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UNIVERSITY OF SAN DIEGO

Hahn School of Nursing and Health Science

DOCTOR OF PHILOSOPHY IN NURSING

USE OF VIDEO GAMES IN PATIENTS' SELF-MANAGEMENT OF PAIN:

A FEASIBILITY STUDY

by

Janet Donnelly, PhD(c), RN-BC, ACNS-BC, PCCN

Dissertation presented to the

FACULTY OF THE HAHN SCHOOL OF NURSING AND HEALTH SCIENCE

UNIVERSITY OF SAN DIEGO

In fulfillment of the

requirements for the degree

DOCTOR OF PHILOSOPHY IN NURSING

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UNIVERSITY OF SAN DEIGO
Hahn School of Nursing and Health Science
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Use of Video Games in Patients' Self-management of Pain: A
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Acknowledgments

I am especially grateful to all of the members of my dissertation committee: Dr. Jane Georges, Dr. Patricia Roth, Dr. Laurie Ecoff, and Dr. Robert Topp. Thank you for your guidance, expertise, support, and advice throughout this research process.

I would like to express my deepest appreciation to Dr. Patricia Roth, who has been tireless in her support as my committee member in the absence of Dr. Jane Georges during her recovery. She has incredible energy and superb knowledge. Her patience and dedication to see me through the dissertation process has been truly extraordinary.

I would also like to express my appreciation to Dr. Jane Georges for chairing my dissertation committee and for her guidance throughout my dissertation proposal, the IRBs, and encouraging me on through the data collection phase.

A very special acknowledgement is in order for Dr. Laurie Ecoff who encouraged me to begin this journey and for her flexibility with my work schedule. I respect and admire her leadership, and I look forward to working together on future clinical research endeavors.

I would like to express my thankfulness to Dr. Robert Topp who assisted me with my database and analyses. I admire his skill, knowledge and expertise.

I extend my gratitude to the institutions and organizations that have provided financial assistance for my doctoral education including the University of San Diego Hahn School Of Nursing, Sharp HealthCare, and the U. S. Department of Health and Human Services Nurse Faculty Loan Program.

I would like to acknowledge the generosity of my work and school colleagues who so willingly shared their time and expertise: Dr. Belinda Toole, Dr. Tanna Thomason, Dr. Kim Failla, Susan Moore, and Heidi Johnson, chaplain, Sharp Memorial Hospital.

I would also like to express appreciation to my professors of the University of San Diego, Hahn School of Nursing who imparted their knowledge to me: Dr. Ann Mayo, Dr. Cynthia Connelly, Dr. Mary-Rose Mueller, Dr. Mary Jo Clark, and Dr. Sally Weinrich.

Lastly, I would like to extend a heartfelt appreciation to my family and friends for their encouragement and support over the years. To my sons and step-daughters, to my mother and brothers, sisters, and my dear friends, especially Chuck, for your unwavering support that made this journey possible, I could not have made it without you all.

Table of Contents

Chapter One	1
Statement of the Problem	1
Introduction.....	1
Background and Historical Overview of Pain	1
Purpose and Research Aims.....	3
Definition of Terms.....	4
Design of the Study.....	5
Self-efficacy Theory	5
Conceptual Model of Video Game Distraction Therapy	8
Significance of the Study	8
Chapter Two.....	10
Literature Review.....	10
State of the Science	10
Adult Studies.....	11
Pediatric Studies.....	14
Neuroimaging Studies.....	20
Meditation, Music, and Art Intervention Studies.....	21
Distraction from Stress Studies.....	22
Older Adult Studies.....	24
Systematic Reviews	24
Gaps in the Literature.....	25

Chapter Three.....	42
Methods.....	42
Specific Aims.....	42
Sample.....	43
Criteria for Inclusion and Exclusion.....	43
Power Analysis	43
Measurement.....	44
Data Collection	47
Data Analysis	48
Human Subjects Considerations	49
Chapter Four	50
Results	50
Introduction.....	50
Findings Related to Study Aims	51
Demographic Variables	51
Pain Location	52
Analgesia Variables	53
Video Game Variables.....	53
Pain Level Perception	60
Conclusion	63
Chapter Five.....	64
Discussion of the Findings.....	64
Aims of the Study	64

Research Aim 1	64
Research Aim 2	66
Research Aim 3	67
Research Aim 4	68
Results Integrated into Conceptual Model	69
Antecedent	70
Intervention of Video Game Distraction Therapy	71
Defining Attributes	71
Matery and Control	72
Social Observations	72
Positive Appraisals	72
Social Supportive Relationships	73
Consequences	74
Self-efficacy in Pain Management	74
Behavioral Analgesia	74
Study Strengths and Limitations	75
Strengths	75
Limitations	76
Implications for Future Research	79
Conclusions	85
Appendices	87
References	95

