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Technology Acceptance and Compliance in Obstructive Sleep Apnea Patients

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This is to certify that the doctoral dissertation by

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Abstract

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by

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MSM, Oakland City University, 2002

MSc, Arkansas State University, 1997

BSc, Arkansas State University, 1995

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

The focus of this study is the problem of declining trend in obstructive sleep apnea (OSA) patient compliance. Studies reported improved compliance in patients with chronic diseases due to technology-based interventions. However, researchers have not investigated the advantages of technology to improve the compliance of OSA patients in detail. The specific problem was the lack of engagement between patients and healthcare managers, resulting in low compliance within OSA patients. The purpose of this qualitative study was to evaluate how technology-based interventions can improve OSA patient engagement with the healthcare managers resulting in improved compliance with treatment procedures. In this study, the technology acceptance model was used as the instrument in evaluating the information collected through interviews with 20 healthcare managers about their attitudes toward usage, perceived usefulness, and perceived ease of use. The transcribed interviews were open-coded using the RQDA library in R Studio. In general, results from this study indicated that the healthcare managers showed a positive attitude towards the use of technology for patient engagement and expressed that the technology is useful for patient engagement and is easier to use. However, they identified technology-related and patient-related challenges in implementing technology for patient engagement. Further, the respondents identified process-related and patient-related opportunities in using technology for patient engagement. Results from this study have practice and policy implications by enabling healthcare managers to devise better compliance plans for OSA patient management. The findings could have a social benefit by helping healthcare managers to implement technology-based interventions to better achieve a higher compliance resulting in better patient health at lower costs.

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Dedication

In dedication to my father, Mr. Manzoor Karim Kidwai, and mother, Mrs. Zakia Kidwai, for making me who I am today, and my wife, Hanniya, son, Raafay, and my daughters, Miriam and Raania, for supporting me all the way.

Acknowledgments

It is with my deepest gratitude and warmest affection that I dedicate this dissertation to Dr. Anthony Lolas, who has been a constant source of knowledge and inspiration to me throughout this journey.

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Chapter 1: Introduction to this Study

Patient noncompliance due to reasons such as missed appointments, missed

medications, and noncompliance with doctors' advice costs the U.S. healthcare system

approximately $290 billion every year (Butler et al., 2017). In the absence of

intervention, there is growing evidence of possible increases in health care spending

because of patient noncompliance (Chernew & Newhouse, 2012). Noncompliant patients

have become a major concern of healthcare managers in regard to clinical intervention

outcomes (Serobatse, Du Plessis, & Koen, 2014). Patient noncompliance to prescription

drugs and daily-use medical equipment has increased negative treatment outcomes in

obstructive sleep apnea (OSA) management such as depression or even death, in addition

to posing additional healthcare challenges for management (Aloia, Arnedt, Strand,

Millman, & Borrelli, 2013). The quality of patient engagement is a major reason for

patient noncompliance in the field of chronic disease management (Health Quality

Ontario, 2017). Although various factors such as patient skills and effective patient

engagement affect patient noncompliance, it is imperative to motivate patients to be

treatment compliant and to educate the healthcare employees, supervisors, middle

managers, case managers, and clinicians to ensure treatment compliance among patients.

In this context, it is necessary to determine how the technology could be used to motivate

the OSA patients to ensure better healthcare management for improved treatment

compliance (American Academy of Sleep Medicine, n.d).

Achieving positive therapeutic outcomes for OSA, which is a chronic health

problem, is a challenge to healthcare managers due to patient noncompliance (Woods et

al., 2016). The noncompliance ratio among OSA patients can be as high as 66% (Sarrell, Chomsky, & Shechter, 2013) with relatively higher percentage among diabetics and cardiovascular patients who are at risk of fatality (Javadi, Jalilolghadr, Yazdi & Rezaie Majd, 2014). Patient compliance can be improved significantly with patient education and intervention with treatment patterns (Koseoglu et al., 2013). Modern technology such as mobile text messages can be used to improve patient compliance to treatment plans in chronic illness by sending timely reminders about their upcoming appointments and medications (Free et al., 2013). Prior research has found that using technology for increasing compliance can improve healthcare management of OSA patients because case managers and clinicians continue to struggle to improve patient compliance (Abbas, Al Fares, Jabbari, El Dali, & Al Orifi, 2015).

In this qualitative study, I used the technology acceptance model (TAM) to investigate how the healthcare managers can utilize the technology more effectively to improve the OSA patient compliance to treatment. The study involved examining the healthcare managers' attitudes toward technology usage, the perception of the usefulness of technology in OSA patient management, and perception of easiness of using technology for OSA patient engagement. The results from this study could be useful for healthcare managers to extend the scope of chronic disease management to better utilize technology for increasing patient compliance among sleep apnea patients, and thereby enabling healthcare-givers to devise efficient compliance plans for the management of sleep apnea patients.

Background of this Study

Patient compliance and adherence to treatment programs have been found to be determinant factors to achieving better therapeutic outcomes in many medical and clinical practices. Noncompliance can be a problem in more than 40% of chronic disease patients (AlGhurair, Hughes, Simpson, & Guirguis, 2012) and can lead to several negative health outcomes including an increased likelihood of hospitalization, a decline in quality of health, and an increase in potentially life-threatening events and even death (Brown & Bussell, 2011). Patient noncompliance remains one of the most critical challenges for healthcare managers in their efforts to avoid treatment failures (Kleinsinger, 2010).

Within chronic disease management, nurse-patient communication can improve through mobile phone technologies. Another efficient dimension of these technologies is text reminders for medication (Raphael, Waterworth, & Gott, 2016). As the application of mobile-phone technology improves, it can be useful to incorporate these innovations to enhance patient compliance in chronic disease management. Mobile-based telemedicine applications are feasible and efficient in chronic disease prevention and management. The applications have also been proven effective for proactive patient engagement and in making a decision about treatment protocols (Riley et al., 2011).

Use of electronic media such as e-mail, text messaging, and social media for patient education and communication is on the rise in the healthcare industry because the technology can help to modify behaviors related to chronic conditions, improve efficiency, and decrease healthcare costs (Ye, Rust, Fry-Johnson, & Strothers, 2010).

Bollig (2010) highlighted some of the critical aspects to enhance treatment compliance, along with the ways to collect and store critical information require further exploration of the methods to improve overall treatment compliance. Treatment compliance is dependent on the information provided to the patient through ongoing education, written instructions, demonstration, and timely reminders (Bollig, 2010). Although talk about patient-centered care is ubiquitous in modern health care, one of the greatest challenges of turning the rhetoric into reality continues to be routinely engaging patients in decision-making (Barry & Edgman-Levitan, 2012). The authors of several studies have suggested patient education is critical to patient compliance to treatment protocols (Hibbard, Greene, Sacks, Overton, & Parrotta, 2016).

Diabetic patients who were using mobile phone technology showed an improved compliance due to better management and positive behaviors (Holtz & Lauckner, 2012). The role of technology, however, is not solely about using mobile phones; patient web-portals can be also used. Guy, Ratzki-Leewing, and Gwadry-Sridhar (2012) evaluated the use of web-based patient portals for chronic disease management. They found that using a web-based patient portal such as web 2.0 technologies was useful for patient engagement and compliance. The patients showed a particular interest in accessing their medical records and communicating with healthcare staff, indicating that the information and communication technologies can increase patients' participation in clinical decisions and self-management (Stellefson et al., 2013).

Consistent patient support with uninterrupted remote monitoring for chronic diseases such as congestive heart failure, stroke, and chronic obstructive pulmonary

disease can be ensured using telemedicine interventions (Bashshur et al., 2014). The telemedicine interventions can be useful for reducing the healthcare cost through the reductions in hospital admissions and readmissions, the length of hospital stay, and emergency indoor visits (Bashshur et al., 2014). Thus, telemedicine interventions are cost-effective and clinically efficient to achieve the desired outcomes from the healthcare plans developed by the healthcare managers. OSA can be either in the form of apnea, where breathing interruption can be 10 seconds or more (Mbata & Chukwuka, 2012), or hypopnea, where the interruption is less than 10 seconds (Salles, Campos, Andrade, & Daltro, 2005). The consequences of OSA include diabetes, cardiovascular disease, and, more seriously, premature death (Al Lawati, Patel, & Ayas, 2015).

The preferred treatment for OSA is the use of continuous positive airway pressure (CPAP), which is a device that forcibly opens the airway (Mbata & Chukwuka, 2012). Other optional treatments for OSA include variable positive airway pressure, nasal expiratory positive airway pressure, automatic positive airway pressure (auto-CPAP), and use of oral appliances or splints. However, compliance to CPAP is the most critical factor in the management of OSA patients. Even though technology-based interventions have been proven effective for compliance of OSA patients to CPAP (Weaver & Sawyer, 2010), case managers and clinicians continue to struggle to improve patient compliance. CPAP therapy compliance is essential to treat patients with OSA. Isetta et al. (2014) reported that OSA patients could benefit greatly from a telemedicine approach for CPAP therapy management. Technology can be a source of motivation for healthcare management to increase patient engagement, resulting in enhanced patient compliance.

Patient compliance can be improved through the use of various technologies (Giger et al., 2015). For instance, monitoring of CPAP is possible even from remote areas without allocation of dedicated staff (Schwab et al., 2013). This task involves implementing auto-CPAP by optimizing the virtual environment for the patient, transmitted telematically along with teleconsultation virtual forums. Coma-Del-Corral et al. (2013) studied 40 patients with sleep apnea to determine the efficiency of information technology in sleep apnea management. They contrasted conventional and contemporary techniques by employing virtual environments for compliance to CPAP. They found that technology such as auto-CPAP could be useful for both diagnostic and therapeutic compliance by developing a virtual sleeping environment and remote monitoring of the patients. Virtual scanning technology has been shown to be reliable for sleep apnea management without causing any interruption in patients' sleep (Angelini et al., 2013). The interactive computer technology can be beneficial for accurate diagnosis and therapeutic management of sleep apnea patients from a distance, suggesting that the technology can be used effectively for improving sleep apnea management (Pauwels, Buist, Calverley, Jenkins, & Hurd, 2012).

For CPAP therapy management, telemedicine is considered to be an effective intervention since it is helpful for improving compliance rates among sleep apnea patients and could also be effective in reducing follow-up visits through teleconsultation. Isetta et al. (2014) investigated the efficiency of teleconsultation among 50 sleep apnea patients by examining whether the OSA patients trained in a face-to-face session demonstrated better knowledge than those trained through video conferencing. The authors found that

95% of the patients were satisfied with teleconsultation, while 66% of the patients indicated that teleconsultation could cause a reduction in their follow-up visits by 50% to 100%. There was also no statistically significant difference in knowledge acquisition between those trained face-to-face and those trained through video conferencing. These study results indicated that the management of sleep apnea patients could be improved by integrating the teleconsultation better into clinical practice and educating the OSA patients virtually. This ultimately could reduce the costs of healthcare due to reduced follow-up visits and better education of patients.

Wireless telemonitoring is another paradigm integrated with information technology for improving sleep apnea management. In a pilot randomized trial, Isetta, Ruiz, Farré, and Montserrat (2015) compared traditional clinical care and wireless telemonitoring of CPAP and investigated their respective effects on compliance and treatment efficacy. They found that the telemonitored patients demonstrated significant improvement in their compliance and treatment outcomes and this collaborative management was more efficient than the traditional sleep apnea management. The patients who received telemonitoring care indicated a higher probability of using CPAP than those who were under regular clinical care. The use of CPAP was significantly higher among the telemonitored patients than those receiving traditional clinical care. The telemonitoring care has clinical and economic benefits for sleep apnea management since the clinical sleep team could monitor the patient swiftly through telemonitoring. Better treatment outcomes due to telemonitoring care can improve the experience of sleep apnea patients.

The auto-adjusting positive airway pressure is also a technology-centered mode of treatment for sleep apnea patients. In comparison of this treatment with traditional treatments such as positive airway pressure and CPAP, an improved sleepiness was observed in patients using auto-adjusting positive airway pressure technology, while there was no statistically significant difference for traditional modes of treatment (Berry & Sriram, 2014). The effectiveness of auto-adjusting positive airway pressure is because of the availability of accurate information about the clinical status of the patient along with adequate results from the home sleep test. The auto-adjusting positive airway pressure also improved short-term compliance to monitoring for sleepiness, which Berry and Sriram (2014) argued was a predictor of long-term compliance.

Traditionally, a variety of interventions have been used to improve compliance among OSA patients. CPAP compliance is critical to effective treatment outcomes in sleep apnea disease; however, a significant number of OSA patients have been found to be noncompliant. Sarrell et al. (2013) found that 66% of sleep apnea patients were noncompliant to their CPAP treatment. CPAP devices have been integrated with technological advancements to continuously provide the support for patients without any interruption, even for those from remote areas (Weaver & Sawyer, 2010). The patient compliance to sleep apnea treatment is of a concern to the management because it requires efficient decision making based on the background information about patients and the treatment approach suitable to their attitudes and behaviors. For example, the effectiveness of a telemedicine approach for sleep apnea patients depends on the patient's

acceptance. Thus, the needs and satisfaction of the patient should be the base for selecting the treatment approaches.

With auto-titrating, the goal is to improve compliance by improving the comfort of the patient (Ip et al., 2012). This systematic review indicated that auto-titrating could increase patient compliance by 11 minutes per night over CPAP. Such technological interventions are vital to increase patient compliance. The arena of chronic disease management is facing challenges due to increasing trends of noncompliance. Higher noncompliance among OSA patients results in negative treatment outcomes. Health managers, medical clinicians, providers, and case managers need to use modern technologies to improve patient compliance in a cost-effective and efficient manner. Chapter 2 presents the outcome of a detailed literature review.

Problem Statement

The general problem is that patient noncompliance alone costs the U.S. healthcare system approximately $290 billion (Butler et al., 2017). In OSA management, patient noncompliance to prescription drugs and the daily-use of medical equipment has increased negative treatment outcomes such as depression or even death, and it is also a significant healthcare challenge for healthcare managers (Bosworth et al., 2016). The specific problem was the lack of engagement between patients and healthcare employees, supervisors, middle managers, case managers, and clinicians results in low rates of patient compliance with OSA patients (Kaskie, Graziano, & Ferrarelli, 2013). However, technology has the potential to improve patient engagement and treatment compliance (Bosworth et al., 2016; Sosa et al., 2017). Therefore, it is imperative to investigate

utilising the technology effectively to improve the patient engagement with healthcare managers to reduce patient noncompliance. For effective patient engagement, it is imperative for healthcare employees, supervisors, middle managers, case managers, and clinicians to ensure they take the necessary steps to promote treatment compliance among patients. A role of management is to ensure that the healthcare managers take the necessary steps toward the use of the technology to ensure increased patient compliance; therefore, it is critical these managers understand the attitudes and perceptions of the healthcare managers regarding the use of technology. In this context, it is necessary to determine how technology could be used to motivate the OSA patients to ensure better healthcare management for improved treatment compliance.

Purpose of the Study

The purpose of this qualitative study was to evaluate how technology-based interventions used by healthcare managers can improve patient engagement with the healthcare managers as well as patient compliance to treatment procedures in OSA disease management. This study was conducted from the healthcare managers' perspective by focusing on their attitudes and perceptions toward using technology for patient engagement that could lead to better treatment outcomes. In this qualitative study, I utilized the TAM to investigate how the healthcare managers can deploy the technology effectively to improve the OSA patient compliance to treatment. This study involved examining the healthcare managers' attitudes toward technology usage, the perception of the usefulness of technology in OSA patient management, and perception of ease of use technology for OSA patient engagement. The results from this study can be useful for the

healthcare managers to extend the scope of chronic disease management to better utilize technology for increasing patient compliance among sleep apnea patients, and thereby enabling health healthcare managers to devise efficient compliance plans for the management of sleep apnea patients.

Research Questions

In this study, the following research questions helped to provide an understanding of the attitudes and perceptions of the healthcare managers toward employing technology-based interventions to improve compliance among OSA patients. The general research question was: What are the attitudes and perceptions of healthcare managers toward employing technology-based interventions to improve treatment compliance among OSA patients? Specifically the RQs were:

RQ1a: What are the attitudes of healthcare managers toward the use of technology in OSA patient engagement that could lead to improved treatment compliance?

RQ1b: What factors are responsible for the attitudes of healthcare managers toward the use of technology for OSA patient engagement that could lead to improved treatment compliance?

RQ2a: What are the perceptions of the healthcare managers about the usefulness of the technology to engage with the OSA patient for improved treatment compliance?

RQ2b: What are the challenges and opportunities that the healthcare managers perceive in making technology useful for OSA patient engagement that could lead to improved treatment compliance?

RQ3a: What are the perceptions of the healthcare managers about the ease of using technology for the OSA patient engagement that could lead to improved treatment compliance?

RQ3b: What are the challenges and opportunities that they perceive in making technology easier to use for OSA patient engagement that could lead to improved treatment compliance?

Answers to these research questions may enable healthcare providers to devise efficient compliance plans for the management of sleep apnea patients. This may help a wide range of healthcare managers, for example, program managers, case managers, and clinicians, to implement technology-based interventions that could lead to a higher level of patient compliance. Because I focused primarily on perceptions and attitudes, there were no null or alternative hypotheses in this study.

In this study, I collected the perceptions and attitudes of healthcare managers involved in treating OSA patients and who were located in the Indianapolis, Indiana, area through semi structured interviews that consisted of open-ended questions. I evaluated this information for technology acceptance among healthcare managers and their perceptions about the impact of technology on patient compliance. The research questions pursued in this study were helpful to understand the attitudes and perceptions of healthcare managers toward the use of technology for patient engagement. Thus, the outcomes of this study can be useful for effective implementation of technology-based interventions to enhance the treatment compliance in the management of chronic diseases such as OSA.

Conceptual Framework

In the TAM, perceived usefulness and perceived ease of use are the determinants to evaluate the intention of an individual to use a system (Davis, Bagozzi, & Warshaw, 1989). The TAM is supported by four major factors that are interconnected. These factors include perceived usefulness (PU), perceived ease of use (PEOU), attitudes toward usage (ATU), and behavioral intention to use (BITU) the technology (Shroff, Deneen, & Ng, 2011). The definition of PU is that an individual's perception that a system could affect their job performance, while PEOU is the perception that using the system could be free of effort. The individual's judgment of the target behavior is captured by ATU, while BITU is the motivation to perform the target behavior (Holden & Karsh, 2010).

In previous studies, TAM has been used extensively to investigate the efficiency of different technologies in diverse settings and for ranging target populations. Arning and Ziefle (2009) evaluated the role of technology for improving compliance by investigating TAM against technology acceptance among chronic disease patients. They specifically investigated the effects of age and gender on the individual's use of technology and found that the participants generally had a positive attitude towards the use of technology in the health field. Participants also believed that the technology was useful, especially in keeping them updated on their health status and in timeliness.

Venkatesh, Davis, and Morris (2007) proposed TAM originally based on the social psychology theory of reasoned action. Davis et al. (1989) applied this model when they compared social theory with TAM. Another theory that was relevant to this research study is innovation diffusion theory (Lee, Hsieh, & Hsu, 2011); however, TAM is a better

model because it provides the appropriate framework for investigating the research questions outlined in Chapter 1.

TAM is an efficient predictor of technology acceptance among users of diverse technologies and the original works by Davis and colleagues have been cited more than a thousand times (Legris, Ingham, & Collerette, 2003). In a recent study, Holden and Karsh (2010) reiterated that TAM is a significant predictor of technology acceptance and use, particularly in the context of information technology (IT) in healthcare. From the perspective of electronic health records, TAM is predominantly used to determine the perceptions of healthcare IT users concerning the acceptance or use of IT related solutions (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012). TAM is the most appropriate theory in the contexts of healthcare management and information technology (Thornton & Beilfuss, 2016).

The technology acceptance among targeted users is critical to determine how effectively an organization is aiming to use IT-based solutions in disease management. When health professionals evaluated the technology acceptance for telemonitoring, Gagnon et al. (2012) found that TAM would be the most appropriate framework for studying technology acceptance among the target users. Since health professionals were the focus of this study, TAM was proven to be effective in evaluating their intention to use telemonitoring. Their PU was determinant to their intention of using telemonitoring in healthcare organizations, suggesting that technology acceptance is contingent upon the PU and PEOU for a particular technology. This concept is related also to the management

perspective in healthcare because the technologies installed for disease management are required to be used effectively for achieving the desired results.

In a recent study, Abdekhoda, Ahmadi, Dehnad, and Hosseini (2014) demonstrated that the TAM could be applied successfully to assess the user acceptance of health information management systems. The researchers found that PU and PEOU were important determinants for user acceptance of information technology. Or and Tao (2014) indicated that the consumer behaviors and attitudes to use health information technology (HIT) are critical to the evaluation of health management strategies. With an increase in the HIT, particularly in chronic disease management, the determination of a health consumer's intention is significant for measuring the efficiency of technology. While studying the behavioral intention, Kim and Park (2012) found that the health consumer's health status, health knowledge, and HIT features and efficiency influenced their perceptions of usefulness and ease of use along with their perceptions of threat about the technology. Also, the TAM was found to be an apt theoretical framework to investigate the factors such as PU and PEOU among the health consumers, enabling the researchers to consider the social and cultural background of health consumers, which are important in evaluating the perceptions of any target community by avoiding bias. I utilized the TAM model as a theoretical framework for the qualitative study to examine the attitudes and perceptions of the healthcare managers in using technology for improvement in OSA patient compliance.

Nature of the Study

In this qualitative study, I interviewed healthcare managers to examine their attitudes and perceptions of using technology for the improvement in chronic disease management for OSA patients. In the study, a cross-sectional research design was an adequate research method since the purpose was to target the current attitudes and perceptions of selected healthcare managers about the technology for patient engagement. In this study, I examined the ATU, PU and PEOU among the healthcare managers. The constructs used by TAM theorists are the basis for the healthcare managers' perceptions of usefulness, their perceptions of ease to use technology, and ATU discussed in detail in Chapter 2.

The target study population comprised of 20 purposively selected healthcare managers to represent the total population from health facilities specializing in treating OSA and located in the Indianapolis, Indiana and surrounding states area.

Definitions of Terms

The definitions of key terms are listed below:

Perceived ease of use (PEOU): The degree, to which a healthcare manager believes that using technology would be free of cognitive effort (Holden & Karsh, 2010).

Perceived usefulness (PU): The degree, to which a healthcare manager believes that using technology would enhance OSA patient compliance (Holden & Karsh, 2010).

Attitudes toward usage (ATU): The degree, to which a healthcare manager judges that using technology will be beneficial to compliance (Holden & Karsh, 2010).

Behavioral intention to use (BITU): The degree, to which a healthcare manager is motivated to use technology (Holden & Karsh, 2010).

Technology acceptance model (TAM): A method to show that a person's intent to use a system can be determined by the system's PU and PEOU (Legris et al., 2003).

Assumptions

There were three major assumptions for the research study. The primary assumption in the study was that the sample of healthcare managers selected for this study was an accurate representation of the intended sample population and was sufficient in answering the research questions. Healthcare managers, who did not provide accurate portrayals of their perceptions during the interviews can introduce errors into the subsequent analysis. However, the assumption of this study was that the information provided by the healthcare managers was authentic and accurate. Another assumption of this study was that the results from the OSA patients getting treatment in health facilities specialized in treating OSA and located in the Indianapolis, Indiana area was representative to the other health facilities specializing in other chronic diseases.

