine diagnostic test acceptance rates in a sample of the general public in a setting outside the ED.

Participants who perceived CT scan severity as low, accepted the scan more than those who perceived the scan severity as high severity, supporting the importance of the HBM variable of *perceived severity*. The variable *perceived susceptibility* to health risk associated with a CT scan did not significantly predict the likelihood to accept a

recommended CT scan, nor did the variable *perceived benefit* of accurate diagnosis. However, the interaction of susceptibility and benefit was predictive of acceptance and the perceived benefit in terms of accuracy of the CT scan in making a diagnosis was an important factor in decision making. Thus, the HBM was partially supported by the findings of this study. Findings from this study extend knowledge and add to existing literature regarding the HBM as a tool to examine risk/benefit consideration in healthy patients in a trauma-free environment.

Limitations of the Study

This research was conducted as an online survey. Thus, the findings may not be generalized to individuals without adequate computer skills, access, and the ability to complete an online survey questionnaire. The findings also may not be generalized to a population with a high school or less, as the study was posted on an online website and the invitation was extended to include participants at a higher academic center or enrolled in college. A large percentage of the participants were African American and highly educated, which does not reflect the composition of the general population in the United States. Health behavior perception and how it predicts health care decision-making for the group recruited for this research may be different from other groups.

Qualitative data was collected in the form of open-ended questions submitted electronically and did not provide an option for a conversation with participants. This did not allow for follow-up questions about the participants' answers or dialog regarding their thought processes. The online setting allowed participants to complete the questions at their leisure and convenience, but the lack of a standard environment may have

influenced how they answered the question regarding CT acceptance and limited data collection. The large percentage of participants who expressed willingness to accept the CT scan was also a limitation of the study, as this led to limited information regarding why the CT scan was rejected.

Recommendations

For more than two decades the medical application of radiation imaging has increased (Armao & Smith, 2014). Researchers have reported increased public awareness about CT scans as well as an increasing trend in the application of this technology (Armao & Smith, 2014). However, patient awareness does not seem to have translated into active participation in decision-making regarding radiation medical imaging. Findings from this study support the existing literature in demonstrating that patients tend to prefer to defer decision-making to the prescribing physician.

The literature search revealed only one previous study that examined the influence of health care recipients' beliefs and attitude regarding radiation imaging outside the ED setting. There is a clear need for more studies designed to investigate and promote patient involvement in healthcare decision-making. Participants in this study primarily based their decisions on three factors: (a) the degree to which they believed the health risk was severe; (b) the need for an accurate diagnosis in the context of that risk; and (c) the doctor's recommendation. Future studies should seek to investigate what patients believe their role is in healthcare decision-making. There is need to understand patient perception about responsibility in their own health care. A qualitative study seems appropriate to explore this concept further in order to fully understand how

individuals perceive their role in health care decision-making. Continued study of decision-making models in the field of health psychology may help discern what information is considered valuable to patients when they seek health care. The current study sought to investigate what factors influence the decision-making process for CT imaging, a future qualitative research study might further investigate why those factors are considered important and how they are prioritized within that process.

The HBM was used to operationalize the independent variables that were used in this study. The HBM was supported by the association of perceived severity as well as the interaction between susceptibility and benefit in the decision to accept the recommendation of a hypothetical CT scan. Although the application of HBM in healthcare has been studied, no previous study has used the HBM to investigate willingness to accept a recommended CT scan. The HBM was a suitable framework in this study and may be recommended to examine the behavioral impact of perceived beliefs and attitudes predicting healthcare decision-making. However, future research might focus on how the variables interact with each other rather than on direct effects of each variable in the model. These findings extend knowledge and add to the existing literature regarding the HBM as a suitable tool to examine risk-benefit acceptance of a sample of healthy patients in a trauma-free environment.