List of Tables

Chapter 2

Table 1: Adult Studies Utilizing Virtual Reality and Video Games in Pain Distraction.....	28
Table 2: Pediatric Studies Utilizing Virtual Reality and Video Games in Pain Distraction	31
Table 3: MRI Brain Scans to Measure Pain-Related Activity during Distraction Interventions.....	34
Table 4: Meditation Practices, Music, and Art Intervention in Pain Intensity.....	37
Table 5: Video Game Distraction in Recovery from Stress: An Online Survey Questionnaire.....	38
Table 6: Pain Management Survey of Community Urban and Suburban Seniors Utilizing Pharmacological Strategies versus Non-pharmacological Strategies.....	39
Table 7: Role of Video Games in Improving Health-Related Outcomes.....	40

Chapter 4

Table 8: Demographic, Video, and Total Time Engaged with Study Subjects Variables.....	54
Table 9: Demographic, Pain Location, and Video Game Type Variables.....	54
Table 10: Name, Dose and Type of Analgesia.....	57
Table 11: Self-efficacy Perception and Pain Interference Perception Following Video Game Distraction Therapy.....	59
Table 12: Pre and Post Video Game Distraction Therapy Pain Levels.....	61
Table 13: Factors that Predict Changes in Pain Level Perception Following VGDT.....	62

List of Figures

Chapter 1

Figure 1: Conceptual Model of Video Game Distraction Therapy in Patients' Self- Management of Pain.....	8
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List of Appendices

Appendix A: USD Demographic, Analgesia, and Video Game Variables Form.....	87
Appendix B: Visual Analog Scale Measuring Patients' Self-report of Pain Levels.....	88
Appendix C: Visual Analog Scale Measuring Patients' Perception of Self-efficacy In Pain Management.....	89
Appendix D: PROMIS Pain Interference Assessment Questionnaire (PROMIS Assessment Center [n.d.], National Institute of Health).....	90
Appendix E: Conceptual Model of Video Games Distraction Therapy in Patients' Self-Management of Pain.....	91
Appendix F: USD Institutional Review Board Approval.....	92
Appendix G: Time of Last Analgesic Administered to Start Time of Video Game #1 with Pre and Post Pain Levels.....	93

Abstract

Background: Pain affects more than 75 million Americans and is the primary reason people seek medical attention. Pain is a common cause of disability and diminished quality of life. While anecdotal evidence exists regarding nurses' use of distraction therapy activities in pain management, little empirical research data is available.

Purpose: To examine the effects of video game use (VGU) on pain perception, pain interference perception and perceived self-efficacy in pain management in adult inpatients.

Conceptual Model: The conceptual model is based on Self-efficacy Theory (Bandura, 1995). The antecedents of the concept of distraction therapy with use of VGs in patients' self-management of pain, is pain itself. The defining attributes are mastery and control, social observations, positive appraisals, and social supportive relationships. The consequences are self-efficacy in non-pharmacological strategies in pain management and behavioral analgesia.

Aims: 1) Describe the demographic variables (age, gender, race/ethnicity, educational level, admitting diagnosis, day of hospitalization, and length of stay); pain location, analgesia variables; VG variables, and total time researcher engaged with subjects of the sample, 2) Describe self-efficacy and pain interference perception following video game distraction therapy (VGDT), 3) Compare changes in pain perception prior to and following VGDT, and 4) Identify factors that predict changes in pain perception following VGDT. This feasibility study utilized a purposive sample of 30 hospitalized adults in a neuro trauma progressive care unit, and an orthopedic acute care unit.

Findings: Subjects' age ranged from 19-79 years, $M = 41.47 \pm 17.52$, with 22 males (73.3%) and eight females (26.6%). Total time researcher was engaged with study subjects ranged from 35 – 90 minutes ($M = 63.03 \pm 13.10$). Pre pain perception $M = 4.93 \pm 2.49$, and post pain

perception $M = 3.17 \pm 2.2$, a 36% decreased following VGD. Self-efficacy perception following VGD mean score was high ($M = 6.97 \pm 2.30$) overall. There were no predictor variables identified.

Implications: Future studies are needed to explore more fully the factors operant in the use of VGs as a therapeutic approach for pain in the adult hospitalized patient.

Chapter One

Statement of the Problem

Pain is one of the most common reasons people seek healthcare. It is also a common cause of disability and diminished quality of life, and patients who suffer from pain are at risk for long-term adverse effects. Despite major advances in pain management, patients continue to report inadequate pain relief. Aggressive use of pharmacologic analgesics, especially opioids, often leads to side effects of nausea, constipation, cognitive dysfunction, and disturbances of sleep. Use of cognitive behavioral techniques such as distraction may help reduce patient perception of pain without increasing the side effects associated with opioids (Watt-Watson et al., 2011; Malchow & Black, 2008).

Background

The following is a brief discussion the domains of pain, an introduction to leaders in modern pain management, and an understanding of the anatomical and neurobiochemical physiology, with the undisputed acknowledgment that pain is a subjective experience and takes place in a social context that impacts how pain is experienced and its meaning for the person (Wright, 2015). John Bonica published the Management of Pain in 1953, declaring a ‘war on pain’, based on his experience as an anesthetist during World War II (Jensen, 2010). He recognized the importance of pain being treated even when its cause was unknown or untreatable, and such treatment needed to be a combined multidisciplinary management approach (Dormandy, 2006).