Scope and Delimitations

I selected the participants for this study from healthcare managers from health facilities specialized in treating OSA and located in the Indianapolis, Indiana area. In this study, I focused on the attitudes and perceptions of using technology for OSA patient engagement and its impact on their compliance in these particular health facilities. I did not investigate in this study about the perceptions of OSA patients in the use of technology in chronic disease management. Future longitudinal research could include a

survey to collect the primary data to observe the changes in perceptions of the healthcare managers over time.

Limitations

Lack of research in sleep apnea management with technology from the perspective of healthcare managers limited comparisons to other studies. The potentially small sample size was a limitation to generalize the outcomes of this study and to conduct the reliable analysis. In addition, the sample collection was restricted to healthcare managers from Indianapolis, Indiana. Therefore, the results obtained from this study were based on the information obtained from the healthcare managers from this state and demographics. Therefore, the application of the findings to healthcare managers from other states could be limited.

Significance of Study

Significance to Business Practice

In this study, I evaluated technology-based interventions within chronic disease management. A relationship between technology-based interventions and better compliance management pertinent to OSA patients could help healthcare managers, program managers, case managers, and clinicians to achieve a higher level of patient compliance. The results of this study demonstrated the attitudes and perceptions of the healthcare managers on the implementation of technology-based interventions and consequent improvement in patient compliance. This study results indicated that healthcare managers benefit from technology-based interventions and enhance patient compliance. With the successful implementation of technology, healthcare managers can

devise more effective compliance plans that remain crucial for achieving better management of chronic diseases. The outcomes of this study are generally useful in improving chronic disease management and specifically OSA management (Nguyen et al., 2013).

Significance to Positive Social Change

Several researchers in their recent studies demonstrated the life-threatening implications of OSA including cardiovascular disorders, type-2 diabetes, hypertension, metabolic syndromes, depression, and even death (Maduka & Obin-West, 2013). Patient compliance is, therefore, critical to their health and life. The information derived from this study provides healthcare managers with a better approach in providing guidance to clinicians, providers, and case managers in their engagement with patients to ensure a higher rate of compliance.

Patient non-compliance alone costs the U.S. healthcare system approximately $290 billion nearly every year recently (Butler et al., 2017). Rising health care cost is an unnecessary burden on the lower income families (Chernew & Newhouse, 2012). State governments are affected by rising health care costs, which may lead to funding cuts to education and social services, further burdening lower income families (Kalman, Hammill, Schulman, & Shah, 2015; Willeme & Dumont, 2015). The results of the study may enable healthcare managers to reduce healthcare costs and thereby avoiding the negative social consequences discussed above.

Summary

Patient noncompliance with prescription drugs and daily-use medical equipment has increased negative treatment outcomes in OSA management, such as depression or even death. It also poses significant healthcare challenges for management. The purpose of this qualitative study was to evaluate how technology-based interventions used by healthcare managers can improve patient engagement with the healthcare managers as well as patient compliance with treatment procedures within OSA disease management. To achieve this objective, I used the TAM to investigate how the healthcare managers can utilize the technology effectively to improve the OSA patient compliance to treatment through interviews among selected healthcare managers. The findings from this study may be useful to improve OSA management and chronic disease management, which in turn could improve patient outcomes and reduce health care costs. Chapter 2 is a review of the current literature.

Chapter 2: Literature Review

Introduction

This chapter presents a narrative review of the literature on patient engagement and motivation toward the realization of cure-oriented care through patient engagement on OSA. In this chapter, I also discuss the methodology adopted to conduct the literature review. The literature review includes an explanation of the review type, the strategy used for literature search, criteria used to select relevant papers (study selection criteria), criteria for data extraction, documentation of criteria for data synthesis, characteristics of the study, and documentation of quality appraisal criteria.

The narrative review of the literature includes a discussion on the information systems and how they support processes of care: the OSA patient engagement and motivation, critical success factors of information systems for improving the efficiency of processes of care with the emphasis on patient engagement, various implemented models, deficits of different approaches to patient engagement, and findings from recent studies on OSA patient engagement with information systems. To form and establish terms of reference for other literature, I considered objective and subjective OSA patient engagement in the review with the focus on the rationale and motivators for OSA patient engagement. The review includes the determinants of patient engagement and their contribution to OSA health outcomes along with the key quality indicators that are relevant to the objectives of this study.

I used the narrative analysis in this review to determine the effectiveness of technologies in OSA management and to identify the factors affecting the success or

failure rate of different technologies for patient engagement. I also used the narrative review to identify current gaps in knowledge in the application of technology for OSA management.

Literature Review Areas

The literature review consisted of the following areas:

- current knowledge status of OSA technological patient engagement and TAM over the past five years;

- key themes from literature on the use of technology (TAM) towards promoting OSA patient engagement;

- knowledge gaps in the use of technology towards supporting OSA patient engagement, if any; and

- recommendations for future research from the gaps in literature.

Methodology of the Literature Review

Type of Review

I used the narrative synthesis approach developed by Popay et al. (2006) in this review because systematic review methods are incorporated in this approach to produce a narrative summary. A narrative synthesis leads to a methodological review and synthesis of knowledge from a number of different studies (Popay et al., 2006, p. 44). Popay et al. also indicated that the studies are summarized along with the explanation of the findings in the narrative synthesis (p. 45). Thus, I used narrative analysis for the current literature review because it facilitates a narrative style by telling a story based on the knowledge gathered by asking a number of questions during the literature review (Popay et al., 2006,

p. 48). Furthermore, there is a difference in comparison to narrative synthesis because the focus is primarily on how transparent and relevant the guidance is to the literature review (Popay et al., 2006, p. 48). Two important competencies are the basis for the use of narrative synthesis. Firstly, the process is significantly large, and it has a methodical approach to finding and extracting relevant information and evidence with the required quality (Popay et al., 2006, p. 49). Secondly, application of narrative synthesis includes the ability to apply criteria to search literature, select relevant studies, extract relevant data, synthesize data, identify the characteristics of the study, and appraise the quality of selected studies. The following sections provide a summary of the criteria used for narrative synthesis

Literature Search Strategy

I implemented an initial literature search strategy to locate primary studies and papers published between 2010 and 2015 and focused on the concept or use of technology towards OSA patient engagement and TAM and its four perspectives. I used multiple databases including Science Direct, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Web of Knowledge, and Google Scholar for the literature search. The main terms used for the search were selected along with the related synonyms and descriptors. The key terms used in the search were *technology acceptance model in patient engagement, TAM perceived usefulness in patient engagement, TAM perceived ease of use in patient engagement, chronic disease management, sleep apnea management, patient compliance, technology management, patient engagement,*

healthcare management, TAM behavioral intentions in patient engagement, and *TAM attitudes in patient engagement.*

Inclusion and Exclusion Criteria

I initially identified a total of 147 papers as relevant to the study. I narrowed this number to 109 based on a set of criteria for inclusion and exclusion. I conducted another search for literature using nonelectronic sources, for example, manual searching of journals (Armstrong, 2012). In this second search, I identified 51 papers, which I similarly filtered to 23 papers. Finally, 132 papers were selected, and their quality was appraised.

Criteria for Data Extraction

I used the criteria for extracting data that were part of the literature review protocol used in this study as the basis in developing review questions and inclusion criteria, formulating a search strategy, selecting studies to review, developing an approach to assess the quality and criteria for synthesizing the data, and disseminating the review findings. The data extraction technique was predetermined to reduce the bias when reviewing the literature. The strategy used for extracting the data included keywords used for the review synthesis and analysis. The key parts used for extracting the data were:

- details related to administration;

- aims and justification;

- study research question(s) and policy or practice focus;

- methods, including design, groups, sampling strategy, recruitment and consent, actual samples, data collection, and data analysis;

- results and conclusions;

- reporting quality, quality of methods, and data quality;

- review of specific questions; and

- review of the record.

The data extraction strategy and criteria were the basis for coding, which was used for the selecting papers for review based on parameters such as quality, trustworthiness, and relevance to this study. Data extraction criteria were useful in the synthesis of literature and for following the data extraction guidelines defined above. The data extraction strategy and criteria used standardized question framework. In addition, the data extraction criteria were focused more on concepts as opposed to empirical statements, resulting in the data extraction supporting narrative and statistical synthesis.

Data Synthesis Criteria

Data synthesis that was used in this study satisfied the requirements for narrative synthesis and statistical synthesis. The data from the quality appraised papers were synthesized using meta-analysis and mainly included narrative analysis, while partly including statistical synthesis. However, it is worthy to note that narrative synthesis is unable to specify the synthesis details beforehand because the approach was designed to be dependent on papers that were available for review. Consequently, narrative synthesis is restricted depending on how meta-analysis was planned, heterogeneity, and whether the random effect model was used or not. The synthesis of data also included bias

determination, analysis of the sensitivity, clear definition of synthesis outline, and specifying the outcomes as per quality appraisal.

Study Characteristics

I defined the characteristics of this study based on the literature search scope and the ability to achieve the research objectives. The characteristics of this study needed to fulfill the guidance developed by Dixon-Woods, Agarwal, Jones, Young, and Sutton (2005). As per the guide, the papers should be graded according to the following key criteria: aims and objectives, the design of research, methodology, findings, and interpretations and conclusions.

Appraisal of Quality

The guidelines proposed by Dixon-Woods et al. (2005) were used to analyze all of the 132 selected studies to appraise their quality. Though "poorer" studies are not excluded through this approach, it gauges the overall quality of papers by analyzing quantitative and qualitative studies together as per their criteria. One point was allocated if each of the above criteria was present, and the quality of a paper was determined based on a score out of five. The studies with the highest score were selected for the final review. A score of three was given if a paper did not have a clear discussion of the methodology such as sampling methods and instrument used, while a score of four was allocated if there is no clear explanation of results. A score of five was given if the paper met the requirements for clarity of study aims, methods, and findings. Consequently, a total of 81 papers were finally selected for this review.

Apart from using the Dixon-Woods et al. (2005) methodology, a primary study

was further selected if it had been peer-reviewed and if it consisted of data triangulation,

methodological triangulation, and theoretical triangulation. These criteria validated the

use of 81 papers selected using the criteria of Dixon-Woods et al. (2005). In addition to

the failure to satisfy the Dixon-Wood et al. (2005) methodology, a primary study was not

included if the research questions were not adequately answered in the article regardless

of the time of publication. The study was also excluded if it did not satisfy the

requirements for triangulations between theory, goals, and conclusion. Studies with

similar findings or follow up studies of a particular primary research were also excluded.

Out of a total of 198 primary studies, 107 papers were excluded from the review.

Role of Information Systems in Patient Engagement

Information systems are an integral part of the performance of an organization

because they assist in the development of positive relationships between stakeholders

such as customers, managers, partners, and executives (Gaines, Hoover, Foxx, Matuszek,

& Morrison, 2012). As the organizational relationships are critical to have competitive

advantage, information systems are important to have the environment of accessibility.

Gaines et al. (2012) suggested that information systems could not be avoided in

healthcare management, where customer satisfaction is important for the sustainability of

the business.

While explaining the cause and effect relationship between trends and changes in

the recent business environment, Hernaus (2011) argued that the global trends affect and

shape the industries worldwide. Hernaus (2011) also recognized that the trends remain

the key drivers of changes in any organization and are applicable in both theory and practice to define the current business environment. The major trends that have been responsible for reshaping and changing the organizations and industries include:

- globalization,

- competitiveness,

- diversity,

- flexibility and adaptability,

- information technology,

- outsourcing, and

- knowledge economy.

Globalization encompasses political, socioeconomic, cultural, and environmental changes that cause the development of new business trends. As businesses are conducted beyond the borders, globalization is the key element for introducing changes in the organizations (Hernaus, 2011). The role of management is critical as leadership may need to think more strategically about their customers and the global economy (Dragoni et al. 2014). The diversity of modern workplaces is another driver of change in organizational behavior and is thus a source of market-push innovation. The organizational structures must be flexible enough to adapt to global changes. In any century, the role of technology is crucial to achieving organizational objectives.

Mergers and acquisitions are increasing in popularity because with added customer value, organizations can outsource work to other organizations that are excellent in performing certain tasks. Hernaus (2011) highlighted that the knowledge

economy is another trend that has become vital for business success because with the introduction of information technology, it has become an immense source of global competitiveness. In the following section of this literature review, I discuss the role of technology in chronic disease management with a particular focus on OSA, followed by a discussion on the TAM. The section on TAM provides justification for using TAM as the theoretical framework for this study.

Role of Technology in Chronic Disease Management

In a systematic literature review, Gaikwad and Warren (2009) evaluated the role of home-based informatics and technology-based interventions for patient engagement. In this review, they demonstrated that the technology-based interventions in chronic disease management, irrespective of chronic disease type, were found to improve functional and cognitive treatment outcomes in addition to reducing healthcare costs. In another review, Polisena, Coyle, Coyle, and McGill (2009) reported the same finding when they evaluated the economic outcomes of telehealth in chronic disease management. They suggested that telehealth could reduce healthcare costs from insurance provider perspectives. However, further scientific research was recommended by these literature reviews to determine the role of technology in chronic disease management.

The consistent increase in chronic diseases across the United States demonstrates the negative treatment outcomes in primary health care (Mulvenon & Bowman, 2015). They have further highlighted that this negative trend is a serious challenge for healthcare management. Mulvenon and Bowman (2015) further expounded that ineffective patient engagement is a predominant cause of inefficient chronic disease management. As one in

every three adults in the U.S. could have diabetes by the year of 2050 (American

Diabetes Association, 2013), the need for robust and efficient chronic disease

management is even more important. Mulvenon and Bowman (2015) proposed a chronic

care model for effective management to reduce the growing threat of illness. The model

was based on proactive patient engagement with technology-based interventions and a

patient-centered approach. The technology-enabled interactive systems may result in

quality care with lower cost.

In addition, Ökem (2015) argued that an integrated approach is the immediate and

sustainable strategy in chronic disease management to address the increasing burden on

the U.S. healthcare system. Based on the evaluation of different integration strategies

across Europe and the USA, they recommended the use of information and

communication technologies (ICT) in healthcare to improve chronic disease

management. The electronic health records and web-based portals can be used effectively

for managing patients with chronic diseases (Talboom-Kamp, Verdijk, Harmans,

Numans, & Chavannes, 2016). For this purpose, various eHealth and telemedicine

approaches are found to be effective integration strategies in chronic disease

management. Thus, technologically advanced integration strategies need to be embedded

in the U.S. healthcare system to strengthen chronic disease management (Graffigna,

Barello, Bonanomi, & Menichetti, 2015).

Interactive voice response (IVR) systems have been used in the treatment of

patients with chronic health problems such as heart failure, diabetes, hypertension, and

mental health disorders (Piette et al., 2012). Piette et al. (2012), Ökem (2015), and

Embuldeniya et al. (2013) suggested that IVR-supported chronic illness management can lead to positive treatment outcomes in addition to being beneficial for promoting healthy behaviors. Embuldeniya et al. (2013) also highlighted the growing need for automated systems that can survey patients and consumers about their health and the need for promoting health education and behavior change interventions using a natural language dialog. These automated systems are important for patient education and behavioral change and may be beneficial to persuade them to accept technology for enhanced compliance. The rising popularity of technology in chronic disease management can be because ICT is utilized for developing healthcare networks and electronic health records to facilitate healthcare management, and to make informed and timely decisions (Gagnon et al., 2012). The common uses of ICT include home monitoring of patients with chronic diseases, replacing personal visits of nurses with telemedicine, sending text reminders along with access to daily healthcare plans, and education.

Recently, investments in technological acquisitions have increased in business organizations. The strategic management tools in the companies have been integrated with the IS to gain competitive advantages. This is an indication of the capability of IS such as efficiency, effectiveness, and strategic alignment (Dulebohn & Johnson, 2013). The implementation of IS has transformed significantly over time. Previously, the primary function of IS was strategic management support; however, it has now emerged as a primary tool to develop a sustainable competitive advantage. Organizations face difficulties to be up-to-date with the current developments in the technological arena, and to employ people with required skills to work on IS. In the context of the crucial role of

IS in the performance of the organizations, the stakeholders, managers, and partners need to recognize the IS, and its importance in the business(Gaines et al., 2012).

Xu and Quaddus (2013) found that IS establishes the trust between customers, and organizations, leading to utmost loyalty from customers. It also develops new relationships and partnerships due to the implementation of management systems. IS can be instrumental to develop business systems that is productive if it can develop relationships with distributors, and suppliers. A good example is the relationship of Amazon with Google, Apple, and Facebook in the e-commerce industry (Manjoo, 2016).

Since organizational IS and business strategy are interdependent for achieving strategic advantages (Cui, Ye, Teo, & Li, 2015), both domains need to be strategically and functionally aligned. In addition, the interdependency between both domains needs to be considered when introducing organizational changes that are strategically important. The strategy formulation theory is useful to develop configurations for organizations to change the strategies. The structure of an organization becomes coherent and aligned with the desired outcomes, by aligning the IS externally and internally across the domains.

The recognition by top management about the critical role that IS plays in current business environments has led to the implementation of IS in organizations (Hemmatfar, Salehi, & Bayat, 2010). The use of integrated IS improved the external and internal relationships leading to improved relationships with customers, suppliers, and stakeholders. The uses of IS in an organization are many, including planning of

resources, change management, cost effectiveness, and improved relationships. IS can also facilitate improved efficiency of the operations of frontline managers.

IS can also have impacts on organizations, and behaviors (Dinter, 2013). IS can facilitate quicker information flow, leading to effective decision making and improved relationships. Sustainable competitive advantage can result due to the improved relationship between the leaders of the organization and the employees. Use of IS can also improve the relationship of a supplier with the customers, resulting in positive outcomes, and efficiency (Shafiq, Johnson, Klassen, & Awaysheh, 2016). It is worthy to note that a synchronized business model can be developed by combining business, and IS strategies (Jafari, 2014). For example, a collaborative culture in an organization can be achieved through strategies focused on customers along with certainty about the IS strategy, according to the contingency theory (Ismail & King, 2014).

Within chronic disease management, mobile phone technologies are used for improving nurse-patient communication (Wang et al., 2014). Another efficient dimension of these technologies is text reminders for medication. As an application of mobile-phone technology improves, it can be useful to incorporate these innovations to enhance patient compliance in chronic disease management (Logan, 2013). Mobile-based telemedicine applications have been endorsed for their feasibility and efficiency in chronic disease prevention and management. The applications have also been proven effective for proactive patient engagement and in making decision about treatment protocols (Riley et al., 2011).

Use of electronic media, such as e-mail, text messaging, and social media for patient education and communication, are on the rise in healthcare industry since the technology can help to modify behaviors related to chronic conditions, to improve efficiency, and to decrease healthcare costs (Ye et al., 2010). Bollig (2010) highlighted some of the critical aspects to enhance treatment compliance, along with the ways to collect and store critical information required to further explore the methods to improve overall treatment compliance. Treatment compliance is dependent on the information provided to the patient through ongoing education, written instructions, demonstration, and timely reminders (Bollig, 2010).

Diabetic patients, who were using mobile phone technology, showed an improved compliance due to better management and positive behaviors (Holtz & Lauckner, 2012). The role of technology is not solely confined to mobile phones; however, it is also complemented with patient web-portals. The use of web-based patient portal for chronic disease management was evaluated by Guy et al. (2012) in their recent study. Guy et al. (2012) found that using a web-based patient portal such as web 2.0 technologies was useful for patient engagement and compliance. The patients showed a particular interest in accessing their medical records and communicating with healthcare staff, indicating that the information and communication technologies can increase patients' participation in clinical decisions and self-management.

Consistent patient support with uninterrupted remote monitoring for chronic diseases such as congestive heart failure, stroke, and chronic obstructive pulmonary disease can be ensured using telemedicine interventions (Bashshur et al., 2014). The

telemedicine interventions can be useful for reducing the healthcare cost through the reductions in hospital admissions and readmissions, length of hospital stay, and emergency indoor visits (Bashshur et al., 2014). This indicates that telemedicine interventions are cost-effective and clinically efficient to achieve the desired outcomes from the healthcare plans developed by the healthcare managers.

After the recent healthcare reforms in the United States, many healthcare providers across the country are taking the necessary steps to increase the access of people to quality services. This is typically done through the integration of highly efficient chronic disease management approaches; however, the healthcare system could come under tremendous pressure with the recent increase in the number of insured patients in the United States (Bauer, Thielke, Katon, Unützer, & Areán, 2014). In this context, there is a strong need for effective technology to ensure satisfactory chronic disease management.

Health information technology (HIT) is an example of using the technology effectively for chronic disease management (Nieboer, Van Hoof, Van Hout, Aarts, & Wouters, 2014). The state-of-the-art hardware and software are used in HIT for archiving, accessing, processing, and disseminating patient data for effective care delivery, and disease management and intervention. Due to massive progress in the consumer health market, diverse ranges of applications are available to both care providers and receivers to ensure effective disease monitoring, management, and treatment intervention. Apart from the Electronic Health Records, which is an information system that is significantly improving care delivery and management, there

are several mobile health applications available for mobile phones, tablets, and laptops (Bauer et al., 2014). Though comprehensive research evidence supporting the efficacy of mobile health applications in chronic disease management is not available, consumers use widely some applications, such as MyFitnessPal LLC, in the United States (Bauer et al., 2014). As a consequence of rapid developments in the mobile health applications, it is now possible to increase the outreach of standard chronic disease management and intervention programs among underprivileged and remote populations.

While the potential of improving chronic disease management through modern information and communication technology paradigms is immense, it is important to investigate the factors that can reduce their positive impacts. Bauer et al. (2014) found that the availability of a large number of mobile health applications did not guarantee efficient chronic disease management. A significant fraction of the society, such as the elderly and the underprivileged, may not have the means and the knowledge to use modern technologies, while communities in the remote regions may not even have access to the latest developments. Other factors, such as cognitive inabilities, can prevent proper use of the technology for disease management. However, studies conducted in controlled environments indicated that modern communication technologies, including the internet, were used by individuals with cognitive impairment without any effect on chronic disease management (Ben-Zeev et al., 2013; Druss, Ji, Glick, & von Esenwein, 2014). Strong research evidence is presented in past studies to suggest that devices used for monitoring vital health signs facilitate efficient care delivery, efficient chronic disease management, and reduction in healthcare costs (Dougados et al., 2015). The needs and aspirations of

the patients should be considered carefully to ensure that modern technological

interventions can improve chronic disease management satisfactorily (Thielke et al.,

2012). This is because skepticism of the end-users on the efficacy or inability to properly

use the technologies can influence the performance of even the best-designed tools

significantly. Bauer et al. (2014) suggested that a better approach is the intuitive

integration or use of modern HIT in the implementation of collaborative care models for

chronic disease management.

Collaborative care is an innovative and effective paradigm that encompasses a

whole range of expertise to improve chronic disease management. Within this paradigm,

care is delivered by the main healthcare providers, such as doctors, in collaboration with

other types of healthcare managers, such as clinical workers, nurses, and psychologists.

Within this paradigm, healthcare managers ensure proper disease management through

regular monitoring of patient conditions, empowerment of patients to self-monitor their

conditions and periodic and exhaustive reviews of disease management outcomes.