Continued research is needed to understand the role of health psychology in bringing awareness to the importance of the individual values, social preferences, and prevalent setting factors predicting healthcare needs of the decision maker. If patient-centered care is to succeed, health care professionals and reform stakeholders need to

improve their knowledge base to understand factors that influence decision-making. Beliefs about healthcare, negative effects and potential side effects are not of lesser significance when compared to clinical needs. One key finding of this study was that patients trust physician recommendations. It is important to not disregard non-clinical needs of patients. It is recommended that health psychology focuses future research on elucidating patient beliefs, values, and preferences.

This non-ED setting of this study sought to minimize the effect of emotional response on decision-making by using vignettes that placed patients in a trauma-free environment. Given the current findings in comparison to those of similar studies conducted in an ED setting, it appears that changing the setting did not significantly impact the acceptance rate of a physician recommended CT scans. It is not clear if setting had any influence on the rate of acceptance. Conducting future studies in an interview format may help explore such factors.

Implications of the Study

Cognitive and affective constructs are significant predictors in all decision-making (Slovic et al., 2005). In order to achieve desired patient-centered care it is important to not ignore the need to understand the social, psychological, and environmental factors motivating the healthcare consuming public to make healthcare related decisions. Previous studies relating benefits and risks from low dose radiation on patients from the perspective of prescribing physicians and imaging care providers have been conducted. However, this study focused on understanding patient preference in healthcare decision-making.

This study sought to determine the impact of psychosocial factors using the constructs of the HBM to assess factors that influence healthcare decision-making. The quantitative findings supported the qualitative findings where the motivation to accept the recommendation was predicted not by the perceived severity of multiple CT scans only, but also by a feeling of uncertainty, fear, and concern about the severity of the presenting health symptom. Participants appeared to indicate that the presenting complaint (chest pain) required a diagnostic solution (a CT scan) to reveal a diagnosis.

Although the findings demonstrate that health severity was a motivating factor influencing healthcare decisions, motivations predicting decision-making are not derived solely from perceived severity of health risk. The continued process of developing knowledge about the beliefs and attitudes affecting health decisions may help healthcare professionals to understand how to implement patient-centered health care delivery. The expectation of desired patient-centered care is to enable the health psychologists to collaborate with other healthcare professionals about how to access patient understanding of risks, benefits, anxiety, and worry.

The implications of this study for the field of health psychology include the need to focus on underlying factors involved in healthcare decision-making. The existing body of knowledge about the role of affective and cognitive constructs in medical decision-making may benefit from this research. The information gained from the study may enhance knowledge that leads to facilitated shared decision-making between patients and their healthcare providers, including psychologists. These constructs are often neglected and understanding them more thoroughly may lead to the development of ways

to improve patient trust and confidence. The outcome of this study may inform a collaborative approach between healthcare professionals and patients (Shyu & Sodickson, 2016).

Efforts to shift the focus from physician driven health care to patient-centered reform needs to continue with cues to action that will increase patient participation and confidence in individual healthcare promotion. Achieving this goal requires challenging traditional beliefs about asking questions and automatically accepting doctors' recommendations. Future research needs to focus on attitudes about decision-making when healthcare recipients are presented with more than one option on diagnostic benefits. The qualitative data demonstrated that physician recommendation was an important factor in accepting the recommendation for the CT scan. This indicates that healthcare providers need to be more aware of their dialogue with patients.

Conclusion

The HBM served as a theoretical guide to assess acceptance of a hypothetical recommended CT scan. The quantitative analysis revealed that one of the three HBM constructs, perceived severity, significantly predicted degree of acceptance of a physician recommended CT scan. The other two HBM constructs, perceived susceptibility and perceived benefits, did not alone predict acceptance, but interacted to predict acceptance. Respondents who read the vignette describing a high degree of susceptibility and low CT scan benefit were less likely to accept the CT scan recommendation than those who read a vignette describing low susceptibility with high benefit.