Dame Cicely Saunders (1963) developed the concept of ‘total pain’ by addressing social, emotional, psychological and the spiritual aspects of patient’s quality of life and that of their

loved ones, recognizing the mind, body link to mental distress from bodily pain. She influenced nurses and physicians to listen to the meaning of pain for the patient and try to understand their experience of suffering, and think of new possibilities of doing everything to alleviate pain. Saunders is considered the 'Mother of Palliative Care', and developed a new philosophy for end of life care (Clark, 2002).

Melzack and Wall's Gate Control Theory (1965) recognized the existence of mechanisms of suppression and regulation of pain information input, which lead to an understanding of how the brain filters, selects, and modulates pain, and that social, emotional, and psychological factors influence pain processing. These major advances have led to a more humanitarian approach to treating the patient in pain, and understanding the person's experience of pain as inseparable from their social and cultural context, and it is a person's human right to have their pain treated based on their pain perception (Wright, 2015).

Nursing has a key role in pain treatment and management. As an integral member of the multidisciplinary or interprofessional care team, nursing recognizes the association of the biopsychosocial model of pain and the neuropsychophysiology of pain. Currently, there is a growing body of empirical knowledge in the domains of massage, music, and cognitive behavioral interventions of self-guided imagery. The American Geriatrics Society (AGS) encourages nonpharmacological strategies (NPS) in conjunction with pharmacological strategies (PS) for pain management in older adults. A research study by Stewart and colleagues (2012) reported that NPS modalities were used far greater by seniors, ages 64 and older, than PS modalities, and meditation, relaxation, and massage were associated with higher self-efficacy for pain management (Stewart, et al., 2012). According to the AGS, NPS strategies promote self-management, patient autonomy, and control (Stewart, et al., 2012). Additionally, NPS strategies

are inexpensive, associated with fewer side effects, and can be used alone or in combination with drug treatments (Tracy, et al., 2006). Despite this growing body of knowledge, nurses report that they do not know enough about pain and pain relief methods (Holley, et al., 2005, p. 845) (McCaffery, et al., 2002). Thus, this feasibility study was an initial step in exploring the use of a NPS, and video game distraction therapy (VGDT) in adult inpatients on a progressive care and acute care units. Distraction therapy with use of video games is defined below in definition of terms.

Purpose and Aims

The overall purpose of this study was to examine the effects of video game use (VGU) on pain perception, pain interference perception, and perceived self-efficacy in pain management in a group of adult inpatients in a progressive care unit (PCU). The specific aims of this study were to:

1. Describe the demographic variables (age, gender, race/ethnicity, educational level, admitting diagnosis, day of hospitalization, and length of stay [LOS]); pain location, analgesia variables (timing/type/dosage); and VG variables (type of VG and length of time engaged in VGU), and total time researcher engaged with subjects of the sample.
2. Describe self-efficacy and pain interference perception following VGDT.
3. Compare changes in pain perception prior to and following VGDT.
4. Identify factors that predict changes in pain perception following VGDT.

Definition of Terms

1. Self-efficacy refers to an individual's belief in his or her capacity to execute behaviors necessary to produce specific performance attainments. Self-efficacy reflects confidence in the ability to exert control over one's own motivation, behavior, and social environment (Bandura 1995, 1997). In the field of health psychology the construct of self-efficacy has been applied to behaviors as diverse as self-management of chronic disease, smoking cessation, alcohol and drug abuse, eating disorders, pain management, and exercise (American Psychological Association. Retrieved from <http://www.apa.org/pi/aids/resources/education/self-efficacy.aspx>).

2. Distraction therapy is defined as “use of pleasing sensory stimuli (such as aromas, images of nature, massage, music) to divert the attention of a patient from an unpleasant clinical experience. Distraction therapy can reduce the pain experienced by patients during, e.g., reduction of fractures, placement of catheters, or wound debridement (Medical Dictionary, 2009. Retrieved from <http://medical-dictionary.thefreedictionary.com/distraction+therapy>).

3. Video game distraction therapy (VGDT) is the use of video games to help stop negative cognitions and ruminations, provide relief from stress, and thereby lead to feelings of relaxation. Video games require cognitive demands on users and have high intervention potential and are able to absorb users and focus their attention away from stress, problems, or negative feelings (Reinecke, 2009). Video games are utilized to distract people from acute or chronic pain (Primack, et al., 2012; Gold, et al., 2006, Wiederhold, et al., 2016).

4. Video game use (VGU) is defined as video game technology applied as an adjunctive tool for health education, self-management of diabetes and asthma, improving self-esteem, promoting physical activity to reduce obesity, enhance the cognitive or physical training of surgeons in endoscopic skills, and applied to distract people from painful interventions and wound debridement (Primack, et al., 2012).