Efficient information sharing between the care providers and the care receivers is

facilitated in the collaborative care model. Even though imparting healthcare knowledge

to the end-users and patients is not considered this model, it is complemented by the

health literate care model proposed by Koh, Brach, Harris, and Parchman (2013). The

strategy proposed by Koh et al. includes the brown bag medication review, where care

managers ask patients to bring all the medication that they are currently on for a review.

Other strategies such as the distribution of education materials to enlighten patients are

implemented through the collaborative care model; these strategies were found to have significantly improved compliance with medication (Lin & Wu, 2014).

Five principles or factors could be critical in facilitating the implementation of collaborative care model for improving chronic disease management (Bauer et al., 2014). The first principle describes designing the healthcare delivery paradigms or interventions such that the needs, aspirations, and expectations of the care receivers are given the utmost importance. This is because the patients could not demonstrate appreciable compliance if the healthcare managers do not take their expectations or real concerns into consideration. One of the key aspects of the patient-centric care principle is the total engagement of patients. Healthcare managers need to provide the confidence to patients for sharing all types of information in a secure manner, and the opportunity to go through their own medical records to contribute new information if any.

The second important principle is that any treatment administered to the patients should have been proven to have satisfactory levels of efficacy in the past. Records of such treatment regimens and their levels of efficacy may be recorded in the electronic health records of patients so that doctors and care managers can make informed decisions. Though evidence-based treatment is primarily directed towards the care providers, patients are demanding increasingly to know the care being offered, and the expected efficacy level of the treatment due to the sharing of knowledge through internet.

The third important principle is that the health care managers should be able to quantify the levels of efficacy of a treatment provided to a patient. This is because a particular treatment can bring more harm than benefits if healthcare managers do not

achieve the expected positive results. Modifications to the treatment protocols can be made if the efficacy of a treatment is low. This also involves the empowerment of patients to self-monitor their vital signs through standard measurement tools, applications, and recording the level of progress during the course of treatment. The records also may be connected to the electronic health records of patients for doctors and care providers to prescribe the exact dose or any particular treatment approach that had shown positive results in the past.

Care outreach is a key concern and challenge to any healthcare provider since patients with the greatest need should be prioritized. The fourth principle, therefore, is the development and maintenance of up-to-date electronic patient registries since care providers can identify the communities with the greatest need of care from the registries and direct their effort towards them. The development of modern information and communication technologies is useful for care providers to access information anytime, and anywhere, in the form of centralized databases and cloud infrastructure.

The accountability factor of the healthcare providers is addressed by the fifth principle. The treatment care can fail to deliver the expected benefits if the care does not reach the target populations in a highly time-sensitive manner. The care providers can use the records of treatment outcomes in the electronic patient registries to facilitate further improvements to protocols and can assist in their compensation. Bauer et al. (2014) suggested a compensation program called the *Mental Health Integration Program*, which is used in the state of Washington to implement a compensation model based on the outcome of the treatment regimens offered by the care providers. Apart from improving

the accountability, the care providers can be encouraged to further improve their services, and garner more patient support and satisfaction. This could be a potential approach to improve chronic disease management in a highly challenging environment.

The chronic conditions are becoming extremely common among the American population (Gee, Greenwood, Paterniti, Ward, & Miller, 2015). In addition, Gee et al. (2015) established that almost half of the United States population suffer from at least one chronic condition, and more than 75% of the American healthcare budget is allocated for their management (Ward, 2014). From a healthcare management perspective, Gee et al. (2015) argued that the chronic care model shows excellent efficacy in the management of chronic conditions. Ward (2014) identified the six founding pillars of the chronic care model as

1. highly robust and effective healthcare support systems;

2. community resources;

3. effective self-management protocols;

4. effective delivery paradigms;

5. robust decision support mechanisms; and

6. state-of-the-art clinical information paradigms.

Patient empowerment concerning self-monitoring and self-management of their conditions is encouraged in the chronic care model. For healthcare managers, enlightened and educated patients, who can monitor their conditions efficiently, provide excellent support in guaranteeing the high efficacy of treatment protocols (Lupton, 2013). Similarly, delivery paradigms that are customized specifically to the needs and

expectations of patients can help care managers significantly to increase patient satisfaction and acceptance of chronic disease management protocols. The efficacy of any chronic disease management approach depends on the agility of the decision-making process. However, any decisions need to be beneficial and informed decisions. For this reason, highly effective decision-support mechanisms that help care providers, and patients, are important for satisfactory chronic disease management to make informed decisions, based on credible facts.

Information technology has become ubiquitous in every aspect of modern living including in healthcare. The availability of state-of-the-art clinical information paradigms can help healthcare managers significantly to access the most current information on every aspect of patient care and bring about time-sensitive modifications and advancements to their treatment protocols for the benefit of the patients. The chronic care model has already been widely accepted across the globe and has been proven to be a credible and effective tool to help the patients to self-manage their conditions. For healthcare managers, this improves treatment outcomes significantly, increases the healthcare outreach, and reduces the pressure on the healthcare system (Hosey et al., 2016).

An integration of mobile and electronic healthcare solutions with the chronic care model can be instrumental in implementing the Affordable Care Act and the Health Information Technology for Economic and Clinical Health Act (Gee et al., 2015). The complete feedback loop, which is essentially an information exchange paradigm starting with the dissemination of patient healthcare data followed by data analysis and

interpretation, can be useful for modern electronic health solutions to facilitate proper

chronic disease management. The knowledge gained from the analysis is used to

ascertain the specific requirements of the patient and modify the care paradigms

accordingly. This is followed by further sharing of information with the end-user on the

modifications that were made to the healthcare protocols, taking into consideration their

needs and aspirations. Finally, the complete feedback loop needs to be executed on a

regular basis.

The concepts of electronic health and social networking are integrated, and it

appears that care managers are successful for their chronic disease management efforts.

Fernández-Luque and Bau (2015) highlighted the case of an online diabetes community

called *TuDiabetes*. They observed that the members of this social networking group had

high efficiency in blood sugar monitoring. There is, however, a lack of research studies to

fully understand the effectiveness of social media in improving chronic disease

management, while it is worthy to note that none of the studies show any negative

impacts of social media to chronic disease management (Merolli, Gray, & Martin-

Sanchez, 2013).

Technology in Obstructive Sleep Apnea Management

With the growth of information technology, the healthcare can be benefitted from

the robust devices for disease management. The management of sleep apnea patients can

become easier since the patients can be monitored even from remote areas without

allocation of the dedicated staff (Schwab et al., 2013). This involves implementing auto-

CPAP by optimizing the virtual environment for the patient, transmitted telematically

along with teleconsultation virtual forums. Coma-Del-Corral et al. (2013) studied 40

patients with sleep apnea to determine the efficiency of information technology in sleep

apnea management. They contrasted between conventional and contemporary techniques

by employing virtual environments for compliance to CPAP. They found that technology

like auto-CPAP could be used for both diagnostic and therapeutic compliance by

developing a virtual sleeping environment and remote monitoring of the patients. Virtual

scanning technology has also been shown to be reliable for sleep apnea management

without causing any interruption in patient's sleep (Ewing, Nwose, & Ewing, 2009). The

interactive computer technology can be beneficial for accurate diagnosis and therapeutic

management of sleep apnea patients from a distance, suggesting that the technology can

be used effectively for improving sleep apnea management.

For CPAP therapy management, telemedicine is considered to be an effective

intervention since it is helpful for improving compliance rates among sleep apnea patients

and could also be effective in reducing follow-up visits through teleconsultation. Isetta et

al. (2014) investigated the efficiency of teleconsultation among 50 sleep apnea patients

by examining whether the OSA patients trained in a face-to-face session demonstrate

better knowledge than those trained through video conferencing. They found that 95% of

the patients were satisfied with teleconsultation, while 66% of the patients indicated that

teleconsultation could cause a reduction in their follow-up visits by 50% to 100% (Lee &

Goldstein, 2015). There was also no statistically significant difference in knowledge

acquisition between those trained face-to-face and those trained through video

conferencing. This study results suggested that the management of sleep apnea patients

could be improved by integrating the teleconsultation better into clinical practice and by educating the OSA patients virtually. This ultimately could reduce the costs of healthcare due to reduced follow-up visits and better education of patients.

Wireless telemonitoring is another paradigm integrated with information technology for improving sleep apnea management. In a pilot randomized trial, Stepnowsky, Zamora, and Edwards (2014) compared between traditional clinical care and wireless telemonitoring of CPAP and investigated their respective effects on compliance and treatment efficacy. They found that the telemonitored patients demonstrated significant improvement in their compliance and treatment outcomes and this collaborative management was more efficient than the traditional sleep apnea management. The patients, who received telemonitoring care, indicated a higher probability of using CPAP than those who were under regular clinical care. The use of CPAP was significantly higher among the telemonitored patients than those receiving traditional clinical care. The telemonitoring care has clinical and economic benefits for sleep apnea management since the clinical sleep team could monitor the patient swiftly through the paradigm of telemonitoring. The experience of sleep apnea patients can be improved with better treatment outcomes due to telemonitoring care.

The auto-adjusting positive airway pressure also is a technology-centered mode of treatment for sleep apnea patients. When this treatment was compared with traditional treatment like positive airway pressure and CPAP, an improved sleepiness was observed in patients using auto-adjusting positive airway pressure technology, while no statistically significant difference can be noticed for traditional modes of treatment (Berry & Sriram,

2014). The effectiveness of auto-adjusting positive airway pressure is because of the availability of accurate information about the clinical status of the patient along with adequate results from the home sleep test. The auto-adjusting positive airway pressure also improved short-term compliance to monitoring for sleepiness, which Berry and Sriram (2014) argued as a predictor of long-term compliance.

Traditionally, a variety of interventions has been used to improve compliance among OSA patients. CPAP compliance is critical to effective treatment outcomes in sleep apnea disease; however, a significant number of OSA patients are non-compliant. Sarrell et al. (2013) found that 66% of sleep apnea patients were noncompliant to their CPAP treatment. CPAP devices have been integrated with technological advancements to continuously provide the support for patients without any interruption even from remote areas (Weaver & Sawyer, 2010). The patient compliance with sleep apnea treatment is of a concern to the management since it requires efficient decision making based on the background information about patients and the treatment approach suitable to their attitudes and behaviors. For example, the effectiveness of a telemedicine approach for sleep apnea patients depends on the patient's acceptance. Thus, treatment approaches by management should be based on the needs and satisfaction of the patient.

Auto-titrating aims to improve compliance by improving the comfort of the patient (Ip et al., 2012). In this systematic review, it was found that auto-titrating could increase patient compliance by 11 minutes per night over CPAP. Such technological interventions are vital to increase patient compliance. Berry and Sriram (2014) proposed technology-based interventions to increase compliance among OSA patients; however,

key factors that motivate compliance are not documented. Koh et al. (2013) and Coma-Del-Corral et al. (2013) concluded that these interventions are cost-efficient and effective for better management of sleep apnea patients. Gee et al. (2015) argued that implementing efficient technology-based interventions could lead to the requirement of less staff, while the interventions can enhance patient compliance at the same time. Many research studies suggested that the use of technology significantly improved treatment outcomes among sleep apnea patients. Integrated technology among healthcare management, clinicians, providers, and the staff is also crucial for achieving the desired treatment outcomes, suggesting that the use of technology is a multifaceted phenomenon involving all stakeholders of healthcare in a sleep apnea facility (Gibbons, 2011). From patients to nurses and from telemonitoring to telemedicine, the role of technology is unavoidable when the compliance rate is dropping sharply particularly for chronic disease management in the United States. Since the TAM is an apt framework to predict the PU and usability of emerging technologies, the TAM is discussed in detail in the next section.

Technology Acceptance Model

The TAM was first proposed by Davis (Legris et al., 2003). The model includes four factors that are critical to an individual's intent to use a system. These factors include PU, PEOU, ATU, and BITU technology (Shroff et al., 2011). PU is defined as an individual's perception that a system could influence their job performance, while PEOU is the perception that using the system could be free of effort. The individual's judgment

of the target behavior is captured by ATU, while BITU is the motivation to perform the target behavior (Holden & Karsh, 2010).

In previous studies, TAM has been used extensively to investigate the efficiency of different technologies in diverse settings and for ranging target populations. Arning and Ziefle (2009) evaluated the role of technology for improving compliance by investigating TAM against technology acceptance among chronic disease patients. They specifically investigated the effects of age and gender on the individual's use of technology and found that the participants generally had a positive attitude towards the use of technology in the health field. Participants also believed that the technology was useful, especially in keeping them updated on their health status and in timeliness.

TAM was originally derived from the social psychology theory of reasoned action that was proposed by Venkatesh et al. (2007). This was applied by Davis et al. (1989) when they compared social theory with TAM. Another theory that is relevant to this research study is innovation diffusion theory (Lee et al., 2011); however, TAM is preferred since it provides the appropriate framework for investigating the research questions outlined in Chapter 1.

TAM has been acknowledged as an efficient predictor of technology acceptance among users of diverse technologies and the original works by Davis and colleagues have been cited more than a thousand times (Boeije, van Wesel, & Alisic, 2011). In a recent study, Holden and Karsh (2010) reiterated that TAM is a significant predictor of technology acceptance and use, particularly in the context of information technology (IT) in healthcare. From the perspective of electronic health records, TAM is predominantly

used to determine the perception of healthcare IT users about the acceptance or use of IT related solutions (Ketikidis et al., 2012). TAM has been considered as the most appropriate theory in the contexts of healthcare management and information technology.

The technology acceptance among targeted users is critical to determine whether an organization aiming to utilize IT-based solutions in disease management could use TAM. When the technology acceptance for telemonitoring was evaluated among health professionals, Gagnon et al. (2012) found that TAM would be the most appropriate framework for studying technology acceptance among the target users. Since health professionals were the focus of the study, TAM was proven to be effective in evaluating their intention to use telemonitoring. Their PU was determinant to their intention of using telemonitoring in healthcare organizations. This suggests that technology acceptance is contingent upon the PU and ease of use for a particular technology. This concept is also related to the management perspective in healthcare context since the technologies installed for disease management are required to be used effectively for achieving the desired results.

The consumer behaviors and attitudes to use health information technology (HIT) are critical to the evaluation of health management strategies (Kim & Park, 2012). With an increase in the HIT, particularly in chronic disease management, the determination of a health consumer's intention is significant for measuring the efficiency of technology. While studying the behavioral intention, Kim and Park (2012) found that the health consumer's health status, health knowledge, and HIT features and efficiency influenced their perception of usefulness and ease of use along with their perception of threat about

the technology. The TAM was also found to be an apt theoretical framework to investigate the factors such as PU and ease of use among the health consumers, enabling the researchers to consider the social and cultural background of health consumers, which are important in evaluating the perceptions of any target community by avoiding bias. The use of TAM in this study is also justified since the objective is to determine the PU and ease of use among OSA patients and to relate their perceptions with their compliance.

From the perspective of healthcare managers and staff, the implementation of technology in any healthcare context, including sleep apnea, is conditioned with their acceptance for the adoption of the technology for decision-making and other purposes. In their study on acceptance of telemonitoring among healthcare professionals, Gagnon et al. (2012) found that TAM was effective to predict their intention to use telemonitoring for the management of patients. They also indicated that the factor *facilitators* were particularly significant to determine a healthcare professional's intention to use telemedicine, indicating that the TAM is an effective framework for evaluating the perceptions of patients and healthcare managers to accept and use technology (Kitsiou, Paré, & Jaana, 2015).

Although the TAM has been a focus for researchers for nearly twenty years, there is a limited amount of research in the health field regarding the impact of management oversight of the health clinicians and providers, vis-à-vis how it can ensure informed use of technology for achieving a higher rate of patient compliance. Use of TAM in this study could help to determine the relationship between technology acceptance and compliance.

Understanding this relationship is important because it can help medical clinicians and healthcare managers to develop measures and implement strategies that can improve compliance among OSA patients through adequate utilization of technology leading to effective disease management. This could include determining the relationship between technology acceptance, and compliance and noncompliance among OSA patients since compliance is critical for achieving better treatment outcomes. With a better understanding of these relationships, the case managers should be able to provide better insight and guidance to clinicians and providers in their interactions with patients to ensure a higher rate of compliance.

Improving Patient Compliance with Sleep Apnea Treatment with Technology

Various technologies have been implemented to improve patient compliance. For instance, CPAP can be monitored even from remote areas without allocation of dedicated staff (Schwab et al., 2013). This involves implementing auto-CPAP by optimizing the virtual environment for the patient, transmitted telematically along with teleconsultation virtual forums. Coma-Del-Corral et al. (2013) studied 40 patients with sleep apnea to determine the efficiency of information technology in sleep apnea management. They contrasted between conventional and contemporary techniques by employing virtual environments for compliance to CPAP. They found that technology like auto-CPAP could be used for both diagnostic and therapeutic compliance by developing a virtual sleeping environment and remote monitoring of the patients. Virtual scanning technology has also been shown to be reliable for sleep apnea management without causing any interruption in patient's sleep (Ewing et al., 2009). The interactive computer technology

can be beneficial for accurate diagnosis and therapeutic management of sleep apnea

patients from a distance, suggesting that the technology can be used effectively for

improving sleep apnea management.

For CPAP therapy management, telemedicine is considered to be an effective

intervention since it is helpful for improving compliance rates among sleep apnea patients

and could also be effective in reducing follow-up visits through teleconsultation. Isetta et

al. (2014) investigated the efficiency of teleconsultation among 50 sleep apnea patients

by examining whether the OSA patients trained in a face-to-face session demonstrate

better knowledge than those trained through video conferencing. They found that 95% of

the patients were satisfied with teleconsultation, while 66% of the patients indicated that

teleconsultation could cause a reduction in their follow-up visits by 50% to 100%. There

was also no statistically significant difference in knowledge acquisition between those

trained face-to-face and those trained through video conferencing. This study results

indicated that the management of sleep apnea patients could be improved by integrating

the teleconsultation better into clinical practice and by educating the OSA patients

virtually. This ultimately could reduce the costs of healthcare due to reduced follow-up

visits and better education of patients.

Wireless telemonitoring is another paradigm integrated with information

technology for improving sleep apnea management. In a pilot randomized trial,

Stepnowsky et al. (2014) compared between traditional clinical care and wireless

telemonitoring of CPAP and investigated their respective effects on compliance and

treatment efficacy. They found that the telemonitored patients demonstrated significant

improvement in their compliance and treatment outcomes and this collaborative management was more efficient than the traditional sleep apnea management. The patients, who received telemonitoring care, indicated a higher probability of using CPAP than those who were under regular clinical care. The use of CPAP was significantly higher among the telemonitored patients than those receiving traditional clinical care. The telemonitoring care has clinical and economic benefits for sleep apnea management since the clinical sleep team could monitor the patient swiftly through the paradigm of telemonitoring. The experience of sleep apnea patients can be improved with better treatment outcomes due to telemonitoring care.

The auto-adjusting positive airway pressure also is a technology-centered mode of treatment for sleep apnea patients. When this treatment was compared with traditional treatment like positive airway pressure and CPAP, an improved sleepiness was observed in patients using auto-adjusting positive airway pressure technology, while no statistically significant difference can be noticed for traditional modes of treatment (Berry & Sriram, 2014). The effectiveness of auto-adjusting positive airway pressure is because of the availability of accurate information about the clinical status of the patient along with adequate results from the home sleep test. The auto-adjusting positive airway pressure also improved short-term compliance to monitoring for sleepiness, which Berry and Sriram (2014) argued as a predictor of long-term compliance.

Traditionally, a variety of interventions has been used to improve compliance among OSA patients. CPAP compliance is critical to effective treatment outcomes in sleep apnea disease; however, a significant number of OSA patients are non-compliant.

Sarrell et al. (2013) found that 66% of sleep apnea patients were noncompliant to their CPAP treatment. CPAP devices have been integrated with technological advancements to continuously provide the support for patients without any interruption even from remote areas (Weaver & Sawyer, 2010). The patient compliance to sleep apnea treatment is of a concern to the management since it requires efficient decision making based on the background information about patients and the treatment approach suitable to their attitudes and behaviors. For example, the effectiveness of a telemedicine approach for sleep apnea patients depends on the patient's acceptance. Thus, treatment approaches by management should be based on the needs and satisfaction of the patient. Auto-titrating aims to improve compliance by improving the comfort of the patient (Ip et al., 2012). In this systematic review, it was found that auto-titrating could increase patient compliance by 11 minutes per night over CPAP. Such technological interventions are vital to increase patient compliance.

Other Approaches to Improve Compliance With Sleep Apnea Treatment

CPAP is an effective treatment for sleep apnea and it is critically important for patients to strictly adhere to the treatment regime prescribed by their doctor to enable progress and improvement. Patient compliance to treatment is of a major concern for healthcare managers, who are under constant pressure to show the high efficacy of treatment protocols offered by healthcare centers and to reduce the increasing financial pressure on healthcare resources. Several studies suggested that incidences of non-compliance with sleep apnea treatment are high leading to failure of prescribed treatments. Russell (2014) reported that a major reason for treatment non-compliance is

lack of appreciation among the patients about the seriousness of the condition. Most patients believe that sleep apnea is not a serious condition to pose a threat to their lives or general well-being. This observation is further substantiated by the study of Skinner et al. (2013), in which patients, who fully appreciated sleep apnea treatment and believed on its serious negative health consequences, were found to show satisfactory treatment compliance.

Patients, who voluntarily seek medical help for the evaluation of their sleep patterns, were more likely to adhere to treatment than those who had undergone evaluation on the insistence by someone else (Russell, 2014). Also, individuals with a stressful situation or younger patients are less likely to adhere to their sleep apnea treatment regimens (Russell, 2014). Russell (2014) also found significant improvements in the level of compliance when healthcare providers educate patients on the potential health risks of sleep apnea and discuss the benefits of CPAP compliance. Patients receiving consultation from a dedicated sleep physician for their sleeping pattern were found to adhere to treatments, such as CPAP. Patients, who are referred by general physicians, are, however, more likely to show non-compliance. Balachandran, Yu, Wroblewski, and Mokhlesi (2013) concluded that sleep physicians are in a better position to motivate the patients by highlighting the importance of treatment compliance since they are with a detailed understanding of the issues of the sleep apnea patients.

Healthcare managers, therefore, need to formulate strategies to ensure that sleep apnea patients mostly receive their consultations from sleep physicians. Pamidi, Knutson, Ghods, and Mokhlesi (2012) indicated that patients, who were treated by dedicated sleep

physicians, have, on average, increased compliance to the CPAP by 58 minutes compared to those, who were treated by non-sleep physicians. The fundamental reason for the difference is that the sleep physicians educated the patients about the potential health risks of sleep apnea and the positive impacts that the treatment can have in alleviating their condition.

Patients, who are exposed to multiple education and empowerment programs, tend to show greater levels of compliance. Falcone, Damiani, Quaranta, Alberto, and Resta (2013) observed that a group of sleep apnea patients, who saw the results of their recordings of brain waves, heart rate, breathing, and eye and leg movements, showed an increase in the compliance level of up to 97% within a period of 12 months compared to the 74% of the group, who had undergone standard sleep apnea educational programs. Therefore, healthcare managers need to refine their intervention strategies and education programs based on this finding to increase compliance levels. Parthasarathy, Wendel, Haynes, Atwood, and Kuna (2013) reported that sleep apnea patients working closely with healthcare counselors engaged themselves in sleep apnea therapy for up to 5.2 hours every night, compared to 4 hours in the case of patients, did not have any counselors to educate and motivate them.