Overall, participants appeared to defer healthcare decision-making to the physician and were motivated by a concern to obtain a diagnosis, while also considering the severity of the risk the CT scan imposed. This study enhances existing literature regarding factors patients prioritize as important to reach a health care decision. The results contribute to existing research that emphasizes the impact of individual perception and emotional reaction on the healthcare decision-making process. The quantitative component employed the HBM lens to investigate the research questions and found CT scan acceptance reached statistical significance with severity of health risk.

The results suggest benefit in learning and understanding patient perception of health risks, benefits and dialog with healthcare givers. There seems to be very little provision to adequately address patients who express uncertainty, fear, or worry regarding the decision-making process. The current primary focus of healthcare providers is the patient's clinical symptoms. Health care decision-making that embraces patient-centered care needs to address patients' non-clinical psychosocial concerns as well. The role of health psychologists includes gaining an understanding of the psychosocial care needs of patients. Findings from this study suggest collaborative multidisciplinary efforts between healthcare providers and patients may help address patient needs and provide more opportunity for patient-centered care.

Although the quantitative data found perceived severity of CT image radiation significantly predict acceptance rates of CT scan recommendations, the overriding emergent theme from the qualitative results indicate that participants prioritize understanding the cause of the presenting health symptom. Most individuals who

participated in the study indicate that they would accept a recommendation for a CT scan. Their main reasons for acceptance include belief that the doctor's recommendation was important and a desire for any diagnostic device to address their feelings of uncertainty, fear, and worry about the pain described in the vignettes. The overall acceptance rate of a CT scan supports the findings of previous research conducted in non-ED settings and extends knowledge beyond the ED setting. A CT scan was the only available diagnostic device offered in this study; participants may have accepted other diagnostic tests offered as well. It is recommended that future studies include more than one diagnostic option (i.e., ionizing and non-ionizing radiation) to determine patient preference and understand the influence of risk-benefit attitude and considerations on health care decision-making.

This research may influence positive social change by emphasizing the importance of the finding that studies of healthcare decision-making in the ED setting may be generalizable to non-ED settings. Although continued research is needed, the foundation of knowledge that has already been built on healthcare decision-making may be applicable to multiple settings. This research also considered the risk-benefit of medical radiation imaging from the perspective of health care consuming public rather than of the caregivers with primary focus on clinical health. The pursuit of this research may provide an understanding of how beliefs, attitudes, values, and preference influence healthcare decision-making associated with low dose ionizing radiation. Imaging administrators and healthcare providers need to consider the psychological, social values, and environmental factors expressed by patients, and patients need to be able to express concerns and ask questions. Patients need to participate in their own health care

decision-making. Having the opportunity for participation may improve confidence in the decision-making process and may serve as a motivating factor for positive impact on health.

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Appendix A: Permission to Reprint Figure 1

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Appendix B: Vignettes

Each respondent will be randomly assigned to two of the eight vignettes**.**

Vignette One: High severity, high susceptibility to ionizing radiation, and high CT Benefit

You have been having chest pain for over two weeks and have decided to see your primary care physician. Upon evaluating the symptoms, the physician recommends multiple (three) Chest CT scans. You are concerned about this, because you think that repeated or multiple CT scans in a single imaging procedure will increase the severity of radiation dose that you receive, and you think three scans is a lot. You have already had multiple exposures to radiation over time because of your medical history, with many X-rays and CT scans in your past. You are concerned that even these low doses of radiation on multiple occasions over time will increase your susceptibility to developing cancer later in life. Your doctor seems confident that the CT imaging procedures can diagnose the possible cause of the chest pain, and you are about 95% certain the cause of the pain will be diagnosed with this procedure.

If you were this individual, please select the response that best describes how likely you are to accept the recommended CT scan.

Vignette Two: High severity, Low susceptibility to ionizing radiation, and High CT Benefit

You have been having chest pain for over two weeks and have decided to see your primary care physician. Upon evaluating the symptoms, the physician recommends multiple (three) Chest CT scans. You are concerned about this, because you think that repeated or multiple CT scans in a single imaging procedure will increase the severity of radiation dose that you receive, and you think three scans is a lot. You have no previous X-rays or CT scans in your medical history, so you are not concerned about a buildup of radiation in your body from CT scans or X-rays. Your doctor seems confident that the CT imaging procedures can diagnose the possible cause of the chest pain, and you are about 95% certain the cause of the pain will be diagnosed with this procedure.