5. Pain interference, also known as pain impact refers to the degree to which pain limits or interferes with individuals' physical, mental, and social activities. This domain of pain is increasingly recognized as important for both understanding patients' experiences and as a key outcome in pain clinical trials (National Institute of Health, National Center of Biotechnology Information; Amtmann, et al., 2010).

Design of the Study

This feasibility study was conducted on an adult inpatient progressive care unit (PCU) and an orthopedic acute care unit at a large metropolitan hospital in southern California, equipped with patient access to video games via the GetWell Network (GWN). A group of 30 adult participants were offered the opportunity to play video games one time during their hospitalization to obtain pre and post pain level assessment. Following the intervention of VGDT, measures of PI, and perceived self-efficacy in pain management was obtained, as well as relevant demographic, analgesic, and video game variables.

Albert Bandura's Self-Efficacy Theory (1995), particularly its application to distraction therapy in patients' self-directed management of pain, guides the proposed study. A fundamental assumption of this model is that self-efficacy beliefs influence how people think, feel, motivate themselves, and act. According to Bandura (1995), four main forms of influence

impact individuals' beliefs in self-efficacy. Bandura (1995) asserts that the first form, mastery experiences, is the most effective way of creating a sense of efficacy. As Bandura (1995) posits, successes build a strong belief in one's personal sense of efficacy, which is developed through cognitive, behavioral, and self-regulatory abilities.

The second influential way of creating and strengthening efficacy beliefs is through vicarious experiences provided by social models. Observing others succeed by perseverant effort encourages the observer to believe that they too have the capabilities to master comparable activities. The significance of observation is strongly influenced by perceived similarities to the models, and the greater the similarity, the more persuasive is the models' success as well as failures (Bandura, 1995).

Bandura (1995) asserts that the third way of strengthening efficacy is through social persuasion. People who are encouraged verbally that they have the capabilities to master certain activities are more likely to motivate themselves and sustain the behavior, than if they suffer self-doubts and dwell on personal deficiencies when they are faced with problems. Persuasive verbal encouragement leads people to try hard enough in order to succeed promoting development of skills and creating a sense of personal efficacy. Successful efficacy builders do more than convey positive appraisals. They structure situations in ways that bring success and avoid situations where they are likely to fail. Efficacy builders encourage people to measure their success in terms of self-improvement in smaller increments, rather than by bold triumphs.

The fourth way of influencing efficacy is to reduce stress and the negative emotional states associated with it (Bandura, 1995). Physiological and emotional states influence a person's perceived capabilities and self-efficacy beliefs. Individuals interpret their stress reactions and

tension as signs of vulnerability to poor performance. Mood also affects a person's concept of their personal efficacy abilities. Positive mood enhances perceived self-efficacy, just as a despondent mood diminishes perceived self-efficacy. Socially supportive relationships also influence a person's vulnerability to stress, depression, and physical illness.

Nurses have long used distraction for painful or uncomfortable interventions, with little empirical research data to support distraction strategies. The stressors of hospitalization, specifically pain and the associated symptoms of pain (anxiety, insomnia, depression), the intervention of VGDT, the defining attributes, and consequences of patient's self-management of pain is illustrated in *Figure 1*, and guides the study.

Figure 1. Conceptual Model of Video Game Distraction Therapy in Patients' Self-Management of Pain

Significance of the Study

Technological and social changes in today's world represent opportunities to health professionals to help meet the demands of modern society to improve how people organize, create, and manage circumstances that affect their health and life course. Globalization has created human interdependence and placed increased demands on efficacy. This concept was presented by Albert Bandura in 1997 and applies to efforts set forth by the New Media Consortium (NMC), a nonprofit organization, which focuses on educational technology. Since

2003, this consortium has produced The Horizon Report, which projects technology trends for a variety of sectors, including applications for patient-centered care (NMC Horizon Report, 2013).

According to the NPD group (2009), a leader in market research for the entertainment industry, 63% of Americans have played a video game in the last six months, as compared to 94% listening to music. An in-depth look at trends provided by the NPD group's U.S. consumer tracking study reports that currently more Americans play video games than go out to the movies, and as of 2014, 150 million Americans, with an average age of 31 years, play VGs. The increasing popularity of video games has strong implications for future research in healthcare.

The National Institute of Nursing Research (NINR) has implemented a Strategic Plan supporting the design and use of new patient care technologies focusing on health promotion and disease prevention. This plan focuses on integrating biological and behavioral sciences to improve patients' quality of life through self-management and symptom management using new technologies (*National Institute of Nursing Research Strategic Plan*, 2006).

Nurses have long used distraction for painful or uncomfortable interventions, and future research endeavors are needed to understand the psychophysiology behind distraction and use of non-pharmacological interventions in pain management. While anecdotal evidence exists regarding nurses' use of distraction therapy during painful or uncomfortable medical procedures, little published empirical research data is currently available. Thus, the overall purpose of this study examined the effects of the use of video game use (VGU) on pain perception, pain interference perception, and the perceived self-efficacy in pain management in a group of adult inpatients in a progressive care unit (PCU). This research study is an initial step in creating a knowledge base regarding the promotion of strategies for patients' non-pharmacologic self-management of pain.