The results of these studies suggest that patients, who receive proper education on the negative effects of sleep apnea and the importance of compliance to treatment, tend to show high levels of compliance. Lai, Fong, Lam, Weaver, and Ip (2014) carried out a randomized control trial with a cohort of 100 sleep apnea patients to highlight the efficacy of a motivational enhancement program to increase treatment compliance. The

cohort was distributed into two groups, namely the control group and the intervention group. The control group received the standard information package on the importance of CPAP treatment, while the intervention group was further exposed to a motivational enhancement program along with the standard information package. The members of both the groups were asked to record the levels of compliance to treatment for a period of three months.

The motivational enhancement program included a video of around 25 minutes on the different aspects of the sleep apnea condition and focused on the significance of CPAP treatment. The video also highlighted the experience of a sleep apnea patient, who were receiving the CPAP treatment. The real-life case study in the video could have helped the sleep apnea patients to better relate to their condition and to better understand how treatment compliance can improve the quality of life. The video was followed by a one-to-one interview with the patients by an individual, who is a nurse and a qualified sleep study technician with special psychiatric training to talk with and motivate sleep apnea patients. The final stage of the motivational enhancement program included a telephone conversation between the patient and the same care provider for a period of 10 minutes on the second day of the treatment. This was essentially a follow-up call to see how the patient was getting along with the treatment (Lai et al., 2014). The standard care program involved a 15-minute talk by the nurse on how the CPAP treatment system works. The talk was given at the beginning of the treatment procedure and at the end. The nurse again gave a 15-minute talk highlighting the significance of CPAP treatment, described how the treatment instrument is cared for, and maintained.

The results of this study demonstrated that the compliance to CPAP treatment was significantly higher in the intervention group compared to the control group. The motivational enhancement program, therefore, can lead to positive changes in the lives of sleep apnea patients and can become an effective tool to increase treatment efficacy. The standard care program, however, failed to convey the importance of treatment compliance to patients, resulting in the control group showing poor levels of compliance. This is a valuable knowledge for healthcare managers to formulate strategies to increase treatment compliance. This study also demonstrates that a much higher level of commitment to sleep apnea treatment is necessary from the patients. The treatment can fail to yield the expected results if patient compliance is low, though a highly acclaimed physician treats a sleep apnea patient using an excellent treatment strategy. The findings from this study may help healthcare providers and managers to devise efficacious and cost-effective treatment plans (Lai et al., 2014).

To investigate the effectiveness of a dedicated motivational enhancement therapy directed towards increasing sleep apnea treatment compliance, Aloia et al. (2013) conducted a study. A cohort of 227 sleep apnea patients, distributed among three groups randomly, were used in this study. One of the groups received standard sleep apnea care, while another group received a special education package on sleep apnea. The third group received a customized motivational enhancement therapy. The results from this study indicated that patients, who showed fair levels of treatment compliance during the 1st week of positive airway pressure therapy, would continue with the high levels of compliance if they were to receive the motivational enhancement therapy. Furthermore,

patients, who already showed high compliance levels in the first week, would continue to adhere to their treatment if they are offered the education package. The motivational enhancement therapy, therefore, generates a greater appreciation of the benefits of positive airway pressure therapy, while standard sleep apnea education does not have any effect on patient perceptions (Aloia et al., 2013).

Summary

Technology-based interventions are crucial in chronic disease and sleep apnea management because they can influence increased compliance among OSA patients. Many research studies found that the use of technology was associated with improved treatment outcomes among chronic disease patients; however, the studies on the sleep apnea patients is limited, especially TAM model components. Many studies also suggested that the technology acceptance among healthcare managers, clinicians, providers, and staff could be crucial for achieving the desired outcomes in chronic disease management. These technology-based interventions are cost-efficient and effective for better management of sleep apnea patients since they require less staff in comparison to traditional approaches that can enhance patient compliance. As a result, it is important to investigate the relationship between compliance and noncompliance, ATU, and intention to use technology as well as the two key factors, PU and PEOU. The knowledge of the above relationships could help healthcare managers to develop strategies to utilize technology-based intervention to achieve a higher level of patient compliance and engagement. As a role of the top management is to ensure that the healthcare managers take the necessary steps towards the use of technology to ensure

increased patient compliance, therefore it is important the top management understands

the attitudes and perceptions of the healthcare managers toward the use of technology.

Chapter 3: Research Methodology

Introduction

In this research, I examined technology-based interventions in chronic disease management from the perspective of healthcare managers. Butler et al. (2017) reported that patient noncompliance alone costs the U.S. healthcare system approximately $290 billion nearly every year. This trend is projected for this to increase, which may pose a grave threat to the healthcare system. Patient noncompliance to prescription drugs and improper use of medical equipment have increased negative treatment outcomes in OSA management such as depression or even death, in addition to posing additional healthcare challenges for management (May et al., 2016). Lack of patient engagement is proposed as one of the major factors behind patient noncompliance in the field of chronic disease management. Lack of patient education is another major factor behind patient noncompliance in the field of chronic disease management, especially in OSA patients (Hibbard et al., 2016). The burden of educating patients lies on healthcare managers and their team that is responsible for patient compliance with the prescribed therapy. For effective patient engagement, it is imperative to motivate the patients to be treatment compliant and to educate the healthcare employees, supervisors, middle managers, case managers, and clinicians to ensure treatment compliance among patients. The efficiency of patient engagement depends on identifying the role of technology to determine whether technology acceptance among OSA healthcare managers could be used to motivate them to use technology for better healthcare management for improved treatment compliance.

For this purpose, I built this research on the TAM, in particular, the four key components of TAM, PU, PEOU, ATU, and BITU technology. From the above-outlined components of TAM, I explored healthcare managers' ATU, PU, and PEOU. The results of this research have both practical and practice implications, as well as policy implications, as the knowledge generated in this study can assist in developing effective plans to increase patient compliance, which can have a secondary effect of lowering costs or financial strain associated with lack of engagement and compliance amongst chronic patients.

The most appropriate research method for answering the key research question was the qualitative research methodology. Qualitative research provides an understanding of the context or setting in which people behave. As this research had an emphasis on TAM and healthcare managers' acceptance, it was a "needs-based" research and warranted a needs assessment, for which the use of primary data was necessary.

With a better understanding of the relationship between technology acceptance among healthcare managers and patient engagement, the healthcare managers could provide better insight and guidance to clinicians, case managers, and program managers as to how to engage with patients and improve therapeutic outcomes. The methodological approach that I implemented in this study is presented in this chapter. I also discuss the research design along with the theoretical justification of qualitative method research in this chapter.
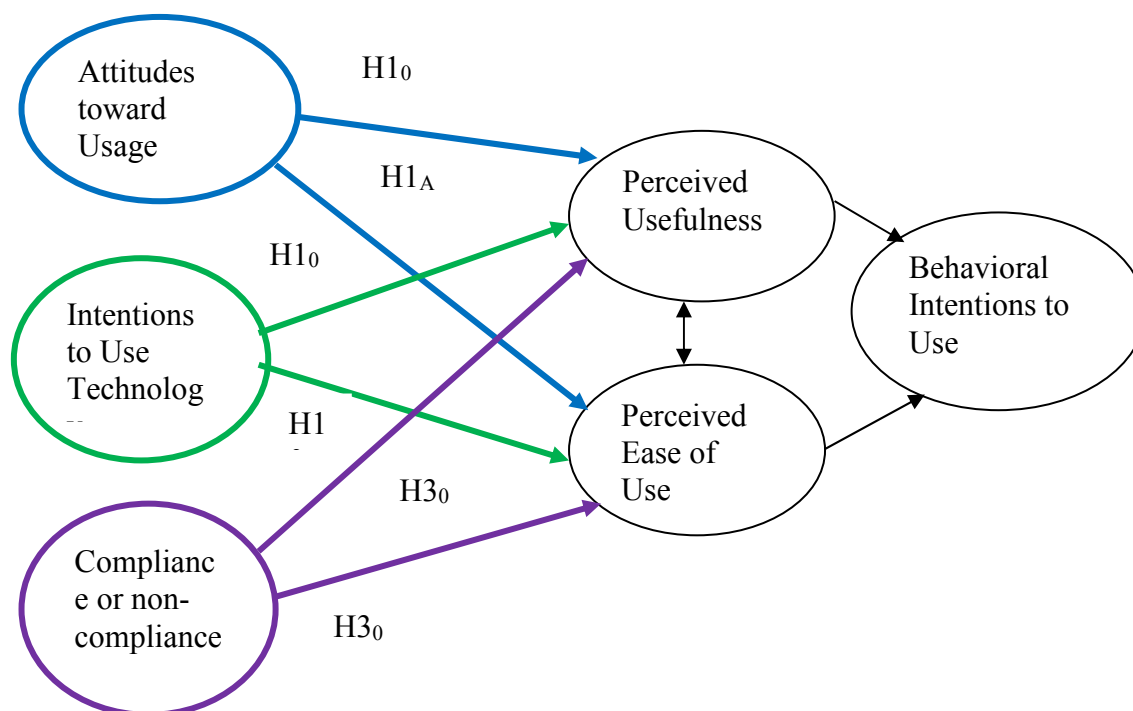
Figure 1. Research model based on dependent and independent factors.

Objectives of the Research Design

The objective of the research design in the context of the study was to investigate how technology-based interventions used by healthcare managers can improve the patient engagement and compliance with treatment procedure. I had undertaken this research using TAM by exploring healthcare managers' PU, PEOU, and ATU. For this research, I used phone interviews.

Research Questions

The research study was based on the following three central research questions:

RQ1a: What are the attitudes of healthcare managers toward the use of technology in OSA patient engagement that could lead to improved treatment compliance?

RQ1b: What factors are responsible for the attitudes of healthcare managers toward the use of technology for OSA patient engagement that could lead to improved treatment compliance?

RQ2a: What are the perceptions of the healthcare managers about the usefulness of the technology to engage with the OSA patient for improved treatment compliance?

RQ2b: What are the challenges and opportunities that the healthcare managers perceive in making technology useful for OSA patient engagement that could lead to improved treatment compliance?

RQ3a: What are the perceptions of the healthcare managers about the ease of using technology for the OSA patient engagement that could lead to improved treatment compliance?

RQ3b: What are the challenges and opportunities that they perceive in making technology easier to use for OSA patient engagement that could lead to improved treatment compliance?

In this research, therefore, I could investigate ATU and intentions to use technology, PU, and PEOU from healthcare managers' perspectives.

Foundation of the Research Paradigm

There are four foundations of research paradigms, (a) positivism (built on experimental testing), (b) post-positivism (viewpoints arising from need for research context and recognition of insufficiency of context-free experimental designs), (c) critical theory (viewpoints that ideas relate to specific ideology because bias ought to be

articulated), and (d) constructivism (from the viewpoint that every individual researcher builds his independent reality and therefore multiple interpretations exist). In this research, it is accepted that within the domain of a constructivist foundation, interpretivism is used interchangeably with the constructivism foundation. With this argument, it is possible to indicate that a research paradigm fits the context presented by Guba (1990), which was characterized by (a) ontology (aspects that are recognized as reality), (b) epistemology (characteristic of how a researcher knows something and ways of knowing), and (c) methodology (characteristic of how to go about finding out the answers to a research question).

In general, the ontological and epistemological positions of research influence the informed choices of research methods. For example, in quantitative research, only one truth, an *objective reality* that is independent of human perception, exists according to the ontological position, whilst the researcher and researched problem are recognized as "independent entities" as per epistemological position (Troudi, 2014). This idealization is important in the current research, where focus could be on the reliability of the findings, validity of the findings, and inter-rate reliability or generalizability of the findings across OSA healthcare manager populations. It could enable policy and practice developments that are uniform across OSA healthcare managers. The study adopted foundations of research paradigms as documented by Cameron (2011) through the recognition that a realist approach is fundamental because the researcher can identify new knowledge about healthcare managers' perceptions about technology-based interventions.

By adopting foundations of research paradigms in the current study, it was possible to identify how to integrate an epistemological perspective through analysis on OSA healthcare managers' attitudes and perceptions about technology-based interventions in chronic disease management practices. This includes the design of care management plans that patient-care managers recommend to nurses or clinical staff, and how OSA patient engagement with technology-based interventions could improve OSA treatment outcomes. Through aligning the research design to foundations of research paradigms, it was possible to identify how I could interact with studies in OSA patient engagement and further help to reconceptualize my ontological view of OSA patient engagement within the cultural context. The values of basing my research paradigm on a methodological foundation aspect were intended to determine how I would go about finding out about the attitudes and perceptions of healthcare managers about technology-based interventions. The methodological aspect formed the basis for my strategic approach to studies on OSA patient engagement with technology-based interventions as opposed to research technique or approach to data analysis. The methodological foundation is informed by scientific research method (qualitative research) that was envisioned to be delivered through case studies.

Conceptual Perspective

The personal beliefs, personal history, culture, and social status of researchers can influence what they study, what questions they ask, and how they approach a topic (Teddlie & Tashakkori, 2009). In a qualitative research, philosophical assumptions are important in guiding the research (Hayes, Bonner, & Douglas, 2015). This is relevant

because the results of the research can be used to understand OSA patient engagement, healthcare managers' acceptance of technology-based interventions, and how they each communicate compliance and noncompliance. The design was influenced by practical perspective (using experience and knowledge to determine what does and does not work), a contextual perspective (being responsive to the demands, opportunities, and constraints to an evaluation or situation), and a consequentiality perspective (making decisions based on practical consequences; Bell, Bromiley, & Bryson, 2012).

Research Design and Approach

Two major research designs that are used often in social science research are descriptive research and experimental research (Yin, 2017). The descriptive research design is also known as the observational study design because measurements are observed and not changed. In the experimental research design, repeated measurements are used for evaluating several factors as dependent and independent variables. A series of measurements are made on all subjects before and after the intervention. The experimental studies examine the effect of an intervention on the outcome of interest. Comparisons could be made between an intervention and no intervention or between one intervention and another. Health data are collected after and often prior to the intervention to assess its relative effectiveness (Levin, 2005). An experiment is a procedure carried out to verify, refute, or validate a hypothesis. Experiments provide insight into cause-and-effect by demonstrating what outcome occurs when a particular factor is manipulated. Experiments vary greatly in goal and scale but always rely on repeatable procedure and logical analysis of the results. There also exist natural experimental studies.

An experiment is an investigation in which a hypothesis is scientifically tested. In an experiment, an independent variable (the cause) is manipulated and the dependent variable (the effect) is measured; any extraneous variables are controlled.

Another design method is observational, which is also known as descriptive research design. Observational studies are used to screen or describe the health status of a population. They are referred to as observational because the investigators only witness what is happening rather than attempting to arbitrate in any way. Health data are collected about one or more groups of subjects from which an inference is made about a target population. Often measurements of risk factors or exposure data are collected as well. These are used to describe the relationship between exposure and the outcome measure of interest, which is often disease or some measure related to the disease. In an observational study, investigators observe subjects and measure variables of interest without assigning treatments to the subjects. The treatment that each subject receives is determined beyond the control of the investigator.

Choosing a study design is determined broadly by who and what is being studied. It is the way in which health status and risk factor data are collected and measured and a hypothesis tested. It is imperative that appropriate study design is selected because a badly designed research study can lead to erroneous outcomes, or it may not provide the result posed by the research questions. Another critical aspect of selecting the right study design is that it determines the methods used to analyze the data. Since this study was to find out about the perceptions of healthcare managers about technology-based interventions and which factors contribute towards the healthcare managers' attitudes and

perceptions, I selected observational design study as my core research design methodology.

In an observational study, investigators observe subjects and measure variables of interest without assigning treatments to the subjects. The treatment that each subject receives is determined beyond the control of the investigator. A longitudinal study is observational, meaning that there is no interference with the respondents, especially if a researcher happens to be surveying. A unique perspective of longitudinal study research design is the timeline of the study. Instead of a researcher collecting data from varying subjects in order to study the same variables, the same subjects are observed over multiple times, often over the course of many years.

Psychologists prefer using longitudinal research design to cross-sectional research design to measure the impact of various therapy practices over time, usually using a control group as a baseline. Another prime example might be a medical study that follows the same 100 individuals over the course of 4 years, measuring the impact of an experimental pharmaceutical. Using the same subjects in a longitudinal study allows for measurable change data to be collected over a period of time. Longitudinal studies provide the snapshot of the outcome of interest in a population at any given time and are used often to look at prevalence. There are three types of longitudinal studies: panel, cohort, and retrospective. A panel usually involves a somewhat random sample of subjects, whereas a cohort study observes subjects in a similar group based on region, age, or common experience. However, a retrospective study involves historical data, often in comparison to updated data. In this study, I employed a cross-sectional research

design because the purpose was to target the current attitudes and perceptions of selected healthcare managers about the technology for patient engagement.

Sampling Strategy and Participants

Sampling is the process of selecting units (such as people and organizations) from a population of interest so that by studying the sample one can fairly generalize one's results to the population from which the units were chosen. For this research study, the population was the healthcare managers working at health facilities specialized in treating OSA in the United States. Therefore, I collected the data from the healthcare managers working at health facilities specialized in treating OSA and located in the Indianapolis, Indiana area, through interviews. The World Health Organization (2004) stipulates that the minimum sample size for qualitative study should 10, while a sample size of 40 is considered as a large sample. Therefore, in this study, I used purposive sampling method for selecting healthcare managers. I contacted the managers of healthcare facilities in Indiana and prepared a list of healthcare managers who are directly involved with OSA patient care. I contacted the managers and provided an overview of my research together with the interview procedure. Among them, 20 managerial level healthcare managers were available to participate in the study.

Role of the Researcher

Chronic diseases are among the most prevalent and costly health conditions in the United States. Nearly half of Americans suffer from at least one chronic condition, and the number is growing (Mathers & Loncar, 2006). Health care workers play a role in managing chronic diseases in general practice and primary health care, including health

assessment, follow-up activities, self-management support, and providing patient education. While I based this study on a purposeful sampling strategy, my role as a researcher included some personal or professional relationships, but not supervisory relationships with the subjects of this study. I obtained informed consent from all of the participants. There were no potential risks because there was no treatment or intervention.

Data Collection and Analysis

I collected the data for this study through phone interviews with the healthcare managers working in health facilities specialized in treating OSA patients and located in the Indianapolis, Indiana and adjacent states. I de-identified the participants' information, and I used the data in this study without compromising participants' privacy, which is a standard approach in medical research. There were no additional ethical considerations related to the use of the data in this study. I analyzed the qualitative data using inductive and deductive coding, and the thematic analysis.

Instrumentation

In the application of the above methodology, I used a prior instrumentation to test the TAM-based model, and how it could provide a basis for responding to the research questions and closing gaps in the literature, and the capacity to support policy and practice development. The investigated themes were the ATU, PU, and PEOU. I collected the qualitative information through open-ended questions during an interview and used coding and thematic analysis to explore the interview findings. The qualitative research instrument consisted of the following open-ended questions:

1. How do you feel about using the technology for patient engagement? Do you think that it will improve the patient engagement and treatment compliance?

2. Why do you feel positive/negative about the technology-based interventions for patient engagement? What factors are responsible for your feeling towards technology-based interventions?

3. In your opinion, how useful is the technology for patient engagement and treatment compliance?

4. What are the challenges and opportunities to make the technology useful for the patient engagement?

5. Do you think that it would be easier to use technology-based interventions for patient engagement?

6. What challenges and opportunities exist to make the technology easier to use for patient engagement.

Ethical Concerns

In this study, the ethical issues were relevant to the risks associated with the nature of qualitative research methodology. The ethical issue may arise when healthcare managers may want to damagingly evaluate their colleagues in chronic disease management team, since any negative evaluation may reflect the ineffectiveness of the team and can lead to relationship breakdown. Additionally, although the design of this study was non-experimental, protection of the subjects of this study is still crucial.

As a researcher of this non-experimental study, I informed participants about the purpose of this research study, the confidentiality of responses, and the voluntary nature

of this study. Furthermore, I used the acquired results only for the intended research purpose, and the researcher and the dissertation committee had access to the data and the research would not pose any threat or risk to the safety or reputation of the participants or their institutes. In order to protect the identity of the healthcare managers, who participated in this study, I used masking techniques to de-identify the data to encapsulate from any person reviewing the data and results of the data.

Summary

The study was a qualitative study utilizing a cross-sectional approach. I collected the data from purposively selected 20 participants to represent the total population of healthcare managers specializing in treating OSA and located in the Indianapolis, Indiana area. In this study, I examined the perceptions and attitudes of healthcare managers using the TAM model and investigated factors such as ATU, PU, and PEOU. I used coding and thematic analysis for extracting information from qualitative data.

Chapter 4: Results

The purpose of this qualitative study was to evaluate how technology-based interventions used by healthcare managers could improve patient engagement with the healthcare managers as well as patient compliance with treatment procedures in OSA disease management. In this research, I explored the attitudes and perceptions of healthcare managers toward the use of technology for patient engagement using the elements of TAM. To achieve the purpose of this research, I interviewed a sample of 20 purposively selected healthcare managers to represent the total population of healthcare managers specializing in treating OSA in Indianapolis, Indiana, and surrounding areas. I used open-ended questions in the interviews, which I conducted over the phone with the participants. Participants provided the consent to use the information in the research and none of them have requested that I discard any of their information to date.

The general research question of this study was: What are the attitudes and perceptions of healthcare managers toward employing technology-based interventions to improve compliance among OSA patients? The objectives of this study were to answer the following specific research questions:

RQ1a: What are the attitudes of healthcare managers toward the use of technology in OSA patient engagement that could lead to improved treatment compliance?

RQ1b: What factors are responsible for the attitudes of healthcare managers toward the use of technology for OSA patient engagement that could lead to improved treatment compliance?

RQ2a: What are the perceptions of the healthcare managers about the usefulness of the technology to engage with the OSA patient for improved treatment compliance?

RQ2b: What are the challenges and opportunities that the healthcare managers perceive in making technology useful for OSA patient engagement that could lead to improved treatment compliance?

RQ3a: What are the perceptions of the healthcare managers about the ease of using technology for the OSA patient engagement that could lead to improved treatment compliance?

RQ3b: What are the challenges and opportunities that they perceive in making technology easier to use for OSA patient engagement that could lead to improved treatment compliance?

In this chapter, I discuss the results and findings of this study. First, I explain the research setting including how I identified the participants, how I contacted them to participate in the interview, how I conducted the interview, how I transcribed the interviews, and how I stored and analyzed the interviews to comply with the confidentiality and privacy policies. Then I explain the demography of the participants followed by data collection and data analysis procedures. Finally, I present the results and findings of this study.

Research Setting

I prepared the interview questions and procedure and submitted them for the approval of Walden University Institutional Review Board on the 19th of June, 2017. I

received the Institutional Review Board approval on the 19th of July, 2017 (approval number 07-19-17-0044438). I contacted 40 potential participants, whose details were given by the managers of healthcare facilities, through phone calls to see whether they would be interested in being interviewed. Twenty people were interested in participating in the interviews, while five refused. I provided the interested participants with the consent form that explained the description of this study, potential benefits of this study to the wider community, and their right to withdraw at any time they chose.

Twenty participants returned the consent forms, and I followed the procedures according to the ethics approval in further correspondence with the participants. I arranged a mutually convenient date and time for the interview. Prior to the interview, I reiterated their right as participants to withdraw from the interview any time as outlined in the consent form, and I also informed them that I would record the interview for transcription. In order to be consistent, I asked each participant same questions. The interview time varied between 30 minutes to 1 hour, and the interviews were recorded using the GoToMeeting platform (Version 8.22.0). After the interviews, I transcribed the interviews from the recordings into a Microsoft Word document using www.temi.com.