If you were this individual, please select the response that best describes how likely you are to accept the recommended CT scan.

Vignette Three: High severity, High susceptibility to ionizing radiation, and Low CT Benefit

You have been having chest pain for over two weeks and have decided to see your primary care physician. Upon evaluating the symptoms, the physician recommends multiple (three) Chest CT scans. You are concerned about this, because you think that repeated or multiple CT scans in a single imaging procedure will increase the severity of radiation dose that you receive, and you think three scans is a lot. You have already had multiple exposures to radiation over time because of your medical history, with many X-rays and CT scans in your past. You are concerned that even these low doses of radiation on multiple occasions over time will increase susceptibility of you developing cancer

later in life. Your doctor thinks that the CT imaging procedures can diagnose the possible cause of the chest pain, and you are about 30% certain the cause of the pain will be diagnosed with this procedure.
If you were this individual, please select the response that best describes how likely you are to accept the recommended CT scan.

Vignette Four: High severity, Low susceptibility to ionizing radiation, Low CT Benefit
You have been having chest pain for over two weeks and have decided to see your primary care physician. Upon evaluating the symptoms, the physician recommends multiple (three) Chest CT scans. You are concerned about this, because you think that repeated or multiple CT scans in a single imaging procedure will increase the severity of radiation dose that you receive, and you think three scans is a lot. You have no previous X-rays or CT scans in your medical history, so you are not concerned about susceptibility to developing cancer later in life due to buildup of radiation in your body from CT scans or X-rays. Your doctor thinks that the CT imaging procedures can diagnose the possible cause of the chest pain, and you are about 30% certain the cause of the pain will be diagnosed with this procedure.
If you were this individual, please select the response that best describes how likely you are to accept the recommended CT scan.

Vignette Five: Low severity, Low susceptibility to Ionizing radiation, and Low CT Benefit
You have been having chest pain for over two weeks and have decided to see your primary care physician. Upon evaluating the symptoms, the physician recommends a single Chest CT scan. You think a single scan is not a lot and nothing to worry about the severity of radiation dose that you will receive. You have no previous X-rays or CT scans in your medical history, so you are not concerned about susceptibility to developing cancer later in life due to buildup of radiation in your body from CT scans or X-rays. Your doctor thinks that the CT imaging procedures can diagnose the possible cause of the chest pain, and you are about 95% certain the cause of the pain will be diagnosed with this procedure.
If you were this individual, please select the response that best describes how likely you are to accept the recommended CT scan.

Vignette Six - Low severity, High susceptibility to ionizing radiation, and High CT Benefit
You have been having chest pain for over two weeks and have decided to see your primary care physician. Upon evaluating the symptoms, the physician recommends a single Chest CT scan. You think a single scan is not a lot and nothing to worry about the severity of radiation dose that you will receive. You have already had multiple exposures to radiation over time because of your medical history, with many X-rays and CT scans in your past. You are concerned that even these low doses of radiation on multiple occasions over time will increase your susceptibility of developing cancer later in life.

Your doctor seems confident that the CT imaging procedures can diagnose the possible cause of the chest pain, and you are about 95% certain the cause of the pain will be diagnosed with this procedure.
If you were this individual, please select the response that best describes how likely you are to accept the recommended CT scan.