Chapter Two

Literature Review

Literature specific to video games (VG) as distraction therapy for pain management in the adult population is limited. The majority of studies related to distraction and pain have focused on the pediatric population, and with virtual reality (VR) in the burn patient population. Some of the studies related to video games are dated; however, they are included in this discussion because of the limited number of relevant studies. Although the goal of this study was to explore the effectiveness of video games in patients' self-management of pain, this literature review will present related studies that focus on other forms of distraction in pain management, such as meditation, VR, music, and books.

State of the Science: Review of Behavioral Distraction Strategies

This chapter critiques research studies involving video games and virtual reality in pain management. In addition, studies of the use of preferred coping styles, meditation techniques, and music as distraction in pain management are described. Finally, studies investigating the use of virtual reality in children and adults undergoing painful procedures will be critiqued. Although there have been numerous studies and a growing body of evidence in virtual reality research, there have been limited studies in the area of behavioral distraction and pain management strategies with video games. Research has primarily focused on the pediatric burn and oncology population, and with healthy young adult subjects in controlled laboratory experiments. Little research to date has explored the adult population in acute care settings.

However, current research is exploring use of technological innovations affecting the physiological and the behavioral domains of human responses in healthcare. Behavioral

scientists have demonstrated the usefulness of distraction therapy as a behavioral analgesic technique for pain management in both clinical and experimental settings. These preliminary distraction therapy studies suggest the success of video games in pain relief may involve endogenous opioids (Johnson, 2005).

Adult Studies

Virtual reality (VR) research indicates significant analgesic effects in distracting patients' attention during painful procedures. The following discussion is a review of the literature in the various behavioral distraction techniques currently reported. According to Forsys and Dahlquist (2007), some individuals cope by distracting themselves and avoiding threatening cues. In the cognitive-social model of health information processing developed by Miller (1987), this style of information processing is called blunting. Blunters respond best to pain management strategies, such as distraction, which require them to direct their attention away from the noxious event or stimulus. Conversely, individuals who search for and tune into threatening stimuli attend closely to their physical sensations and are termed monitors (Miller, 1987).

In a study of distraction and nociceptive signals, Forsys & Dahlquist (2007) assigned 95 participants into one of three coping style groups: low monitors, mixed, or high monitors on the basis of their scores on the Miller Behavioral Style Scale (MBSS), as shown in Table 1. Participants were then randomized to either a control or experimental condition (distraction or sensation monitoring). Participants in the control condition underwent three cold pressor trials with no pain management strategies taught. Participants in the experimental condition underwent a baseline cold pressor trial, a cold pressor trial in which they were to use distraction, and a cold pressor trial in which they were told to use sensation monitoring.

Results of Forsyth & Dahlquist's (2007) study indicated that distraction, which interferes with the detection of nociceptive signals, and a sensation monitoring strategy, which alters the affective component of pain, were both effective. Compared to baseline performance, participants had higher pain thresholds and demonstrated greater pain tolerance when they utilized either one of the cognitive pain management strategies (arithmetic subtraction counting from 1000 by 7s or sensation monitoring) compared to the control group. It is interesting to note that low monitors had higher pain thresholds during distraction (a matched condition) than during sensation monitoring. In contrast, high monitors did not demonstrate a differential response to either of the cognitive interventions. This study demonstrates the need for future research in acute care settings to explore individual coping styles for the development of individualized pain management programs and NPS promoting patient self-efficacy.

Cacau and colleagues (2013) studied the intervention of VR in the cardiac surgery population during the postoperative course (postoperative day 1, 3, and day of discharge). Results indicated that the VR group reported less pain on all three post postoperative days compared to the control group (no VR), as shown in Table 1. Results from this study also demonstrated a decrease in length of stay for the VR group compared to the control group. An additional finding from this study indicated that for most of the patients in this study, it was their first experience with virtual video games and they were eager to learn something new that would speed their recovery.

Campbell and colleagues (2010) explored catastrophizing styles and behavioral analgesic effects of distraction with video games, as shown in Table 1. The investigators divided healthy subjects in low or high catastrophizer groups based on their situational catastrophizing scores.

Both groups were given three sessions, pain alone, pain plus distraction (video games), and distraction alone (video games). Results of the study indicated that pain was rated significantly lower during the distraction session compared to the pain alone session. High catastrophizers were delayed in experiencing the pain-reducing effects of video games. However, this difference may be due to a type I error. Another explanation is high catastrophizers may experience greater pain due to exaggerated attentional engagement with the pain stimuli, and greater difficulty disengaging attention from pain.