Demographic Characteristics

I interviewed 20 participants purposively selected from the total population of healthcare managers specializing in treating OSA who were located in Indianapolis, Indiana, and surrounding area. I allocated a unique identifier for each participant to protect the participants' privacy and identity. Among the 20 participants, there were 16 women and 4 men. Of the 20 participants, three participants had master's degrees, 11 had

bachelor's degrees, and six had associate's degrees. All the participants had 6 or more

years of experience. Table 1 provides a summary of the demographic characteristics of

the participants.

Table 1

Demographic Characteristics of Participants

ID	Sex	Education	Years of experience
1	F	Associate	8
2	F	Associate	6
3	F	Associate	6
4	F	Bachelor	10
5	F	Bachelor	8
6	F	Associate	7
7	M	Bachelor	9
8	M	Masters	8
9	F	Masters	7
10	F	Bachelor	7
11	F	Bachelor	6
12	F	Associate	6
13	F	Associate	9
14	F	Bachelor	8
15	F	Bachelor	10
16	F	Bachelor	6
17	M	Masters	6
18	F	Bachelor	8
19	F	Bachelor	12
20	M	Bachelor	13

Data Collection

I randomly assigned a number from 1 to 20 for each participant to hide their

identity. I set up login details at www.gotomeeting.com for each participant, and the

participants logged into the platform with the provided credentials. After a formal

introduction and reminding them their rights to withdraw from participation, I conducted

the interviews and recorded them using the inbuilt recording function. The interview

included two icebreaker questions about the existing technology-based interventions that

the participants were currently using at their workplace and the ideal technology that they

would prefer to have. The remainder of the interview questions were directly relevant to

the research questions. They appear below:

1. How do you feel about using the technology for patient engagement? Do you

   think that it will improve the patient engagement and treatment compliance?

2. Why do you feel positive/negative about the technology-based interventions

   for patient engagement? What factors are responsible for your feeling towards

   technology-based interventions?

3. In your opinion, how useful is the technology for patient engagement and

   treatment compliance?

4. What are the challenges and opportunities to make the technology useful for

   the patient engagement?

5. Do you think that it would be easier to use technology-based interventions for

   patient engagement?

6. What challenges and opportunities exist to make the technology easier to use

   for patient engagement.

The participants did not report any problem in understanding the interview

questions. However, they generally identified similar challenges and opportunities that

existed to make technology useful (Interview Question 4) and those that existed to make technology easier for patient engagement (Interview Question 6).

Data Analysis

I transcribed the interviews using the website www.temi.com and the transcription was faster than manual transcription. On average, it took 20 minutes per participant. However, I verified the accuracy of the transcription by manually listening to the interviews and cross-checking with the transcription. I corrected any discrepancies and mistakes in the transcription. On average, I made 18 corrections per transcript. I de-identified the participant details in the transcribed Microsoft Word document by using the corresponding number that I had assigned. I sent the corresponding transcribed document to each participant and gave them a week to contact me if there were any concerns or misrepresentations of their responses. None of the participants raised any concerns after the expiry of one week. Therefore, I proceeded with the analysis of the data from 20 participants.

I used RQDA library in R Studio version 1.1.383 software for the data analysis. I uploaded the interview transcripts in the RQDA platform and inductively open-coded by reading the transcripts several times. I adopted sentence-by-sentence coding during the open coding process and developed 41 codes. Based on the research questions and the emerging themes during the open coding process, I developed inductively and theoretically the following eight code categories related to the technology-based interventions and linked them to the 41 codes: attitudes, challenges, easiness, opportunities, positive factors, technology for engagement, existing technology, and

usefulness. The eight primary level code categories are given in Table 2, while the

corresponding codes are given in Appendix A:

Table 2

Primary Level Code Categories along with the Summary of Codes

Code category	Description
Attitudes	Attitudes of the participants toward the technology-based interventions
Challenges	Challenges to make the technology useful or easy for the patient engagement
Easiness	Easiness of using technology-based interaction for patient communication
Existing technology	Existing technology used by the healthcare managers for patient engagement
Opportunities	Opportunities to make the technology useful or easy for the patient engagement
Positive factors	Positive factors that support the use of technology-based interventions
Technology for engagement	Technologies needed by healthcare managers for patient engagement
Usefulness	Usefulness of technology-based interaction for patient communication

Evidence of Trustworthiness

Trustworthiness is a critical component in any qualitative study to assert the

unbiased nature of the data collection and analysis. Trustworthiness indicates that the

results are accurate and consistent, and the outcomes of the data analysis are legitimate.

Therefore, it is important that each step during the analysis process, such as data

collection, data treatment, data organization, and the result reporting, is trustworthy (Elo et al., 2014). Credibility, transferability, dependability, and confirmability are measures used to evaluate the trustworthiness of a qualitative study (Houghton, Casey, Shaw, & Murphy, 2013).

Credibility

There are many ways to assess the credibility of a qualitative study. In this study, participants' agreement with the transcription of their interview and triangulation were the methods used to assess the credibility. Participants had the chance to review copies of the transcriptions of the interviews and to point out any mistakes or misinterpretations of their responses.

The internal validation process of triangulation is an important method to improve the credibility and validity of the study outcomes (Carter, Bryant-Lukosius, DiCenso, Blythe, & Neville, 2014). Selecting participants of different genders, with different levels of education, and with varying experience levels was useful for triangulation. Examining their responses to similar questions for any underlying pattern was useful to understand the similarities and differences within the industry.

Dependability

Dependability is an important attribute in qualitative research design since it provides information to any researchers who want to repeat the study in a similar context. Such information includes the adopted methods, study context, population, samples, and sample selection criteria. Consequently, the scrutinization of the study and its outcomes would be possible (Thomas & Magilvy, 2011).

Confirmability

Confirmability refers to the degree to which the data can be confirmed or corroborated (Cope, 2014). I checked and rechecked the transcription by the transcription software, temi, and ensured that they were accurate. In addition, I shared the transcription with participants so that they can review and clarify if there were any discrepancies.

Transferability

Transferability is defined as the degree to which the study outcomes can be generalized to another population (Munhall, 2012). Sample size and the diversity of the participants are some of the factors that determine the transferability of the study outcomes. The study participants came from different healthcare facilities and fulfilled the selection criteria. Furthermore, the participants consisted of male and female healthcare managers. Therefore, this study results may have some transferability since the participants had some diversity (Table 1). The interview questions were the same for each participant and I did not significantly interfere when they responded.

Study Results

I designed the interview questions to be direct so that the participants can answer directly without deviating from the main focus of the questions. I linked each interview question to a research question except the first two questions, the focus of which were to understand the existing technology that the healthcare managers currently use and the ideal technology that they would prefer to have. I linked the research questions and interview questions as shown in Table 3.

Table 3

Link between Research Questions and Interview Questions

Interview question	Research question
Which technology-based interventions do you use in your facility?	Not applicable
What would be an ideal technology-based intervention method that you would need to effectively perform your job?	Not applicable
How do you feel about using the technology for patient engagement? Do you think that it will improve the patient engagement and treatment compliance?	RQ1a: What are the attitudes of healthcare managers toward the use of technology in OSA patient engagement that could lead to improved treatment compliance?
Why do you feel positive/negative about the technology-based interventions for patient engagement? What factors are responsible for your feeling towards technology-based interventions?	RQ1b: What factors are responsible for the attitudes of healthcare managers toward the use of technology for OSA patient engagement that could lead to improved treatment compliance?
In your opinion, how useful is the technology for patient engagement and treatment compliance?	RQ2a: What are the perceptions of the healthcare managers about the usefulness of the technology to engage with the OSA patient for improved treatment compliance?
What are the challenges and opportunities to make the technology useful for the patient engagement?	RQ2b: What are the challenges and opportunities that the healthcare managers perceive in making technology useful for OSA patient engagement that could lead to improved treatment compliance?
Do you think that it would be easier to use technology-based interventions for patient engagement?	RQ3a: What are the perceptions of the healthcare managers about the ease of using technology for the OSA patient engagement that could lead to improved treatment compliance?
What challenges and opportunities exist to make the technology easier to use for patient engagement.	RQ3b: What are the challenges and opportunities that they perceive in making technology easier to use for OSA patient engagement that could lead to improved treatment compliance?

I analyzed the 41 codes for themes that I can use to answer the research questions. Interestingly, when asked about the challenges exist in making the technology useful (Interview Question 6) and those in making it easier (Interview Question 8), participants identified similar challenges in both contexts. Similarly, the participants explained similar opportunities in related to making technology useful (Interview Question 6) and easier (Interview Question 8).

The responses to Interview Question 3 on the attitudes of the healthcare managers toward technology, three themes, namely positive attitude, negative attitude and neutral attitude, emerged from the response. For Interview Question 4 about the reasons for such attitude, I identified 11 reasons (themes) outlined by the participants when I asked about why they have positive or negative or neutral attitudes. Participants responded to the questions on easiness (Interview Question 5) and usefulness (Interview Question 6) elaborately and I treated them as separate themes in their own right. Interview Question 7and Interview Question 8were on the challenges and opportunities, and I treated challenges and opportunities as separate themes.

Interview Question 3

As discussed above, three themes emerged from the responses of participants to the question 'how you feel about using the technology for patient engagement?' These themes are the positive attitude towards technology, negative attitude towards technology, and neutral attitude towards technology. The following responses were related to the first theme, that is, positive attitude towards technology:

1-F-[5878:6022]

We would be able to engage patients more frequently and reminders, as long as not too annoying, it would be beneficial, probably 85% of the time

1- F - [1785:1842]

I feel technology for patient engagement is very helpful.

10-F- [765:1290]

Sure, it seems like we have the ability to get in touch with far more patients now that we did a few years ago, and with getting data from their CPAP machines directly, we do not have to spend as much time with them on the phone and can allow for more automated surveys.

Of course, that will also improve the compliance rate because we actually touch every patient and give the reassurance that we, as a representative on behalf of our client, are there for them. If they have that, they will comply better and remain loyal.

11-F-[613:840]

I think it is great and the only way of the future to use technology to reach out to patients. That way, we can tell if they need help with their CPAP machine before it's too late and make sure they get the best care possible.

12-F-[1102:1352]

Yes, the more information available, the better intervention there is and that gives opportunity for more compliant patients. The exchange of data and information is the only way for this to happen efficiently and that only comes through technology.

13-F-[1182:1809]

Patient engagement is reliant on technology in our era, and I concur that it must be. It helps to streamline the quality of care allowing for more patients to be taken care of

and having the data to take care of them in a more timely fashion. For instance, with our OSA patients, we can see their compliance and usage data through a direct link with the manufacturer of their PAP equipment. Therefore, we can inform our clients about the patients who need intervention much earlier than two year ago without that technology. If authorized, we will just jump in and offer encouragement to the patient with a risk assessment.

15-F- [1015:2207]

In my opinion, technology for patient engagement is inevitable with technological progression of society. It also is beneficial for streamlining workflows for all parties involved whether the subscribed payer physician provider, medical equipment provider, facility provider, EMR system, management/billing system, device manufacturer, or patient engagement platform… and all those third parties in between.

Of course, engagement and compliance would benefit from the use of technology with outcome-based responses and real-time reporting, information is in abundance not only for the ability to intervene for increased compliance, but also for studies that could be lucrative to the future of care in general or for specific diseases like obstructive sleep apnea.

For instance, a patient who is not compliant with a positive-airway-pressure device within their first couple of weeks, in the past, without the technology, may have never gotten compliant prior to the payer need for reimbursement. Therefore, the patient would lose the care they needed. With current technology, early intervention is

possible and key for improving their compliance so that they can stay on long-term care.

16-F-[664:918]

Patients who are properly taught how to use their CPAP machine and kept engaged, not only have better care, but also are loyal patients later. Using the application to keep in touch with patients makes them feel like we are always there for their needs.

17-M- [619:704]

It works better than waiting on them to call back and makes them use their cpap more

18-F- [666:970]

Technology definitely makes work easier and faster. If we had automated phone calls telling patients the CPAP supplies they are eligible for and when they are eligible for then, they can call to say yes or no. It will save time, and they will know ahead of time what CPAP supplies they are eligible for.

19-F-[517:980]

Technology makes work easier and faster. Yes, it does improve patient compliance with all their equipment, especially for OSA. They get automated reminder calls to fill their prescriptions when they are due to be filled, or when they are ready to be picked up. Sometimes elderly patients do not have a ride, and they have to wait for someone to take them. So, we have delivery system too at CVS. It helps a lot for service which in turn increases compliance.

2-F- [1021:1981]

Patient engagement helps with quick responses, no downtime in care. Being patient-centric is ideal situation for patient comfort and loyalty. Then, the treatment

compliance is much better in turn. If the contact tool is strong, therefore patients would be more apt to use supplies and need to replace them too.

To perform my job, it would be helpful to have more data. The patient gets frustrated when I cannot take their payment or see more of their history or account information and even the compliance data and rates from their CPAP machine. Then, they lose faith in our contact solution. If they have confidence in the engagement process, they will stick to their sleep apnea treatment plan better too. We establish a relationship with the patient and ask about their usage nightly and how many nights per week. If they need more intervention, I get them to the respiratory therapist via the Alert notification within our software application.

2-F-[5177:5766]

Sure, it is more efficient because now you can reach out to a larger population of patients. There are benefits of both because there are still patients, especially the older population, or patients who want to remain on a live-call platform because they know they will have questions. The younger generation and middle-aged patients want the technology to incorporate into their schedule. However, those e-mails get forgotten, and they need a call as a reminder to check that e-mail. That could be powerful, and I know this from my son's own diabetic adherence and supply replenishment.

20-M-[5804:5974]

They can keep track of certain things. They can give reminders they can also intervene at certain stages. Caregivers are better informed for a better plan of treatment.

3-F- [992:1206]

Yes, because the medical team always has the patient information readily available, and anyone working the floor, even if not their patient, can read clinical notes immediately and engage patient more effectively.

3-F- [1310:1350]

Positive - information readily available

4-F- [404:416]

Yes it does

5-F- [3035:3270]

So, I think technology has been very positive from that perspective because again before we had that, it was kind of hit or miss and the patients like the doctor said I had to have the machine, so I have it but it's sitting in a closet.

6-F- [995:1671]

A lot of serious health issues can be avoided with proactive engagement because we can direct a patient toward the right intervention with keeping that contact with them open. Then, they will be more compliant. It should start with the live call and give them the option of the automated IVR call or e-mail contact mode. For instance, most of the older generation patients want human interaction and do not use technology to communicate. So, it should be based upon the needs and convenience of the patient. The technology keeps down room for error with visual plus data transfer in the e-mail survey, but there is some room for human error with the live-call contact mode.

7-M-[2243:2338]

I think it's very useful because now in this age everyone is connected especially our patients.

7-M-[5588:5781]

It I think as we discussed before, that technology in the era we are living, automatic reminders and tools of compliance are really useful in quality of care and improvement in quality of life.

8-M-[562:808]

We have to use our computers for electronic medical records. This allows the treating physician to see what is going on with their patient immediately. Also allows the on-call nurse immediate access should patient need assistance after hours.

8-M-[1909:2294]

Very useful. If I am having an issue with a patient the treating physician can log in and read all notes, and effectively help me to manage the patient's care, if it is something I am not able or allowed make a decision on based on being the nurse, not the physician. I can also continue with immediate care of the patient while waiting for the physician to respond or be available.

The second theme is the negative attitude towards using technology-based interventions for patient engagement and the following responses are relevant to this theme:

20-M-[5975:6409]

The negative side is that we cannot replace human mind with technology. So definitely technology can give us certain ideas and certain solutions, but they cannot in my opinion they cannot make complex judgments they cannot have

emotional or replace things when. Talking to a patient would never be replaced by a technology. It's not possible to completely replace human interaction. People think that and that is the negative side.

3-F-[1353:1485]

Negative - carrying tablet in every patient room, having to find a secure place to place tablet when providing hands on patient care

The third theme is neutral attitude, where the participants expressed both positive and negative views. The following responses align with third theme:

20-M-[5975:6409]

The negative side is that we cannot replace human mind with technology. So definitely technology can give us certain ideas and certain solutions, but they cannot in my opinion they cannot make complex judgments they cannot have emotional or replace things when. Talking to a patient would never be replaced by a technology. It's not possible to completely replace human interaction. People think that and that is the negative side.

3-F- [1353:1485]

Negative - carrying tablet in every patient room, having to find a secure place to place tablet when providing hands-on patient care

Interview Question 4

I investigated which factors are responsible for the positive attitudes of the participants toward technology through Interview Question 4. Eleven secondary codes emerged, and I grouped them into the following themes: system related (relevant codes:

deficient system, automation efficient communication, and fast system), time-related (relevant codes: busy schedule, call duration, and reminders), and process related (relevant codes: absence of personal interaction, engagement of more patients, less call and more data). The following responses captured the first theme related to the responses to Interview Question 4, that is, the system related theme:

10-F [288:392]

There is too much guessing with our system which is used to manage patient engagement and its outcomes.

11-F [1311:1559]

But before, we had to wait until we had the time to call them even as the third party, and THEN find out what was going on. Even further, we would have to inform the provider who would have to reach out to the patient again. It was not efficient.

1-F [1346:1630]

So, there are other ways they don't even have to speak to a person. They can just get their CPAP supplies shipped to them directly every month or every three months. They don't have worry about speaking to anyone or having to even remember that they need those supplies for their OSA.

10-F [1512:1627]

We are able to touch more patients due to having more data and more automation within the patient engagement tools.

18-F [718:875]

If we had automated phone calls telling patients the CPAP supplies they are eligible

for and when they are eligible for then, they can call to say yes or no

1-F [2911:3006]

Getting rid of all of that would allow me to speak to more people and even reach

more patients.

1-F [2595:2716]

Also, it would allow me to speak to more patients throughout the day because they

would cut out some of the smaller steps

17-M [324:454]

If I had a better way to communicate if they did not answer the phone, it would work

better. a lot of times, they never call back.

17-M [619:704]

It works better than waiting on them to call back and makes them use their CPAP

more

2- F [3080:3335]

Our proactive engagement is a huge benefit for them. Otherwise, they may give up

and not even proceed with therapy, will not be compliant, and even stop treatment

just because they don't know how to use it. Then, that OSA patient is the one who

suffers.

2- F [1222:1336]

If the contact tool is strong, therefore patients would be more apt to use supplies and

need to replace them too.

2- F [1397:1573]

The patient gets frustrated when I cannot take their payment or see more of their history or account information and even the compliance data and rates from their CPAP machine.

3-F [992:1206]

Yes, because the medical team always has the patient information readily available, and anyone working the floor, even if not their patient, can read clinical notes immediately and engage patient more effectively.

5-F [2495:2697]

Before you never used to get data in real time then you have to wait 30 days and then finding out. Now you have a new solution for technology-based solution. Now you have data availability even sooner.

5-F [3875:4007]

The factors contributing to the positiveness are because we have a quicker response quicker feedback to the patient and their usage.

The following responses are relevant to the second theme, which is the time-related theme:

1-F [4174:4270]

Sometimes they don't want to talk on the phone, or are just don't have the time in the day due to work, maybe school, hectic schedules, and no time

12-F [3600:3741]

The industry seems overwhelmed with workload so much so that no one has the time to get those challenges addressed and solutions implemented.

13-F [3101:3205]

With that is taking care of their needs in their own time, not when we are able to call during the day.

13-F [3206:3318]

Technology allows for our assessments to be done at their convenience, and we still get the information we need.

15-F [3923:4151]

Other generations following grew up with the technology, and in turn, seem to prefer the convenience of taking care of business on their own terms via technology rather than speaking to a human during "regular business hours."

6-F [512:599]

Those who are busy and work, like to respond to e-mail because that requires less time.

1-F [4273:4616]

That's a disadvantage to a live call or video call. Those types of calls last me 30-40 seconds, but as opposed to those where the call can last eight or even 20 minutes because the patient just keeps talking because they either want someone to talk to or they want to explain their comorbidities and they feel comfortable with the live call.

1-F [6091:6321]

Then there are those difficult patients who just want to talk and will not let you get off the phone because they are lonely or those who take the extra time because they really just don't know how to care for their CPAP machine.

11-F [2673:2877]

Even though we seem to be in an age of information overload, patients want to be able to answer all their billing, compliance, cleaning, and resupply questions on one call in as little time as possible.

1-F [3309:3391]

So, I had to set a reminder on my phone to make sure I use the device each night.

1-F [3659:3747]

So, it really does help those patients and those who are also very busy to remind them.

1-F [4992:5040]

Even doctor offices call to remind of patients.

20-M [5843:5909]

They can give reminders they can also intervene at certain stages.

20-M [7777:8020]

Make my nurse's job easier and they'll get easier reminders and will be able to screen those patients certainly and the system will give us alerts and will tell us what needs to be done if this patient needs an early follow-up or not complying.

5-F [1581:1661]

The advantage of reminding them from time to time has a positive effect to that.

5-F [2130:2203]

We need some way to alert the patient and get them to be more responsive.

5-F [2368:2492]

Regarding the previous question, being able to remind the patient when they are not OSA compliant would be a positive effect

5-F [6443:6575]

That's why I said earlier that I wish it would kind of beep at him at night and say, "Hey, I'm plugged in, but you're not using me!"

7-M [2815:3040]

So, if we can talk to the patient about sleep hygiene and make them compliant by certain matter using electronics that reminding them that they should not delay their sleep, this should not use caffeine will be really useful.

7-M [3717:3954]

I think that's a very useful way of for and it is very positive in the sense that if you use technology to remind patients to follow through with compliance, and it will definitely improve the quality of care and improve their condition.

7-M [5588:5781]

It I think as we discussed before, that technology in the era we are living, automatic reminders and tools of compliance are really useful in quality of care and improvement in quality of life.

The process related theme, which is the third theme emerged from the responses to Interview Question 4 as follows:

1-F [4123:4169]

Sometimes they don't want to talk on the phone

15-F [3923:4151]

Other generations following grew up with the technology, and in turn, seem to prefer the convenience of taking care of business on their own terms via technology rather than speaking to a human during "regular business hours."

17-M [1836:1956]

Sure, some folks don't want to be bothered with our calls, but we too even depend on technology to make our "live calls"

1-F [2911:3006]

Getting rid of all of that would allow me to speak to more people and even reach more patients.

10-F [1512:1627]

We are able to touch more patients due to having more data and more automation within the patient engagement tools.

11-F [2321:2459]

Yes, it is easier for tech-based intervention because I can call many more patients with our system than I ever could with a spreadsheet.

13-F [1269:1425]

It helps to streamline the quality of care allowing for more patients to be taken care of and having the data to take care of them in a more timely fashion.

15-F [2964:3191]

Without such, the overworked home medical equipment providers' employees would not be able to handle the patient load much less perform the necessary early intervention posed by the insurance providers' 90-day compliance rules.

16-F [1118:1298]

My job is easier because I have less incoming calls and less questions for patients myself with the information from the application that calls and e-mails our sleep apnea patients.

16-F [1299:1388]

This allows me time to deal with the patients who are not doing well with sleep therapy.

16-F [1498:1650]

As I said above, taking care of the patients who need more attention is important with sleep apnea, and with technology, I can do this more efficiently.