Vignette Seven: Low severity, High susceptibility to ionizing radiation, and Low CT Benefit
You have been having chest pain for over two weeks and have decided to see your primary care physician. Upon evaluating the symptoms, the physician recommends a single Chest CT scan. You think a single scan is not a lot and nothing to worry about the severity of radiation dose that you will receive. You have already had multiple exposures to radiation over time because of your medical history, with many X-rays and CT scans in your past. You are concerned that even these low doses of radiation on multiple occasions over time will increase your susceptibility of developing cancer later in life. Your doctor thinks that the CT imaging procedures can diagnose the possible cause of the chest pain, and you are about 30% certain the cause of the pain will be diagnosed with this procedure.
If you were this individual, please select the response that best describes how likely you are to accept the recommended CT scan.

Vignette Eight: Low severity, Low susceptibility to ionizing radiation, and High CT Benefit
You have been having chest pain for over two weeks and have decided to see your primary care physician. Upon evaluating the symptoms, the physician recommends a single Chest CT scan. You think a single scan is not a lot and nothing to worry about the severity of radiation dose you will receive. You have no previous X-rays or CT scans in your medical history, so you are not concerned about susceptibility to developing cancer later in life due to buildup of radiation in your body from CT scans or X-rays. Your doctor seems confident that the CT imaging procedures can diagnose the possible cause of the chest pain, and you are about 95% certain the cause of the pain will be diagnosed with this procedure.
If you were this individual, please select the response that best describes how likely you are to accept the recommended CT scan.

Each vignette paragraph is followed with a five point Likert-type scale.

Appendix C: Demographics Questionnaire

Sex:

- Male
- Female

Age: (in years)

Race:

- Caucasian
- African American
- American Indian
- Asian
- Other

Ethnicity:

- Hispanic
- Not Hispanic or Latino

Highest level of education completed

- High school diploma
- Bachelor's degree
- Graduate degree
- Post graduate degree

Are you or have you been employed as a healthcare provider?

- No
- Yes

If yes, what type (e.g., nurse, doctor, mental health professional)?

Nurse

- Doctor
- Mental health professional
- Other

Please indicate your overall health status

- Very Good
- Good
- Average
- Less than Average
- Poor

Do you have a primary healthcare provider?

- Yes
- No

Have you had a CT scan in the past?

- Yes

- No

If yes, how many CT scans have you had?

- At least One
- Fewer than Five
- More than Five

Appendix D: Introducing the Study to Online Research Pool Participants

I am a graduate student working on my Ph.D. in Health Psychology at Walden University in Minneapolis, Minnesota. I am conducting a survey on the perceptions, attitudes, and health beliefs of the general public about Computed Tomography (CT) scans. The title of my dissertation is "An Assessment of the Impact of Perceived Health Risk of Ionizing Radiation on Healthcare Decision-Making." The purpose of the study is to assess whether perceptions about CT scans affects willingness to accept recommended diagnostic imaging. I request your participation in a brief survey questionnaire that will take approximately 20 minutes to complete. The study could be of significant benefit because it may promote awareness and increase participation in healthcare decision-making. As a participant you will be presented with a scenario describing yourself as an individual with chest pain discomfort. The physician recommends a CT scan to diagnose the cause of the discomfort. You will be asked to read one short healthcare scenario and respond to a question regarding your willingness to accept the recommendation of a CT if you were the individual. You will be asked a follow up question regarding what the two most important factors that made you decide to accept or reject the recommended CT scan. Your participation will be anonymous and will not be linked to any information that could identify you. There is no obligation to complete the survey, and it is completely voluntary. There is no compensation for participating. Please feel free to contact Walden University if you have any questions.

Appendix E: A 5-Point Likert-Type Scale

1. Likert Scale for Vignettes
    a. I would definitely not accept this recommendation and would not have a CT scan
    b. I would probably reject this recommendation
    c. I am not sure and don’t feel one way or the other
    d. I would probably accept the recommendation and would have a CT scan
    e. I would definitely accept this recommendation and would have a CT scan

Appendix F: Qualitative Research Question

Descriptive Open Ended Response
Please write-in your response to the following question
What is the most important factor that led you to make your decision regarding the CT scan? Please explain why.

_____

_____

What is the second most important factor that led you to make your decision regarding the CT scan? Please explain why.

_____

_____