Edwards and colleagues (2006) investigated the nociceptive flexion reflex (NFR) threshold and pain ratings in 40 healthy adults. Nociception is the neural transmission of information about perceived or actual tissue damaging-stimulus. The insult to the skin causes activation of peripheral nociceptors that excite nociceptive neurons in the spinal cord dorsal horn, which relays the information to higher brain centers to be processed. Distraction techniques using number repetition and mental arithmetic were selected. Biological markers of heart rate and cardiac contractility were obtained to characterize levels of arousal and attentional demands since previous NFR modulation studies reflected variations in levels of arousal and distraction, and inclusion of biological markers help to clarify the relationship of arousal tasks and the NFR thresholds, and pain ratings. Results of this study indicated NFR thresholds were the same during mental arithmetic and number repetition. However, subjective pain ratings were lower with mental arithmetic indicating pain is inhibited by increased cognitive and physiological arousal, as shown in Table 1.

The effectiveness of high-technology VR goggles, by Hoffman and colleagues (2006), demonstrated that the patients' peripheral vision was increased in the virtual world, and

influenced the VR analgesia in healthy volunteers. Researchers randomly assigned subjects to either a low-technology VR goggles group, to a high-technology VR goggles group, or to a no VR group. Both subjects and RAs collecting pain ratings remained unaware that the helmet goggles quality was being manipulated. Compared to the low-technology group (35 degree field view diagonal), the high-technology VR goggles group (60 degree field view diagonal) reported 34% reduction in worst pain, 46% reduction in pain unpleasantness, 29% reduction in time spent thinking about pain, and 32% more fun during the pain stimulus during VR. Overall, there was a 65% reduction in pain intensity with the high-technology VR goggles compared with only 29% with the low-technology goggles, as shown in Table 1.

In a study performed by Wender and co-workers (2009) involving helmet quality, the VR system was manipulated via interactivity of study subjects. Healthy volunteers were randomly assigned to one of two treatment groups. All participants glided through the virtual world SnowWorld, but one group followed a trackball and interacted with the game, while the second group could not interact (no trackball). Following the intervention, subjects rated their subjective pain ratings (0-10). The more-immersive VR group interacting with the trackball showed significantly more pain reduction than the less-immersive VR group with no interaction, as shown in Table 1 (Wender, et al., 2009).

Pediatric Studies

As shown in Table 2, Dahlquist and colleagues (2007) tested the effectiveness of interactive versus passive distraction delivered through a virtual reality head mounted display helmet for children experiencing cold pressor pain. Forty children, ages 5 to 13 years, underwent 1 or 2 cold pressor trials followed by interactive distraction and passive distraction trials. Pain

threshold and pain tolerance were the outcome measures. Children who experienced either the interactive or the passive distraction demonstrated significant improvements in both pain tolerance and pain threshold relative to their baseline scores. In contrast, children in the control group who received cold pressor pain with no distraction showed no improvement in pain tolerance or threshold.

Dahlquist and co-workers' (2007) findings indicate that electronic games are multisensory compared to the passive virtual reality display helmet. In addition to visual and auditory sensations, tactile and kinesthetic senses are involved in video games. Therefore, electronic games may offer the potential to block more sensory domains associated in acute pain stimuli. Video games engage the gamer and utilize more attentional resources than passive tasks. Furthermore, Dahlquist and co-workers (2007) posit that tasks which involve active problem-solving may be more likely to interfere with catastrophizing and other pain-exacerbating maladaptive thought processes.

A small study of the effects of video games in pediatric oncology patients performed by Kolko and Rickard-Figueroa (1985) assessed three male patients ages 11, 16, and 17 years. These patients reported anticipatory distress and anxiety symptoms of post-chemotherapy side effects that were collected at each video game session. Compared to the baseline condition, access to video games resulted in a reduction in the number of anticipatory symptoms experienced and observed, as well as a lessening of aversive chemotherapy side effects. Video games were introduced concurrently with the administration of chemotherapy. Patients' self-reported and observer-recorded anticipatory symptoms were decreased, as well as post-chemotherapy distress. The continuous sensory stimuli designed to redirect attention from

chemotherapy associated side effects in this study demonstrates the usefulness of attentional distraction achieved with video games in this age group, as shown in Table 2.

Preliminary results from a study by Hoffman & Patterson (2008) found that immersive VR distraction can reduce patients' pain ratings during severe burn wound care by 30%-50%. In addition to opioid analgesics, patients received VR during some portion of their wound care, and no VR during an equivalent portion of wound care. During physical therapy sessions, compared to opioid analgesic medications alone, patients receiving adjunctive VR during physical therapy reported large reductions in the amount of time spent thinking about pain, pain intensity, and how unpleasant they found their pain. During staple removal from a severe burn skin graft, a patient reported a 90% reduction in pain with immersive VR compared to pain ratings while playing a Nintendo video game during the same wound care session. This patient reported a strong illusion of going into the virtual world. In applying the same protocol with another similar patient, there was a more moderate reduction in worst pain, as well as a moderate illusion of going into the virtual world. Although the study results are preliminary, the stronger the patients' illusions of going into the VR, the more effectively they are distracted from pain, as shown in Table 2.