2- F [5177:5268]

Sure, it is more efficient because now you can reach out to a larger population of patients.

20-M [7454:7776]

It's going to help me to have a system available, it will make treatment easier because I if I'm not if I have 200 patients I'm following I'm following up in my sleep clinic and out of 200 if I have to if I have this availability and at least 150 of those patients will get help of those 200 and will make my job easier.

1-F [6026:6089]

Too many calls and the headache of them would be less effective.

10-F [934:1035]

We do not have to spend as much time with them on the phone and can allow for more automated surveys.

10-F [235:287]

Having more data and a system that worked properly.

10-F [469:600]

We do not have access to the information we often need and have to circumvent the whole point of the application to get work done.

10-F [1512:1627]

We are able to touch more patients due to having more data and more automation within the patient engagement tools.

10-F [2038:2173]

Challenges that exist are that we still need more data, a system that can process that data, and a better tool to assess the patients.

10-F [2432:2514]

Sure, we can reach more patients in less time giving far more measurable outcomes.

11-F [1938:2207]

If we had better access to other systems and data, not only could we care better for the patient and be more timely, but also, the patient would have better confidence in us as the callers if we could answer all their questions no matter what "department" we were from.

11-F [2648:2673]

We need more information.

12-F [1102:1226]

Yes, the more information available, the better intervention there is and that gives opportunity for more compliant patients

12-F [1229:1352]

The exchange of data and information is the only way for this to happen efficiently and that only comes through technology.

12-F [1552:1757]

We can better assess an OSA patient's need for intervention only based upon this exchange of information, whether it comes from device data from the manufacturer or subjective information from the patient.

13-F [560:607]

We could perform ideally with more information.

13-F [609:707]

Our application has not grown with our need, and clients often only provide the bare minimum data.

13-F [766:1017]

If we could have a system that also gave us more information instead of relying on our IT team to answer questions and keep all the reasons "in their head" instead of in our system, it would streamline so much of our day when reaching out to patients.

13-F [2832:2910]

We are desperate for information in what is supposed to be an information era.

13-F [3434:3599]

More artificial intelligent systems versus strict yes/no-based assessments and more easily-accessible data would make it easier for both the assesser and the patient.

15-F [1424:1781]

Of course, engagement and compliance would benefit from the use of technology with outcome-based responses and real-time reporting, information is in abundance not only for the ability to intervene for increased compliance but also for studies that could be lucrative to the future of care in general or for specific diseases like obstructive sleep apnea.

17-M [1613:1722]

Sometimes the patients don't trust us when we call because we do not have access to all of their information.

17-M [2072:2101]

We just need more information

18-F [288:499]

Computers, automated phone calls, correct data, working phone numbers of the patients, and information about when they got the supplies last time and if they got it at the doctor's office or at the sleep center.

2- F [1338:1396]

To perform my job, it would be helpful to have more data.

2- F [2735:2825]

Having everything at our fingertips efficiently is a positive as long as we have the data.

2- F [6094:6298]

If we had more in-depth demographic information, we could better determine how best to categorize the mode of contact for the specific patient. We are in a gap of the tech savvy and those who refuse it.

20-M [5912:5974]

Caregivers are better informed for a better plan of treatment.

20-M [7180:7294]

If you if you confront them with actual proof and data, know what the actual problem is, you can help them better.

3-F [1310:1351]

Positive - information readily available.

6-F [3139:3357]

They may tell me they are using their machine every night since they do not want to be judged, but the compliance data from the manufacturer may show they are not and still need our intervention before it is too late.

6-F [4357:4419]

I can be more informed about necessary intervention timely.

7-M [3955:4086]

The negative of this is there can only be intervention if we know how much patients will be including that in their life lifestyle.

Interview Question 5

The primary theme that emerged from the responses to Interview Question 5 was the usefulness of the technology. The participants generally expressed the level of usefulness as very useful. For example, 19-F said that "It is very useful, it increases patient compliance and improves their health then." Thus, the responses are mostly on one end of the spectrum. Thus, I considered the responses as single-themed and the relevant responses that captured this theme are as follows:

1-F [1785:2116]

I feel technology for patient engagement is very helpful. In my mind, I think about how to make the patients become more aware of what they're doing and how their health is being affected by what kind of supplies that they use and how involved they are in their OSA, being on top of what they need, and how they interconnect that.

1-F [4849:4990]

Very important because if left to their own CPAP devices, a lot of patients would not remember to manage their OSA like they are supposed to.

11-F [1669:1823]

With the number of patients receiving care nowadays, it is very useful so that we can intervene early on as mentioned above for patients with sleep apnea.

12-F [1102:1352]

Yes, the more information available, the better intervention there is and that gives opportunity for more compliant patients. The exchange of data and information is the only way for this to happen efficiently and that only comes through technology.

12-F [2060:2162]

The usefulness comes with the growing number of patients and the lessened physician-to-patient ratio.

13-F [1182:1809]

Patient engagement is reliant on technology in our era, and I concur that it must be. It helps to streamline the quality of care allowing for more patients to be taken care of and having the data to take care of them in a more timely fashion. For instance, with our OSA patients, we can see their compliance and usage data through a direct link with the manufacturer of their PAP equipment. Therefore, we can inform our clients about the patients who need intervention much earlier than two year ago without that technology. If authorized, we will just jump in and offer encouragement to the patient with a risk assessment.

13-F [2311:2602]

As already discussed, that early intervention is key for compliance. Two years ago, we may not have known if an OSA patient were noncompliant early enough to intervene and get them compliant before their compliance period was over. Then, their insurance company would not have covered their sleep-apnea therapy.

15-F [2808:3191]

Technology aids in streamlining the patient engagement platform such as ours, and therefore the increases outcomes and potential for compliance treatment. Without such, the overworked home medical equipment providers' employees would not be able to handle the patient load much less perform the necessary early intervention posed by the insurance providers' 90-day compliance rules.

16-F [1498:1650]

As I said above, taking care of the patients who need more attention is important with sleep apnea, and with technology, I can do this more efficiently.

17-M [1218:1498]

As I said above, makes it better because our clients just sit back and wait on us to reach out to their patients. Patients need to know our clients are there for them since this whole new treatment plan is significant to a person's life… even though the client does it every day…

18-F [1399:1513]

It is very useful as it increases patient compliance with their CPAP machines, and they get their supplies timely.

19-F [1409:1491]

It is very useful, it increases patient compliance and improves their health then.

2- F [2936:3078]

It is huge! So many patients in our community are aging, cannot get out, will not go online, or sometimes even make a call to their provider.

2- F [3080:3335]

Our proactive engagement is a huge benefit for them. Otherwise, they may give up and not even proceed with therapy, will not be compliant, and even stop treatment just because they don't know how to use it. Then, that OSA patient is the one who suffers.

20-M [6958:7294]

So, I think a patient would engage more with you and tell you more of their problem rather than if they straight away tell you they are using it and are very happy. Then, they don't want to discuss anymore. Case closed. If you if you confront them with actual proof and data, know what the actual problem is, you can help them better.

3-F [1587:1806]

In a nursing home environment, as an example, if patient is required to have sleep therapy, the respiratory therapist can access patient electronic chart to see how the patient is doing, before interrupting their care.

5-F [4258:4400]

On a scale of 1 to 10, I would probably say it's an 8. Even with improvements in data collection, technology always has room for advancement.

6-F [2228:2518]

Significantly useful for engagement and compliance both. For instance, the patient may be better educated for the use of care if they have questions or were not told how to use their machine like if they did not know they were supposed to use their CPAP machine for four hours per night.

7-M [2243:2339]

I think it's very useful because now in this age everyone is connected especially our patients.

7-M [5588:5781]

It I think as we discussed before, that technology in the era we are living, automatic reminders and tools of compliance are really useful in quality of care and improvement in quality of life.

7-M [3717:3954]

I think that's a very useful way of for and it is very positive in the sense that if you use technology to remind patients to follow through with compliance, and it will definitely improve the quality of care and improve their condition.

Interview Question 6

Interview Question 6 was about the challenges and opportunities in making the technology useful for patient engagement. The respondents generally identified challenges and opportunities related to the usefulness of technology (Interview Question 6) as similar to those related to the easiness of the technology (Interview Question 8). For example, respondent 10-F said that "Challenges that exist are that we still need more data, a system that can process that data, and a better tool to assess the patients." According to 10-F, technology is still not comprehensive enough to provide the required data, which is a significant challenge. However, the participants did not clearly understand whether this challenge is related to usefulness or easiness of the technology. Furthermore, some participants responded to my question about the challenges and

opportunities related to the easiness of the technology with "same as above". Hence, I present the challenges specific to easiness here and I will present the combined challenges in a separate sub-section at the end. Similarly, the opportunities are generally relevant to both easiness and usefulness. Hence, I will also present the opportunities as a separate sub-section. The responses related to challenges to make the technology useful are as follows:

1-F [5146:5235]

Again, age, where they live, access to technology, and their technological comfort level.

1-F [5500:5615]

Most folks do not understand how that a healthier lifestyle, or even just losing weight, would eliminate their OSA.

1-F [5618:5774]

They are not aware of the bacteria and importance of cleaning supplies, and if were educated, would be much more proactive about their health in this regard.

10-F [2038:2172]

Challenges that exist are that we still need more data, a system that can process that data, and a better tool to assess the patients.

10-F [2174:2318]

The opportunity is there, and the solutions seem simple, but keeping up with new dev when keeping current client surveys running is a challenge.

15-F [3306:3404]

Challenges faced by my organization go back to the "universal interoperability"

alluded to before.

16-F [1765:1924]

Seems like there are some breaks in communication on the back side of things,

and if all of these systems could just work together, the patients would benefit.

17-M [1613:1722]

Sometimes the patients don't trust us when we call because we do not have access

to all of their information.

18-F [1630:1743]

Some patients don't have computers or don't know how to use them. Sending

them e-mail reminders would be useless.

5-F [4516:4585]

With sleep apnea, the biggest challenge is patient usage/compliance.

7-M [4231:4369]

It may make some patients non-compliant and push themselves away from the

care or caregiver, and that could be a negative aspect of this.

Interview Question 7

The easiness of the technology was the theme emerged from the responses to

Interview Question 7. The participants generally expressed the level of easiness, though it

is difficult to group them into "very easy," "moderately easy," and "difficult." For

example, 12-F said that "[Y]es, technology-based interventions would make patient

engagement easier." The relevant responses are as follows:

1-F [5878:6023]

We would be able to engage patients more frequently and reminders, as long as

not too annoying, it would be beneficial, probably 85% of the time.

10-F [2432:2514]

Sure, we can reach more patients in less time giving far more measurable

outcomes.

11-F [2321:2532]

Yes, it is easier for tech-based intervention because I can call many more patients

with our system than I ever could with a spreadsheet. Also, patients like to be

contacted more when it is convenient for them.

12-F [3055:3206]

As mentioned before, yes, technology-based interventions would make patient

engagement easier for those informed patients and those willing to use it.

13-F [3024:3318]

Of course, because today's patient has become used to instant gratification. With

that is taking care of their needs in their own time, not when we are able to call

during the day. Technology allows for our assessments to be done at their

convenience, and we still get the information we need.

15-F [3735:4151]

Absolutely technology intervention would make patient engagement more

feasible. The baby boomers are becoming the elder generation, and they too are

technology driven for the most part. Other generations following grew up with

the technology, and in turn, seem to prefer the convenience of taking care of business on their own terms via technology rather than speaking to a human during "regular business hours."

16-F [2038:2161]

Sure, since most folks now days grew up with or are familiar with technology, we can better communicate with them this way.

17-M [1836:1956]

Sure, some folks don't want to be bothered with our calls, but we too even depend on technology to make our "live calls"

18-F [1860:1870]

Yes, I do.

20-M [8807:9053]

Similarly, I think the more you make them easier to interface, obviously they would they would be more willing to use those things. But if I have to go over firewalls and complex things to achieve a simple thing, I too would stay away from it.

4-F [1318:1361]

Not in all cases but yes for the most part

5-F [5293:5619]

Yes. Even within our support team for the patients: some of our respiratory therapists have been doing this for 20 even 30 years. Technology has changed so much for them that sometimes, it presents challenges. Once it's accepted, it's

benefitted them, and they know how that embracing it helps the patient's sleep

therapy.

6-F [2989:3458]

Caregivers and tech can better collaborate where a patient may be in denial and

just state they are doing fine, when the data may show they are not. They may tell

me they are using their machine every night since they do not want to be judged,

but the compliance data from the manufacturer may show they are not and still

need our intervention before it is too late. Then, the caregiver, provider, and

patient are all better informed, and the level of care is better.

7-M [7553:7611]

Its ease-of-use of technology will improve the engagement.

Interview Question 8

Interview Question 8 was about the challenges and opportunities in making the

technology easier for patient engagement. As discussed before, the respondents generally

identified similar challenges and opportunities in relation to the easiness of technology

(Interview Question 8) and those in relation to the usefulness of the technology

(Interview Question 7). For example, respondent 1-F said that "So, each patient is

different and how they respond to engagement is different." In this case, the diversity of

patients can improve or decrease the usefulness and easiness of technology for patient

engagement. Hence, I present the challenges specific to easiness here and I will present

the combined challenges in a separate sub-section at the end. Similarly, the respondents

did not clearly distinguish the opportunities in making the technology 'easier' and

'useful'. Hence, I will present the combined opportunities at the end. The responses

related to challenges to make the technology easier are as follows:

1-F [6025:6090]

Too many calls and the headache of them would be less effective.

1-F [6757:6890]

Availability of resources, age of the patient… as I said before, the patient

themselves and their personalities would be a challenge.

13-F [3434:3599]

More artificial intelligent systems versus strict yes/no-based assessments and

more easily-accessible data would make it easier for both the assessor and the

patient.

16-F [2277:2510]

If all these systems we use could speak to one another, let each other know when

updates are happening, the patient could have better care, but we are doing better

than even five years ago with the technological advancements already.

17-M [2072:2101]

we just need more information

2- F [5882:6029]

Challenges we have discussed are the elderly patients or poor patients without

access to internet, computer, even voicemail, or even desire for it.

20-M [9957:10063]

And as I said before, should be not only easier for the person who is using it, but also for the patient.

20-M [10622:10691]

An easy-to-use user interface for both the patient and the physician.

6-F [3574:3681]

Some challenges are the patients who are not used to using technology and those patients being compliant.

7-M [8326:8446]

They can find it available all the time. They should not feel like that they have to struggle by learning a new skill.

7-M [7727:8258]

As you mentioned, the age, experience, and education level of patients for use of technology is one challenge for ease-of-use so the patient can be engaged in that particular process. Improving access to the technology, to the knowledge, and to the information to advance care modalities. That's another one. The other thing is that the patient should feel that there is a support system that is available and a clinical component as a physician or staff is available. That could be a situation where patients would comply more.

Challenges to Make Technology Useful (Interview Question 6) and Easy (Interview Question 8) for Patient Engagement

In addition to specific responses to the challenges of usefulness and easiness of technology for patient engagement, the respondents also provided non-specific responses

when asked about the challenges. I grouped the responses into the following themes: technology-related challenges (relevant codes: technology, proper system, cost and solutions), and patient-related challenges (relevant codes: diversity, and technically challenged patients). The following responses captured technology-related challenges theme:

10-F [2038:2318]

Challenges that exist are that we still need more data, a system that can process that data, and a better tool to assess the patients. The opportunity is there, and the solutions seem simple, but keeping up with new dev when keeping current client surveys running is a challenge.

10-F [2630:2962]

Finding just the right time to catch a patient when it is convenient for them, making the call fast enough for someone who wants to speed through it, but slow enough for someone who just does not understand/hear it, and keeping a patient's confidence when we do not always have all the information we need to answer their questions.

11-F [1938:2206]

If we had better access to other systems and data, not only could we care better for the patient and be more timely, but also, the patient would have better confidence in us as the callers if we could answer all their questions no matter what "department" we were from

11-F [2648:2877]

We need more information. Even though we seem to be in an age of information overload, patients want to be able to answer all their billing, compliance, cleaning, and resupply questions on one call in as little time as possible.

12-F [2616:2941]

Interoperability is key, and even with the technological advances in our era, still this is severely lacking. Communication among healthcare professionals must be seamless in the near future or the information overload will explode, and the lack of a framework will cause care to crumble before it has a chance to get better.

12-F [3477:3554]

Information sharing, interoperability, and patient education are challenges.

12-F [3600:3741]

The industry seems overwhelmed with workload so much so that no one has the time to get those challenges addressed and solutions implemented.

13-F [2717:2830]

Both a challenge and opportunity exist in connectivity and having systems speak with one another on the back end.

13-F [3434:3599]

More artificial intelligent systems versus strict yes/no-based assessments and more easily-accessible data would make it easier for both the assessor and the patient.

15-F [3306:3621]

Challenges faced by my organization go back to the "universal interoperability"
alluded to before. Not all entities are willing to work [agnostically] with others in
fear of losing some proprietary knowledge and therefore missing out on revenue.
The system is not patient-centric. It is very much revenue-driven.

16-F [1765:1924]

Seems like there are some breaks in communication on the back side of things,
and if all of these systems could just work together, the patients would benefit.

16-F [2277:2510]

If all these systems we use could speak to one another, let each other know when
updates are happening, the patient could have better care, but we are doing better
than even five years ago with the technological advancements already.

17-M [1613:1722]

Sometimes the patients don't trust us when we call because we do not have access
to all of their information.

18-F [1630:1744]

Some patients don't have computers or don't know how to use them. Sending
them e-mail reminders would be useless.

18-F [1988:2193]

Some patients are very rude. They are mean they even start cussing. I have an
accent, and some people make rude comments like "what language are you
speaking?" The automated system would help with that.

19-F [1966:2367]

If the prescriptions are not ready on time, the patients get upset since they are already sick. If the person typing the prescriptions is slow, they do not get filled on time, and the pick-up time increases. If the doctor's office makes any mistakes, it causes problems for us to have to verify things. Sometimes the drugs or devices they need are not available, and we need to special order them.

2- F [3450:4644]

The challenges that I face personally like I said earlier are not being able to tell the patient what their cost is. Also, when we send in alerts and exceptions to the provider, we really don't follow those. I wish there was a way that we would see the follow up just for personal. We know that the patient hasn't just been left behind. That always concerns me especially when they have my name, that we're going to do something. Even though I put it in my notes, sometimes there was no follow up by the provider who is our client.

Even though that responsibility goes back on the client, we are the ones engaging the patient. I see it as a personal responsibility to that patient. That is the biggest challenge I see because sometimes patients do call back and they're mad because they haven't received a response and are upset. Of being able to quickly access the cushion that goes with that mask, that being that you know that can be a challenge sometimes or trying to find the right pieces and parts to go with that machine if not ordered before. A system with a knowledge base of the products listed and having those products available for quick reference is a significant challenge.

2- F [5882:6299]

Challenges we have discussed are the elderly patients or poor patients without access to internet, computer, even voicemail, or even desire for it. Today I had a patient without even power due to lack of income. If we had more in-depth demographic information, we could better determine how best to categorize the mode of contact for the specific patient. We are in a gap of the tech savvy and those who refuse it.

20-M [9957:10172]

And as I said before, should be not only easier for the person who is using it, but also for the patient. And again, if a patient has a problem they should be they should be able easily approachable with a reminder.

20-M [10622:11045]

An easy-to-use user interface for both the patient and the physician. It must also be cost-effective than actually bringing the patient in the clinic or if the system can avoid something which is going to cost more or is inevitable, but you can stop it based all the technological interventions that you can do beforehand, would definitely be more desirable. Cost-effective health outcomes too would be much more desired.

4-F [1116:1204]

Very challenging for senior patients or adults that are not up to date with technology

4-F [1477:1553]

Many challenges such as training and constant update from the customer side

5-F [4516:5179]

With sleep apnea, the biggest challenge is patient usage/compliance. More and more people are diagnosed with sleep apnea and provided with PAP equipment when I, unfortunately, I do think that there are other alternatives such as losing weight. There are other contributing factors, and as a society, we tend to just give a piece of equipment or this medication rather than looking at some of the underlying causes and changing that.

There has to be has there should be a better way to prescreen these patients for sleep apnea. So, if those factors are addressed, then treatment might not go that far as using a CPAP device: being proactive instead of reactive.

6-F [3574:3784]

Some challenges are the patients who are not used to using technology and those patients being compliant. They may not respond well to technology-based engagement. Minimizing steps for the patient is ideal.

6-F [3785:4111]

So, with the IVR, patients do not like "robo" calls. They like the truly interactive feel like with Siri or Alexa. IVR is not as good as these interactive intelligences yet, but the younger generations find it more convenient than a live call and know how to use it and be more patient with it when it is not as interactive.

7-M [4230:4369]

It may make some patients non-compliant and push themselves away from the care or caregiver, and that could be a negative aspect of this.

7-M [6756:7054]

While technology is available, but it's not available to everybody necessarily available to everyone like in some part of the different states and countries where a country that the Internet availability is not always available, but with the Bluetooth technology it can be overcome in certain way.

7-M [7727:8687]

As you mentioned, the age, experience, and education level of patients for use of technology is one challenge for ease-of-use so the patient can be engaged in that particular process. Improving access to the technology, to the knowledge, and to the information to advance care modalities. That's another one. The other thing is that the patient should feel that there is a support system that is available and a clinical component as a physician or staff is available. That could be a situation where patients would comply more.

Technologies should be patient-friendly, should have ease-of-use. They can find it available all the time. They should not feel like that they have to struggle by learning a new skill. Then, technology has to be sustainable because patients should feel like it is always available for them. There are much more opportunities in the market now that baby boomers are turning grey, but it has to be comprehensive and connected.

8-M [2400:2483]

Challenges would still be not always having internet access or cell phone service.

20-M [10693:11045]

It must also be cost-effective than actually bringing the patient in the clinic or if the system can avoid something which is going to cost more or is inevitable, but you can stop it based all the technological interventions that you can do beforehand, would definitely be more desirable. Cost-effective health outcomes too would be much more desired.

10-F [235:286]

Having more data and a system that worked properly.

10-F [393:468]

It seems like it cannot keep up with the need and is always breaking down.

13-F [3434:3599]

More artificial intelligent systems verses strict yes/no-based assessments and more easily-accessible data would make it easier for both the assesse and the patient.

2- F [3450:3982]

The challenges that I face personally like I said earlier are not being able to tell the patient what their cost is. Also, when we send in alerts and exceptions to the provider, we really don't follow those. I wish there was a way that we would see the follow up just for personal. We know that the patient hasn't just been left behind. That always concerns me especially when they have my name, that we're

going to do something. Even though I put it in my notes, sometimes there was no follow up by the provider who is our client.

1-F [5237:5326]

Maybe another perspective is needing to educate the patient on OSA and the CPAP therapy.

1-F [5327:5498]

If the providers are easier to get in touch with or better inform the patient of the therapy plan, of course, that support would be incredibly influential for their health.

The patient related challenges theme include diversity and technically challenged patients and the following responses captured this theme:

1-F [6573:6651]

So, each patient is different and how they respond to engagement is different.

1-F [3392:3658]

These older patients don't know how to take care of their supplies, how to remember to use the device, much less remember when they are supposed to get new supplies which may be each month, three months, six months, and sometimes even a year for some CPAP supplies.

1-F [4617:4749]

So, the patient group is definitely a factor as well as age, working environment, urban or rural, and comfort level with technology.