Hoffmann and Patterson (2006) propose that the illusion of going into the virtual world draws the patient's attention into that perceptual framework. SnowWorld is the first virtual world designed specifically for burn patients. By donning a VR helmet, which blocks their view of the burn wound care, patients float through an icy 3-D canyon during severe wound care or physical therapy sessions. Patients aim the head-tracked gaze and shoot snowballs at snowmen, igloos, and robots (complete with explosions and 3-D animations and sound effects). Because VR is interactive and multisensory, VR is unusually attention-grabbing, reducing attention to process

incoming pain signals. Conscious attention is required for the experience of pain (Hoffman & Patterson, 2006, <http://www.ampainsoc.org/pub/bulletin/spr05/inno1.htm>).

Kipping and colleagues (2012) investigated off-the-shelf VR for acute pain reduction in adolescents undergoing burn wound care. Forty-one adolescents (11-17 years) participated in the study. Subjects were randomized in the VR group (VRG) or the standardized group (SDG). Both groups received identical wound care procedures and medication protocols. Mean pain scores were higher for the SDG compared to the VRG in both dressing removal and application; however, these differences were not statistically significant. Nursing staff observations revealed statistically significant differences between the VRG and SDG during dressing removal, with fewer pain behaviors observed for the VRG. There was also a statistically significant reduction in the number of Entonox (nitrous oxide and oxygen) doses given, and a trend for the mean pain scores to be lower, compared to the SDG, as shown in Table 2.

As shown in Table 2, Miller and colleagues (2011) studied 40 children, ages 3-10 years, undergoing burn care. Subjects were randomized to standard distraction (SD) group and a multi modal distraction (MMD) group. Pain intensity and distress were measured prior to and during the procedure. A combined MMD protocol significantly reduced pain intensity and distress compared to SD. The MMD device is a customized hand held console that is interactive for the child through movement, touch screen, and multisensory feedback (visual, auditory, and vibration). This interactive-device offers the child games with “touch and find” story features. The story is titled, “Bobby got a Burn” and informs the child of what they are to expect when getting their burn dressings changed. Children had their choice of the interactive story or a game throughout the wound care procedure.

Using a mixed model design, Weiss and colleagues (2011) examined the effects of interactive versus passive distraction on healthy preschool-aged children's pain tolerance, applying cold-pressor pain stimulation. Subjects were randomly assigned to one of three experimental groups, an interactive distraction, a passive distraction, or no distraction (control). All subjects underwent a baseline cold-pressor trial with no distraction, followed by an interactive distraction trial, passive distraction trial, or second baseline trial (control subjects), as shown in Table 2.

For the interactive distraction, Weiss and co-workers (2011) implemented a joy-stick for participants to engage in a developmentally appropriate video game displayed on a TV monitor. During passive distraction, subjects watched a prerecorded game output from the same video game segment utilized in the interactive distraction condition on the TV monitor, but did not manipulate the video game controls. Visual and auditory stimuli were the same in both conditions. The only difference between the two conditions was the child's ability to interact with the game. This allowed investigators to examine whether either condition resulted in improved pain tolerance over and above the effects of repeated exposure to the cold pressor test. In order to compare the relative effectiveness of interactive and passive distraction with optimal power, each child participated in one or two additional trials. This design provided investigators the ability to compare pain tolerance scores during both experimental distraction conditions, as well as compare pain tolerance during the last baseline trial (Weiss, et al., 2011).

Windich-Biermeier and colleagues (2007) evaluated the effects of a variety of self-selected distracters which included bubbles, a book, a music table, VR glasses, or hand held video games on pain, fear, and distress in 50 children and adolescents with cancer, needing

venous port access or venipuncture. Nearly all study subjects experienced 6 or more previous venous port access or venipuncture. The design of the study was an intervention-comparison with participants randomized to the comparison group (standard care) or the intervention group (distraction plus standard care). Results of this study indicated that pain scores were not significantly different between the two groups but did tend to be lower in the intervention group. Forty-six percent of study subjects in the intervention group reported the needlestick was “better” or “much better” than their last port access or venipuncture compared to 39% in the standard care group. Participants were experienced in needlesticks and likely developed an anticipatory conditioned pattern of coping in response to the painful procedure. Nonetheless, the study findings support distraction strategies as beneficial for improved procedure-related outcomes as reported by the nurses. Equally important, parents reported their children tolerated the procedure much better while distracted compared to previous port access or venipuncture without distraction interventions. All parents who participated in the study reported that they would encourage distraction interventions in future procedures and nearly all participants reported that they wanted to do so. Thus, distraction interventions with parental encouragement during venous port access and venipuncture influences positive clinical outcomes with a primary benefit of decreased fear and distress, and contributes to a growing body of evidence which supports the benefits of cognitive-behavioral distraction interventions in the management of pain, fear, and distress in children as shown in Table 2 (Windich-Biermeier, 2007).