15-F [3816:3921]

The baby boomers are becoming the elder generation, and they too are technology driven for the most part.

18-F [1172:1287]

Personally, I don't feel very comfortable using computers. I like to get phone call as a reminder and not e-mails.

18-F [1630:1743]

Some patients don't have computers or don't know how to use them. Sending them e-mail reminders would be useless.

19-F [1182:1297]

I personally don't feel very comfortable using computers. I like to get phone call as a reminder and not e-mails.

19-F [1608:1721]

Some patients don't have computers or don't know how to use them, sending them e-mail reminders would be useless.

2- F [2948:3077]

So many patients in our community are aging, cannot get out, will not go online, or sometimes even make a call to their provider.

2- F [5270:5462]

There are benefits of both because there are still patients, especially the older population, or patients who want to remain on a live-call platform because they know they will have questions.

2- F [5882:6029]

Challenges we have discussed are the elderly patients or poor patients without access to internet, computer, even voicemail, or even desire for it.

4-F [1116:1204]

Very challenging for senior patients or adults that are not up to date with technology

6-F [1318:1435]

For instance, most of the older generation patients want human interaction and do not use technology to communicate.

6-F [3574:3783]

Some challenges are the patients who are not used to using technology and those patients being compliant. They may not respond well to technology-based engagement. Minimizing steps for the patient is ideal.

7-M [5339:5478]

For instance, an older patient may prefer a live call versus a traveling young professional may want an e-mail to answer in their own time.

7-M [7728:7911]

As you mentioned, the age, experience, and education level of patients for use of technology is one challenge for ease-of-use so the patient can be engaged in that particular process.

Opportunities to Make Technology Useful (Interview Question 6) and Easy

(Interview Question 8) for Patient Engagement

The respondents provided nonspecific responses when asked about the opportunities that exist to make the technology useful and easy for patient engagement. I grouped the responses into the following themes: process related opportunities (relevant codes: tech intervention opportunities, quality of care and treatment compliance), and patient-related opportunities (relevant codes: patient engagement, personal interaction, proactiveness, and tech-savvy patients). The following responses captured process related opportunities theme:

10-F [1737:1923]

Tech is useful for engagement and compliance both by being able to intervene early for patients who need it and greatly increasing their quality of care and therefore compliance as well.

12-F [2060:2501]

The usefulness comes with the growing number of patients and the lessened physician-to-patient ratio. Properly assessing patients through technology with the ability to categorize them with the results allows for physicians and device providers to better focus their efforts toward struggling or needy patients and not waste it on patients that do fine with or not want anything other than the convenience of the technological intervention.

13-F [2717:2830]

Both a challenge and opportunity exist in connectivity and having systems speak with one another on the back end.

2- F [4645:5063]

Opportunities to make the technology more useful for the patient-centric contact, combining multiple systems or just having the data available in our software application. Even being able to add notes just for our own internal staff so we don't have to go to even another e-mail system about a specific patient. It would all be secure for the PHI too. The less steps taking, especially out of the system, the better.

20-M [7409:8116]

Well, I don't see I don't see a big challenge. It's going to help me to have a system available, it will make treatment easier because I if I'm not if I have 200 patients I'm following I'm following up in my sleep clinic and out of 200 if I have to if I have this availability and at least 150 of those patients will get help of those 200 and will make my job easier. Make my nurse's job easier and they'll get easier reminders and will be able to screen those patients certainly and the system will give us alerts and will tell us what needs to be done if this patient needs an early follow-up or not complying. Get them come in the clinic early. So, there is no challenge. There is an opportunity for it.

4-F [617:831]

Very positive because patients can check in at the station without exchanging conversation out loud with the desk person where everyone at the lobby could hear the symptoms and everything is kept more confidential

5-F [831:935]

Having that data available automatically now helps us monitor the patients more closely and more timely.

5-F [1341:1661]

So, it's a much quicker turnaround in response to usage and compliance so that we have a quicker ability to contact that patient and say, "Hey, do you have problems? Don't you like your mask?" Find out what might be the issue with that. The advantage of reminding them from time to time has a positive effect to that.

6-F [2633:2874]

Proactive engagement and technology also make life easier for the caregiver and family because they know someone is looking after their loved ones. Life becomes more convenient, organized, and treatment is more documented and efficient too.

6-F [4112:4602]

The opportunities to make it easier for a patient care if they are doing a survey about their care online exist that I do not have to call them, I can assess their survey results by a report or in detail within their account and all in real time. I can be more informed about necessary intervention timely.

I cannot fathom any disadvantages to the technology at all. I love interacting with my own physician via the portal. I know where to go for everything I need at my own convenience.

7-M [6383:6605]

Using technology we can empower patients to take control of their health is an opportunity to implement and to have an integrated information system available for patients and for compliance and improvement in health care.

8-M [3058:3257]

Now that patient charting is electronic, I am not wasting time with paper charts, double reporting, and not handwriting every detail. So, technology has proven to give me more time with my patients.

13-F [2091:2179]

Technology helps to keep the quality of care there for them, if not, making it better.

15-F [2015:2072]

Therefore, the patient would lose the care they needed.

15-F [2523:2698]

This is definitely a positive in that not only is the quality-of-life better for a human being, but also their life is extended most likely from the continuation of treatment.

16-F [664:808]

Patients who are properly taught how to use their CPAP machine and kept

engaged, not only have better care, but also are loyal patients later.

5-F [2849:3035]

So, it allows the OSA patient to be a better patient: to help them breathe better,

sleep better, do all of the things that CPAP is supposed to do to have them have a

better lifestyle.

5-F [3549:3782]

From a positive perspective for patient engagement, technology has been

beneficial to improve the patient's welfare and health by having tighter monitoring

thus resulting in better usage of the product that they've been provided for.

6-F [3358:3458]

Then, the caregiver, provider, and patient are all better informed, and the level of

care is better.

7-M [3717:3954]

I think that's a very useful way of for and it is very positive in the sense that if you

use technology to remind patients to follow through with compliance, and it will

definitely improve the quality of care and improve their condition.

7-M [5588:5781]

I think as we discussed before, that technology in the era we are living, automatic

reminders and tools of compliance are really useful in quality of care and

improvement in quality of life.

1-F [2117:2381]

It will improve the patient engagement and treatment compliance by allowing me to be more personal with my patients, and make them feel like they are speaking to someone and any concerns that they have can get handled right away or much faster than they're used to

10-F [765:1290]

Sure, it seems like we have the ability to get in touch with far more patients now that we did a few years ago, and with getting data from their CPAP machines directly, we do not have to spend as much time with them on the phone and can allow for more automated surveys.

Of course, that will also improve the compliance rate because we actually touch every patient and give the reassurance that we, as a representative on behalf of our client, are there for them. If they have that, they will comply better and remain loyal.

10-F [1737:1923]

Tech is useful for engagement and compliance both by being able to intervene early for patients who need it and greatly increasing their quality of care and therefore compliance as well.

12-F [1102:1226]

Yes, the more information available, the better intervention there is and that gives opportunity for more compliant patients

13-F [1182:1809]

Patient engagement is reliant on technology in our era, and I concur that it must

be. It helps to streamline the quality of care allowing for more patients to be

taken care of and having the data to take care of them in a more timely fashion.

For instance, with our OSA patients, we can see their compliance and usage data

through a direct link with the manufacturer of their PAP equipment. Therefore,

we can inform our clients about the patients who need intervention much earlier

than two year ago without that technology. If authorized, we will just jump in and

offer encouragement to the patient with a risk assessment.

13-F [2311:2602]

That early intervention is key for compliance. Two years ago, we may not have

known if an OSA patient were noncompliant early enough to intervene and get

them compliant before their compliance period was over. Then, their insurance

company would not have covered their sleep-apnea therapy.

15-F [1015:2207]

In my opinion, technology for patient engagement is inevitable with technological

progression of society. It also is beneficial for streamlining workflows for all

parties involved whether the subscribed payer physician provider, medical

equipment provider, facility provider, EMR system, management/billing system,

device manufacturer, or patient engagement platform… and all those third parties

in between.

Of course, engagement and compliance would benefit from the use of technology

with outcome-based responses and real-time reporting, information is in

abundance not only for the ability to intervene for increased compliance but also for studies that could be lucrative to the future of care in general or for specific diseases like obstructive sleep apnea.

For instance, a patient who is not compliant with a positive-airway-pressure device within their first couple of weeks, in the past, without the technology, may have never gotten compliant prior to the payer need for reimbursement. Therefore, the patient would lose the care they needed. With current technology, early intervention is possible and key for improving their compliance so that they can stay on long-term care.

15-F [2808:2964]

Technology aids in streamlining the patient engagement platform such as ours, and therefore the increases outcomes and potential for compliance treatment.

16-F [664:918]

Patients who are properly taught how to use their CPAP machine and kept engaged, not only have better care but also are loyal patients later. Using the application to keep in touch with patients makes them feel like we are always there for their needs.

19-F [559:980]

Yes, it does improve patient compliance with all their equipment, especially for OSA. They get automated reminder calls to fill their prescriptions when they are due to be filled, or when they are ready to be picked up. Sometimes elderly patients do not have a ride, and they have to wait for someone to take them. So,

we have delivery system too at CVS. It helps a lot for service which in turn increases compliance.

19-F [1409:1491]

It is very useful, it increases patient compliance and improves their health then.

2- F [1166:1221]

Then, the treatment compliance is much better in turn.

5-F [2698:3346]

I think technology has improved the patient's compliance, but from a patient perspective, the whole purpose of being compliant is to help the patient. So, it allows the OSA patient to be a better patient: to help them breathe better, sleep better, do all of the things that CPAP is supposed to do to have them have a better lifestyle. So, I think technology has been very positive from that perspective because again before we had that, it was kind of hit or miss and the patients like the doctor said I had to have the machine, so I have it but it's sitting in a closet. You know I hate to say that monitoring has helped people use it, but it has!

5-F [4516:4585]

With sleep apnea, the biggest challenge is patient usage/compliance.

6-F [1871:2118]

It is a positive to use tech for patient intervention because it more organized and chance for less error. Patients are more compliant because the information is more readily available and also, we can see who needs more intervention and does not.

7-M [3802:3954]

You use technology to remind patients to follow through with compliance, and it will definitely improve the quality of care and improve their condition.

7-M [3419:3516]

The engaged patient will comply more readily as compared to our unengaged and uninformed patient.

7-M [5588:5781]

It I think as we discussed before, that technology in the era we are living, automatic reminders and tools of compliance are really useful in quality of care and improvement in quality of life.

The following responses captured the patient related opportunities:

1-F [1844:2116]

In my mind, I think about how to make the patients become more aware of what they're doing and how their health is being affected by what kind of supplies that they use and how involved they are in their OSA, being on top of what they need, and how they interconnect that.

1-F [2117:2381]

It will improve the patient engagement and treatment compliance by allowing me to be more personal with my patients, and make them feel like they are speaking to someone and any concerns that they have can get handled right away or much faster than they're used to

1-F [2383:2593]

If they feel like they have a comfortable face someone to talk to frequently, they feel more open to discuss the problems they're having to be more honest about how much they actually do use their CPAP devices.

1-F [2595:2716]

Also, it would allow me to speak to more patients throughout the day because they would cut out some of the smaller steps

10-F [765:1290]

Sure, it seems like we have the ability to get in touch with far more patients now that we did a few years ago, and with getting data from their CPAP machines directly, we do not have to spend as much time with them on the phone and can allow for more automated surveys.

Of course, that will also improve the compliance rate because we actually touch every patient and give the reassurance that we, as a representative on behalf of our client, are there for them. If they have that, they will comply better and remain loyal.

10-F [1737:1923]

Tech is useful for engagement and compliance both by being able to intervene early for patients who need it and greatly increasing their quality of care and therefore compliance as well.

10-F [2630:2962]

Finding just the right time to catch a patient when it is convenient for them, making the call fast enough for someone who wants to speed through it, but slow

enough for someone who just does not understand/hear it, and keeping a patient's confidence when we do not always have all the information we need to answer their questions.

12-F [2162:2501]

Properly assessing patients through technology with the ability to categorize them with the results allows for physicians and device providers to better focus their efforts toward struggling or needy patients and not waste it on patients that do fine with or not want anything other than the convenience of the technological intervention.

13-F [1182:1809]

Patient engagement is reliant on technology in our era, and I concur that it must be. It helps to streamline the quality of care allowing for more patients to be taken care of and having the data to take care of them in a more timely fashion. For instance, with our OSA patients, we can see their compliance and usage data through a direct link with the manufacturer of their PAP equipment. Therefore, we can inform our clients about the patients who need intervention much earlier than two year ago without that technology. If authorized, we will just jump in and offer encouragement to the patient with a risk assessment.

15-F [80:127]

My workplace specializes in patient engagement.

15-F [1424:1781]

Of course, engagement and compliance would benefit from the use of technology with outcome-based responses and real-time reporting, information is in abundance not only for the ability to intervene for increased compliance, but also for studies that could be lucrative to the future of care in general or for specific diseases like obstructive sleep apnea.

16-F [808:918]

Using the application to keep in touch with patients makes them feel like we are always there for their needs.

17-M [904:1108]

Patients are not properly educated by our clients. even though we are calling their patients, if they told these sleep apnea patients how to use their CPAP machines, it would be more successful treatment.

17-M [1218:1498]

As I said above, makes it better because our clients just sit back and wait on us to reach out to their patients. patients need to know our clients are there for them since this whole new treatment plan is significant to a person's life… even though the client does it every day…

17-M [1613:1722]

Sometimes the patients don't trust us when we call because we do not have access to all of their information.

18-F [1988:2193]

Some patients are very rude. They are mean they even start cussing. I have an accent, and some people make rude comments like "what language are you speaking?" The automated system would help with that.

2- F [3080:3335]

Our proactive engagement is a huge benefit for them. Otherwise, they may give up and not even proceed with therapy, will not be compliant, and even stop treatment just because they don't know how to use it. Then, that OSA patient is the one who suffers.

2- F [1021:1090]

Patient engagement helps with quick responses, no downtime in care.

2- F [1091:1165]

Being patient-centric is ideal situation for patient comfort and loyalty.

2- F [1576:1847]

Then, they lose faith in our contact solution. If they have confidence in the engagement process, they will stick to their sleep apnea treatment plan better too. We establish a relationship with the patient and ask about their usage nightly and how many nights per week.

2- F [2182:2735]

A positive thing with a lot of these patients because of their health and they can't get out and do for themselves. A lot of patients don't even accept our calls, but once they figure out that we're there to help, they do engage more when realize it is not a scam call. They appreciate the service that we can provide because they

don't have to get out or rely on someone to take them, or their inability to get out because a lot of patients that I have called on don't just have sleep apnea. There are other health issues that they are dealing with.

5-F [2698:3346]

I think technology has improved the patient's compliance, but from a patient perspective, the whole purpose of being compliant is to help the patient. So, it allows the OSA patient to be a better patient: to help them breathe better, sleep better, do all of the things that CPAP is supposed to do to have them have a better lifestyle. So, I think technology has been very positive from that perspective because again before we had that, it was kind of hit or miss and the patients like the doctor said I had to have the machine, so I have it but it's sitting in a closet. You know I hate to say that monitoring has helped people use it, but it has!

5-F [1790:1877]

The biggest gap I see is that we get the OSA compliance data, but the patient doesn't.

6-F [1871:2118]

It is a positive to use tech for patient intervention because it more organized and chance for less error. Patients are more compliant because the information is more readily available and also, we can see who needs more intervention and does not.

6-F [2989:3139]

Caregivers and tech can better collaborate where a patient may be in denial and just state they are doing fine, when the data may show they are not.

7-M [3802:3954]

You use technology to remind patients to follow through with compliance, and it will definitely improve the quality of care and improve their condition.

7-M [3244:3417]

Absolutely, the informed patient is the more engaged patient, and the more engaged patient is more likely to follow through with it prescribed regimen that is given to them.

7-M [4370:4497]

As we discussed before, the technology is useful for engaging patient and engaged patient this compliant patient in most cases.

7-M [4832:5015]

If they had been informed, and they engage in them, then that's part of the help they're going to with improving the lifestyle and making them uncomfortable is also a negative factor.

7-M [5115:5245]

If it is found to be adequate, then engage patients with the technology-based interventions for compliance and improvement in care

1-F [1061:1225]

Also, it's more personal if you can see someone, and they feel like they're actually being helped better, like if there was like some kind of personal aspect to it.

1-F [1226:1290]

Something more personal than just a phone call would be helpful.

1-F [2184:2381]

Allowing me to be more personal with my patients, and make them feel like they are speaking to someone and any concerns that they have can get handled right away or much faster than they're used to

1-F [2383:2594]

If they feel like they have a comfortable face someone to talk to frequently, they feel more open to discuss the problems they're having to be more honest about how much they actually do use their CPAP devices.

1-F [2595:2716]

Also, it would allow me to speak to more patients throughout the day because they would cut out some of the smaller steps

10-F [1036:1227]

Of course, that will also improve the compliance rate because we actually touch every patient and give the reassurance that we, as a representative on behalf of our client, are there for them

12-F [1758:1905]

However, it must also have a degree of personalization, or the patient may continue to feel a disconnect with the equipment and/or physician provide

20-M [6238:6299]

Talking to a patient would never be replaced by a technology.

6-F [1318:1435]

For instance, most of the older generation patients want human interaction and do not use technology to communicate.

6-F [3838:3900]

They like the truly interactive feel like with Siri or Alexa.

6-F [3901:4110]

IVR is not as good as these interactive intelligences yet, but the younger generations find it more convenient than a live call and know how to use it and be more patient with it when it is not as interactive.

1-F [6323:6487]

On the other side of the seesaw, there are patients who are absolutely on top of everything too and may even call you the day before you are scheduled to call them.

1-F [6489:6571]

Those people are probably healthier too and are regularly cleaning their supplies.

1-F [6892:7155]

Opportunities would be those patient who are ready to care for their health, are more open to technology to help them do what they need, not having to re-enter information on different platforms, add-to-cart buttons that they are used to would make things easier.

10-F [1737:1923]

Tech is useful for engagement and compliance both by being able to intervene early for patients who need it and greatly increasing their quality of care and therefore compliance as well.

11-F [709:840]

That way, we can tell if they need help with their CPAP machine before it's too late and make sure they get the best care possible.

11-F [1040:1112]

Without technology, we would not know early on when patients needed help

11-F [1115:1310]

For example, if they stopped using their CPAP machine because it was blowing too hard, with technology, we would have an alert automatically, and be able to call them to see what the matter was.

11-F [1669:1823]

With the number of patients receiving care nowadays, it is very useful so that we can intervene early on as mentioned above for patients with sleep apnea.

12-F [1102:1226]

Yes, the more information available, the better intervention there is and that gives opportunity for more compliant patients

13-F [1575:1710]

Therefore, we can inform our clients about the patients who need intervention much earlier than two year ago without that technology.

13-F [2009:2088]

As stated before, early intervention is key with the growing number of patients

13-F [2289:2358]

As already discussed, that early intervention is key for compliance.

13-F [2359:2520]

Two years ago, we may not have known if an OSA patient were noncompliant

early enough to intervene and get them compliant before their compliance period

was over

15-F [423:643]

Ideally, an interoperable, direct integration universally with all device

manufacturers so that we could evaluate at-risk patients or those for which we

could provide proactive, early intervention for positive outcomes.

15-F [1424:1781]

Of course, engagement and compliance would benefit from the use of technology

with outcome-based responses and real-time reporting, information is in

abundance not only for the ability to intervene for increased compliance, but also

for studies that could be lucrative to the future of care in general or for specific

diseases like obstructive sleep apnea.

15-F [1782:2013]

For instance, a patient who is not compliant with a positive-airway-pressure

device within their first couple of weeks, in the past, without the technology, may

have never gotten compliant prior to the payer need for reimbursement.

15-F [2072:2207]

With current technology, early intervention is possible and key for improving their compliance so that they can stay on long-term care.

15-F [2407:2522]

As mentioned above, early intervention in OSA for PAP patients is key to success and the betterment of their life.

15-F [2964:3191]

Without such, the overworked home medical equipment providers' employees would not be able to handle the patient load much less perform the necessary early intervention posed by the insurance providers' 90-day compliance rules.

18-F [877:970]

It will save time, and they will know ahead of time what CPAP supplies they are eligible for.

19-F [646:778]

They get automated reminder calls to fill their prescriptions when they are due to be filled, or when they are ready to be picked up

2- F [1848:1982]

If they need more intervention, I get them to the respiratory therapist via the Alert notification within our software application.

2- F [3080:3131]

Our proactive engagement is a huge benefit for them.

5-F [4076:4148]

So that is a much quicker response time and quicker intervention time.

6-F [995:1171]

A lot of serious health issues can be avoided with proactive engagement because we can direct a patient toward the right intervention with keeping that contact with them open.

6-F [2633:2780]

Proactive engagement and technology also make life easier for the caregiver and family because they know someone is looking after their loved ones.

6-F [4357:4419]

I can be more informed about necessary intervention timely.

7-M [3040:3162]

So, prevention and improvement in quality care and both fight for the patient as well as well as from the physician side.

1-F [3164:3235]

Most millennials like myself do not like to speak to someone (as I do).

1-F [4617:4749]

So, the patient group is definitely a factor as well as age, working environment, urban or rural, and comfort level with technology.

1-F [3236:3308]

I don't remember to use my device each night like I am supposed to do.

15-F [3923:4151]

Other generations following grew up with the technology, and in turn, seem to

prefer the convenience of taking care of business on their own terms via

technology rather than speaking to a human during "regular business hours."

16-F [2038:2161]

Sure, since most folks now days grew up with or are familiar with technology, we

can better communicate with them this way.

2- F [5464:5567]

The younger generation and middle-aged patients want the technology to

incorporate into their schedule.

6-F [3901:4110]

IVR is not as good as these interactive intelligences yet, but the younger

generations find it more convenient than a live call and know how to use it and be

more patient with it when it is not as interactive.

7-M [5339:5478]

For instance, an older patient may prefer a live call verses a travelling young

professional may want an e-mail to answer in their own time.

7-M [7728:7911]

As you mentioned, the age, experience, and education level of patients for use of

technology is one challenge for ease-of-use so the patient can be engaged in that

particular process.

Summary

I presented the results of an investigation on the attitudes and perspectives of healthcare managers about the usefulness and easiness of the technology for patient engagement. I interviewed twenty participants from healthcare facilities specialized in treating OSA in the Indianapolis, Indiana and surrounding areas through open-ended interview questions. I followed the methods that I outlined in the ethics approval for sampling, data collection, and data analysis. I analyzed the data using RQDA library in R Studio software using open and axial coding method. The analysis resulted in 41 codes that were grouped into different themes according to the similarity and differences. The findings from this study indicated that the attitudes of the healthcare managers toward the use of technology for patient engagement were generally positive. System related, time-related, and process related reasons existed for the positive attitude among participants. Some of the reasons are that the healthcare managers can use the automated system for effective communication, easier to communicate with patients who are busy, and possibility of engaging with more patients. The participants also generally agreed that the technology is useful for patient engagement and is easier to use. Either the challenges identified by the participants for making technology useful and easy for patient engagement were technology related challenges such as improper system and cost, or patient related challenges such as patient diversity and the level of technical skills of the patients. Similarly, the respondents identified process related opportunities such as improved quality of care, and patient related opportunities such as personal interactions as some of the opportunities exist when using technology for patient engagement.

I presented the interpretation of the findings and conclusions in Chapter 5 along with the

study limitations and recommendations for further research.

Chapter 5: Discussion, Conclusions, and Recommendations

The purpose of this qualitative study was to evaluate how technology-based interventions used by healthcare managers can improve patient engagement with the healthcare managers as well as patient compliance with treatment procedures in OSA disease management. I interviewed 20 healthcare managers to understand their attitudes toward using technology-based interventions for patient engagement as well as their perceptions on the easiness and usefulness of the technology for patient engagement. From the data analysis, 41 unique codes and a number of themes for each research question emerged.

The focus of this chapter is the interpretation of the results discussed in Chapter 4 for each research question along with the discussion on the limitations of this research study. Finally, Chapter 5 also includes the recommendations for future research direction together with the implications of the outcomes of this research study.

Interpretation of Results

I asked the participants in the first two interview questions to explain the technology that they currently use at their workplaces for patient engagement and the technology that they would ideally like to have. Seventeen participants directly made reference to their existing technology. The most widely used technology-based interventions were the live calls and e-mails, followed by IVR. Thirteen participants discussed live calls and e-mails, while 10 participants mentioned IVR. The text messaging technology was the least used technology with only three participants mentioning it. A few workplaces use a dedicated system for the patient engagement and

interventions such as electronic medical record system that allows the patients to interact via chat or text message or e-mail. Some participants also use Skype, web conferencing, and VoIP services.

When inquired about the ideal technology that they would require for effective patient engagement that can lead to improved treatment compliance, 10 of the participants (50%) emphasized the need for a system that can interface different technologies and provide access to different healthcare professionals so that every health professional can update the patient health information in a central platform. Consequently, healthcare managers would have complete and comprehensive patient data that could help them to make accurate care plans. One participant said that the ideal system should allow technologies to "talk" to each other, that is, an integration of various different technologies such as web interface and text messages, or they should have a centralized data platform with patient health information accessible to healthcare managers. Another participant mentioned that the integrated system should connect the patient information, compliance data from the manufacturers, and insurance details from the insurer.

One participant stated that the ideal technology should have a video calling facility similar to Face Time in iPhones to ensure that the patients explain the situation accurately. Furthermore, a video calling facility provides a personal face-to-face interaction with patients that can encourage them to listen actively and follow the instructions. Consequently, their compliance with the treatment plan can improve.

Four participants suggested that it is ideal to develop a mobile phone application to improve the interaction between the patients and healthcare managers leading to effective patient engagement and increased treatment compliance. A respondent agreed that the major gap in the technology-based interventions is that the patients do not have access to their OSA compliance data. Hence, they do not realize their actual compliance and have to rely on the healthcare managers to inform them. The mobile phone application could be useful in such cases because it can provide alerts to the patients and make them responsive.

Seven participants indicated that the ideal technology-based interventions need to be a tailored system that can cater for patients with different attitudes toward technology. Some patients are happy with the technology such as IVR, while others would be comfortable only with the live calls. Similarly, patients with busy work schedules may prefer the e-mail because they can respond to them at their convenience. Interpretation of the results presented in Chapter 4 for each specific research question is discussed in the following subsections.

Research Question 1

RQ1a: What are the attitudes of healthcare managers toward the use of technology in OSA patient engagement that could lead to improved treatment compliance?

RQ1b: What factors are responsible for the attitudes of healthcare managers toward the use of technology for OSA patient engagement that could lead to improved treatment compliance?

Eighteen participants exhibited a positive attitude towards using the technology for the patient engagement. Participants stated that the technology can be used to engage patients and encourage them to adhere to the treatment protocols through frequent reminders, leading to quicker responses from patients and reduced downtime in providing appropriate assistance. One participant stated that the live calls can take up to 20 minutes because the discussion often deviates beyond the topic and is difficult to control. In contrast, technology-based interventions such as IVR and e-mails take typically 30-40 seconds to complete saving a significant amount of time for healthcare managers because the developed communication template can be simultaneously e-mailed or texted to many patients. If the healthcare managers can streamline the care through technology, they can care for more patients at the same time. One participant stated that incoming calls and questions from patients about their treatment had reduced with the introduction of technology-based interventions because the information was already included in the application that automatically calls and e-mails the patients. Consequently, the respondent has more time to focus on patients who are in need of more assistance to adhere to their treatment plan. However, it is not clear that the reduction in correspondence with the healthcare manager is definitely due to the availability of readily accessible information.

Two participants mentioned that the technology-based interventions facilitate patient-centric care, which can result in increased patient comfort and treatment compliance. Healthcare managers can engage with the patients frequently through e-mails, text messages, or IVR to encourage them to use their medical supplies and to

replace them when necessary. Furthermore, due to the communication with patients

through various communication platforms, patients feel that they are always connected

with their healthcare managers, leading to increased compliance with treatment plans and

increased confidence with their team of healthcare managers. Additionally, participants

believe that the technology-based interventions provide a systematic and more organized

approach resulting in a chance for fewer errors.

Access to readily available data about patients and their treatment compliance

patterns are reasons for a positive attitude towards technology among participants.

Twelve participants associated the availability of more data with the positive attitude.

The respondents stated that the patients lose their confidence in healthcare managers if

such data are not readily available when they consult the patients. This can lead to

noncompliant behaviors, resulting in poor treatment compliance and increased OSA

conditions. In contrast, availability of such data can assist in building a strong

relationship with patients and facilitate early interventions by healthcare managers if

needed. Outcome-based responses and real-time reporting are two other important

reasons for positive attitudes toward technology-based interventions among the

participants.

However, two participants cautioned the use of technology-based interventions

without proper planning and implementation from upper management, though they

completely agreed with the potential benefits of technology-based interventions. For

example, one participant suggested that the healthcare managers should make the first

contact personally via live calls, and then provide the options of automated IVR call or e-

mail for future correspondence. This is because some patients from the older generation usually prefer the human interaction over technology and are not familiar with the current technologies. Providing the option for the patients to choose between live and technology-based communication can assist some patients to choose the appropriate mode of communication leading to increased confidence and treatment compliance. In summary, it appears that the use of technology-based intervention needs to involve the patients as well as healthcare managers in order it to be successful.

Two participants also pointed out the negative aspects of technology-based interventions. For instance, some patients forgot to check their e-mail reminders as well as forgot to follow the instructions after receiving an e-mail, leading to noncompliance to the treatment plan. Age, working environment, location, and comfort level with technology are some of the factors for deciding whether the technology-based interventions can be effective for a particular patient. For example, in rural areas with no cell towers or internet, technology-based interventions would be difficult to implement. In addition, technology cannot analyze complex situations and judge the appropriate actions. Furthermore, technology-based interventions cannot provide emotional support or understand underlying feelings of the patients. This may lead to treatment noncompliance and a worsening of the conditions of patients. However, technology in combination with the caregivers working with the patient can lead to improvements in compliance.

Research Question 2

RQ2a: What are the perceptions of the healthcare managers about the usefulness of the technology to engage with the OSA patient for improved treatment compliance?

RQ2b: What are the challenges and opportunities that the healthcare managers perceive in making technology useful for OSA patient engagement that could lead to improved treatment compliance?

Fifteen participants accounting for 75% of the total participants generally agreed that the technology-based interventions are useful to engage the patients to achieve treatment compliance. Technology assists the healthcare managers to make the patients aware of the current status of their health, how the treatment affects their health, and their level of commitment to the treatment compliance. One participant said that frequent reminders through communication platforms are critical for the patients to manage their OSA using their CPAP devices.

Twelve participants (60%) stated that the technology is useful for proactive engagement with patients. They emphasized that some patients, especially the older patients, may not proceed with the therapy or may not be compliant because they do not know how to use the devices properly. Technology, in terms of IVR calls, can be useful for healthcare managers to connect with these patients when necessary leading to proactive interventions to bring them back into compliance or prevent them from becoming noncompliant.

Another useful aspect of technology for patient engagement is the facility to store patient data, treatment plan, and progress in a central database platform that can be accessed by healthcare managers. This helps the healthcare managers to provide accurate advice to the patients leading to increased trust of healthcare managers and consequently stronger patient engagement. Such a technological platform also reduces unwanted interruption to the treatment plan by different healthcare managers and ad-hoc treatment procedures that undermine the patient confidence in the care leading to lack of patient engagement.

Research Question 3

RQ3a: What are the perceptions of the healthcare managers about the ease of using technology for the OSA patient engagement that could lead to improved treatment compliance?

RQ3b: What are the challenges and opportunities that they perceive in making technology easier to use for OSA patient engagement that could lead to improved treatment compliance?

Because most patients are familiar with or are growing up with technology, the healthcare managers find it easy to utilize the technology to engage with the patients. The baby boomers have become the older generation, and they grew up for the most part of their lives with limited exposure to technology. However, they are generally technology driven. Hence, with some effort, it is possible to engage them in using technology. As for younger generations, they have full exposure to technology; therefore, it is relatively easier to engage them via technology.

Technology facilitates the engagement of patients after hours. In traditional settings, healthcare managers need to communicate with the patients via live calls, which can be only made during the office hours. However, healthcare managers can communicate through other technologies such as e-mail, and the patients can communicate with the healthcare managers when it is convenient for them. One respondent noted that this has increased the patient engagement because the communication between patients and healthcare managers are not restricted by the time. Furthermore, technology allows the assessments to be done at a time convenient to the patients, providing required information to the healthcare managers for further follow-ups.

The data provided by the technology about treatment compliance of patients assists in strong patient engagement. Some patients tend to be in denial about their treatment noncompliance and refuse to engage with the healthcare managers. Technology provides hard data about their compliance and assists the healthcare managers to easily engage with the patients to have the conversation. Because the healthcare managers, provider, and patients are well informed about the treatment compliance, it is easier to engage with each other via technology.

The healthcare managers can reach out to many patients through technology in comparison to live calls. This aspect allows the healthcare managers to easily engage with more patients compared to conventional communication tools. However, one participant stated that the interface of the technology used for patient engagement should be easier to encourage its wider usage. Additionally, they feel that the healthcare

managers would stay away from the technology if the procedures require them to bypass

filters and firewalls to achieve a simple thing. For some healthcare managers, using the

technology for patient engagement involves a huge learning curve. However, the benefits

of technology encourage them to use the technology for patient engagement.

Challenges and Opportunities

As discussed in Chapter 4, all the participants identified similar challenges and

opportunities in relation to making technology useful (Interview Question 6) and easy

(Interview Question 8). Most of the participants agreed that the age of the patients, access

to technology, level of education, availability of resources, the personality of the patients

and their comfort level in using technology as the major challenges to utilize technology

for patient engagement. A significant challenge regarding the use of technology, as some

of the caregivers highlighted the challenges they faced with the older population, as older

patients do not rely heavily on the technology. Similarly, many poor patients do not have

access to internet or computer. Hence, engaging them through technology is a significant

challenge with these patients.

Participants indicated that the technology used for patient engagement should not

make the healthcare managers or patients feel like they are learning a new skill, with 8 of

the participants specifically pointing out the need to cater for technically challenged

persons. In other words, the technology should be simple and is readily available for them

to use it. The capital and operational costs of using such technology should be reasonable

for the healthcare managers in the context of the benefits achieved. Otherwise, the

healthcare managers may not be interested to use it. Some participants pointed out that

the healthcare managers are not properly trained or have only limited training in technology. Consequently, they find it difficult to implement the technology for patient engagement. Others argued that the technologies such as IVR calls are not interactive like live calls, and the patients regard them as 'robot' calls. Furthermore, non-interactive features of these technologies make it difficult for patients to truly engage with their healthcare managers. A solution could be the use of interactive technologies similar to Siri and Alexa that could make the engagement interactive and more interesting to the patients.

In general, the technology-based patient engagement involves frequent reminders to the patients, the amount of which may be overwhelming to some patients, leading to some patients opting out of the use of technology to engage with the healthcare managers. Another major challenge identified by ten of the participants who responded is that different technology and databases are not interconnected to provide comprehensive and complete information about the patients. As such, healthcare managers rely on partial information to assess, judge, and develop an appropriate care plan, leading to inaccurate and incomplete treatment procedures. Consequently, patients can lose the confidence in healthcare managers, resulting in poor patient engagement with healthcare managers.

Participants identified various opportunities that the technology provides for effective patient engagement. Early intervention is a key opportunity for healthcare managers since the healthcare managers can readily identify the patients, who are not compliant and can continuously monitor them closely through the technology. Technology provides the opportunity to identify the patients, who are struggling or in

need so that the healthcare managers can focus on such patients. Some respondents pointed out that technology facilitates a more organized workplace with less chance of making errors.

Participants also highlighted the opportunities that the technology provides in terms of improving the process of engagement between patients and healthcare managers. Eight respondents noted that the technology cuts down smaller steps in the communication, allowing them to communicate with more patients. Additionally, healthcare managers can get the compliance information directly from the devices rather than relying on patients' account of the story, allowing them to analyze the information accurately and providing them with the opportunity to have a meaningful conversation with the patients. The engagement with patients has significantly improved due to technology because the healthcare managers can communicate with the patients through multiple modes. Consequently, patients, who previously could not be reached through live calls due to conflicting schedules, can communicate through another mode of communication. Use of technology also helps the healthcare managers to limit the personal interaction with patients, who are generally rude, though healthcare managers still can engage with them through technology and provide the quality care that they would require. Furthermore, technology reduces the downtime in care significantly since patients can access the required information through technology without the assistance of a healthcare manager.

Contribution of this Study

The TAM model formed the theoretical foundation of this study to evaluate the attitudes and perceptions of the healthcare managers toward the technology for patient engagement. The focus of several past studies was on the technology acceptance among the patients. The conclusions of most studies were that the patients had a positive attitude towards the technology and that the technology is useful to be up to date about their health situation (Arning & Ziefle, 2009). In this study, healthcare managers also showed mostly a positive attitude towards the technology. Consequently, technology appears to have a significant potential for the effective engagement between patients and their healthcare managers.

Some researchers such as Abdekhoda et al. (2014) found that the perceptions of participants about the usefulness and easiness were critical for them to adopt the technology. I also found that the participants treated these two distinct attributes without any distinction such that they generally identified same challenges and opportunities for both attributes. Therefore, it appears that any user needs to perceive a given technology as both useful and easy for them to use it actively.

Kim and Park (2012) investigated the behavioral intention of patients to use the technology for health management and found that the health knowledge and attributes of the proposed technology as major factors influencing their perceptions about the usefulness and ease of use of the technology. The findings of this study indicated that the age of the patients, access to technology, level of education, availability of resources, the

personality of the patients and their comfort level in using technology as the major factors influencing the effective utilization of technology for patient engagement.

Or and Tao (2014) found that the behaviors and attitudes of the patients to use the technology are important to develop health management strategies. However, the attitudes and behaviors of healthcare managers are equally important to design effective health management strategies. The outcomes of this study are an important contribution to the knowledge in this regard.

Limitations of this Study

The sample size of 20 in this study may limit the transferability of the findings to other regions and to the United States. Similarly, interview responses from only healthcare managers from the OSA field may limit the applicability of the study outcomes to other chronic diseases. Furthermore, I did not conduct any pilot study to test whether the participants understood the interview questions accurately, since the interview questions were straightforward. Though the participants understood the majority of questions, they identified similar challenges and opportunities for making the technology-based interventions useful (Interview Question 6) and easy (Interview Question 8). It is not clear whether the participants had difficulty in understanding the questions or the challenges and opportunities are similar in both cases. Lack of elaborative responses by some participants, as the interview questions were limiting itself since they were designed specifically to provide insight to the research questions, is another problem in this research, making it difficult to provide the context to their responses.

This study was a qualitative study and I collected the data through interviews over the phone. I coded the data for analysis through subjective judgment. Regardless of precautionary measures taken to avoid any bias during the analysis, subjective assessment is generally susceptible to personal bias. Therefore, future research should focus on using objective judgments during coding to avoid any bias.

It is the responsibility of the management to ensure that technology is made available to both the caregivers and the patients as it can reduce the downtime in patient care. In added benefit to the management, the patients can have access to the required information that empowers them to take control of their wellbeing without the assistance of the caregivers.

Recommendations

Though qualitative studies are useful in exploring the perspectives and attitudes, it is important to draw quantifiable relationships between different variables. Quantitative correlations are often useful in predictions required for effective planning. Future research should focus on developing correlations between the attitudes of the healthcare managers toward the technology-based interventions, and their perceptions of usefulness or easiness of the technology. This knowledge can assist when implementing technology-based interventions in a health facility to identify the potential attitudes toward technology among the employees based on their perceptions of easiness and usefulness of technology. Consequently, health facilities can plan the level of training required to make the technology easier and useful to the employees in order to change their attitudes.

I did not separate the participants into cohorts based on age or sex or any other. These factors have an influence on the attitudes toward technology-based interventions. Therefore, it is important that future studies focus on grouping the participants into cohorts to better understand their attitudes and perceptions toward technology.

I found several factors that the participants stated as reasons for their positive attitudes toward technology-based interventions. However, it is not clear how each factor influences the attitudes of the participants toward technology. Therefore, future studies should focus on understanding the influence of these factors on the attitudes of employees toward technology. The future research should also focus on developing quantitative relationships for different cohorts.

The participants generally indicated that the opportunities for the use of technology were significant it the patient care. Although they identified several challenges, these can be overcome with the proper support and oversight of the management. The opportunities to improve patient compliance with the use of technology has shown significant promise and with the proper support and oversight of the management, it can overcome the challenges.

Implications for Social Change

A primary aim of social change in a research is to generate outcomes or findings or results that are useful for the populations to improve their current conditions by replacing the negative aspects into positive ones or by preserving and enhancing the positive aspects (Du et al., 2013; Hielscher et al., 2012). Fields et al. (2016) investigated the use of technology for patient engagement and found a greater improvement in the

patients and overall satisfaction with their care. The outcomes of the study by Fields et al. (216) indicate that the technology could be a useful mode of communication to improve the patient health. The focus of this study was on the attitudes and perception of healthcare managers towards the use of technology. Therefore, this study could be useful for the top management of the healthcare facilities to plan to upgrade their technology-based interventions for engaging with the patients in their practices by providing essential information to improve a positive attitude towards technology among their employees.

Razmak and Belanger (2018) stated that user friendliness, i.e. ease of use, as the most important factor for patients to effectively use the technology for healthcare management. In this study, healthcare providers identified several aspects of a technology as important factors for them to consider the technology useful. Some of these factors include the level of complexity, capital and operation cost, proper training and interactive nature. This study could be useful for those healthcare managers and case managers to better understand the challenges and how to overcome them in making the technology useful and easier for the caregivers to improve patient compliance.

In a study by Faysel (2015) investigating the attitude of patients towards technology, 63% of patients interviewed expressed a positive attitude towards using technology to engage with their healthcare providers. In this study, healthcare providers had a positive attitude towards using technology with their patients. The outcomes of the study by Faysel (2015) and this study indicate that both patients and healthcare providers are willing to accept technology to interact with each other. However, there are various challenges that need to be properly addressed to achieve this objective. In this study, I

identified the challenges faced by healthcare managers to implement the technology. Healthcare managers can use these findings to prepare them for various challenges and opportunities that they would face during the use of technology for patient engagement.

The study findings can also be useful for the information technology team. In this study, I highlighted the ideal technology-based interventions that the healthcare managers expect together with the features that they believe to be useful. Thus, the team can develop technology-based intervention techniques that can accommodate these features and enhance the experience of the healthcare managers during the engagement with patients.

Conclusions

This research study contributed information that could increase the understanding that healthcare managers may have about the attitudes and perceptions of healthcare managers about the usefulness and easiness of the technology-based interventions for patient engagement. Based on the analysis of the data, 90% of the participants expressed positive attitudes toward the technology-based interventions. They also identified several system-related, time-related, and process related factors being responsible for the positive attitude. Some examples include engagement of more patients, less call, and automated communication. The participants generally agreed about the usefulness and easiness of using technology for patient communications. They outlined the challenges and opportunities to make the technology useful and easier. The challenges included age of the patients, access to technology, level of education, availability of resources, the

personality of the patients and their comfort level in using technology. The opportunities

identified by the participants included early interventions, the ability to reach more

patients, and the ability to communicate through multiple modes.

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Appendix A: Codes

Code Category	Description	# of associated characters	# of respondents associated
Attitudes	Attitudes of the participants toward the technology-based interventions		
Negative	Negative comments toward the technology	283	2
Positive	Positive comments toward the technology	345	18
Neutral	Neutral comments toward the technology and/or both positive and negative comments at the same time	610	3
Challenges	Challenges to make the technology useful or easy for the patient engagement		
Easiness	Challenges to make the technology easier	155	8
Technology	Challenges related to the use of technology-based intervention	295	16
Usefulness	Challenges to make the technology useful	120	8
Cost	Challenges related to the cost of implementing technology-based intervention	352	1
Diversity	Challenges due to the diversity of patients	78	1
Proper System	Challenges related to improper system	206	3
Solutions	Solutions identified by the participants to	130	1

	some challenges related to technology		
Technically challenged patients	Challenges due to patients who do not have the necessary skills to use technology	144	8
Easiness	Easiness of using technology-based interaction for patient communication		
Easiness	Easiness of using technology-based interaction for patient communication	192	14
Existing technology	Existing technology used by the healthcare managers for patient engagement		
Current	Responses related to existing technology	143	17
E-mail	E-mail technology	89	13
IVR	Interactive voice response using automated call facility	76	10
Live calls	Live calls made by the healthcare managers	75	13
SMS	Text messages	166	3
Opportunities	Opportunities to make the technology useful or easy for the patient engagement		
Tech intervention opportunities	Opportunities related to technology-based interventions	305	10

Patient engagement	Opportunities for improved patient engagement	244	12
Personal interaction	Personal interaction with patients	140	5
Proactiveness	Proactive responses to patient requirements	146	12
Quality of care	Improved quality of patient care	157	6
Tech-savvy patients	Opportunities due to patients who use and operate technology without any problems	140	6
Treatment compliance	Improved treatment compliance of the patients	310	11
Positive Factors	Positive factors that support the use of technology-based interventions		
Absence of personal interactions	Absence of any personal interaction between the patients and healthcare managers	131	3
Automation	Automated system	185	3
Busy schedule	Patients who do not have time to speak to healthcare managers during the usual hours	128	5
Call duration	Duration of a live call between healthcare managers and patients	259	2
Deficient	System that does not function effectively	176	2

system	to perform the job		
Efficient communication	Improved communication between patients and healthcare managers	149	4
Engage with more patients	Increased number of patients engaged by healthcare managers	157	8
Fast system	A system that can be operated rapidly	167	1
Less calls	Reduced number of live calls needed to be made by healthcare managers	82	2
More data	Detailed information required by healthcare managers	128	12
Reminders	Patients who are in need of reminders	133	4
Technology for Engagement	Technologies needed by healthcare managers for patient engagement		
App	Mobile phone application	58	4
Ideal technology	Ideal technology needed by healthcare managers for effective engagement	293	15
Integrated platform	A platform where different technology can be integrated for easier and efficient operation	241	10
Tailored communication	Communication technology tailored according to the patient need	287	7
Video calls	A call facility with video enabled	96	1
Usefulness	Usefulness of technology-based		

interaction for patient communication

| Usefulness | Usefulness of technology-based | 229 | 1 |

interaction for patient communication