Virtual reality (VR) distraction during painful medical procedures in pediatric oncology patients was reported to decrease distress in children during port access. Wolitzky and colleagues (2005) examined twenty 7 to 14 year old patients, randomized to the immersive VR or to a no VR control group. Children’s distress was assessed through self-reported physiological and

behavioral ratings. Narrative accounts of the experience were utilized to capture how well the participants coped during the procedure. Results of this study indicate that VR is useful in children undergoing painful and distressing medical procedures. Children's narratives provided the investigators information about how children are coping with anxiety and distress, as shown in Table 2.

Neuroimaging Studies

Neuroimaging studies comparing brain activity and pain alone versus brain activity with simultaneous distraction tasks show significant effects in brain pain regions. Valet and colleagues (2004) found that a distraction task performed during noxious pain stimulation reduced pain intensity and reduced neural activity in multiple pain-related brain areas compared to identical noxious stimulation with no distraction activity. Pain plus distraction compared to pain alone, increased activation in the cingulo-frontal cortex, the periaqueductal gray (PAG), and the posterior thalamus (Bantick, 2002), as shown in Table 3.

MRI studies indicate similar results, implicating processing in the pain-modulatory pathway descending from the frontal cortex to the amygdala, through the PAG, rostral ventral medulla, and spinal cord dorsal horn (Tracey, I., et al., 2002; Villemure & Bushnell, 2002). Moreover, endogenous opioids are central neurochemical modulators, such as beta-endorphins, which act in both the peripheral and central nervous systems to moderate noxious stimuli with resultant behavioral analgesic effects (Campbell, et al., 2010), as shown in Table 3.

Hoffman and colleagues (2004) report that a VR intervention with magnetic resonant imaging (fMRI) study where thermal pain stimulated pain related brain activity in the five regions of interest in the brain (SS1, SS2, ACC, Insula, and Thalamus) and VR analgesia was

accompanied by reductions in brain activity when in SnowWorld. In this controlled laboratory study, participants showed large (>50%) reductions in pain-related brain activity when in SnowWorld compared to no VR during their MRI scan. Participants also reported significantly large reductions in subjective pain when in the virtual reality environment of SnowWorld (Hoffman & Patterson, 2005, <http://www.ampainsoc.org/pub/bulletin/spr05/inno1.htm>), as shown in Table 3.

Hoffman and co-workers (2007) compared and contrasted fMRI brain scans in 9 healthy adult participants receiving either VR, opioid analgesia, or a VR/opioid analgesia combination. Subjective pain ratings as well as objective measures of brain activity patterns were analyzed. Thermal pain stimuli were applied during fMRI scans. Results demonstrated that the VR and opioids each reduced pain ratings and brain activity. As shown in Table 3, when VR was combined with opioids, there was significantly more reduction in pain than opioids alone, and patterns of brain activity were consistent with subjective pain ratings (Hoffman et al., 2007).

Meditation, Music, and Art Intervention Studies

In a study exploring the effects of music and art on pain perception, Mitchell and colleagues (2008) recruited 80 subjects who underwent three trials of cold pressor with the conditions of preferred music, preferred painting, and silence control. The dependent variables were pain tolerance time, self-ratings of pain intensity, perceived control over pain, and stated anxiety. Findings from this study indicate the efficacy of music listening for pain relief, with the use of preferred choice of music, leading to longer pain tolerance, less anxiety, and a greater perceived control over the experience of pain compared to both a silence control and a visual art distraction condition, as shown in Table 4.

Meditation is another alternative therapy in pain management. Perlman and colleagues (2010) designed an experimental procedure using nine long-term meditation practitioners with at least 10,000 hours of formal meditation practice in the Kagyu and Nyingma traditions of Tibetan Buddhism. Ten control participants were recruited from the local community with no previous experience with any type of meditation, but expressed an interest in learning meditation. They were given instructions written by a scholar familiar with the practice of meditation, and then told to practice at home for 30 minutes a day for 7 days prior to the experiment. For the experiment, a painful stimulus was applied using thermal stimulation to the medial surface of the left wrist for a total of 10 trials. The temperature range was 46 degrees to 49 degrees Centigrade, and participants were instructed to indicate their pain level when they reached 8 on a scale of 0-10, where 0 equals no pain at all, and 10 indicates unbearable pain.

As shown in Table 4, findings from Perlman and colleagues' (2010) study support the hypothesis that training of specific cognitive strategies can affect the subjective thermal pain stimulus experience and the participant's degree of attention to the unpleasantness. Perlman and colleagues (2010) refer to this as mindfulness meditation, and the significance of these findings extend beyond the area of pain perception. They posit that Cognitive behavioral therapy (CBT) could utilize these techniques to provide specific training to clients to change negative patterns of cognition, such as the progression of catastrophizing and rumination into severe negative affect states.

Distraction from Stress Studies

Reinecke (2009) investigated the use of video games for recovery purposes in 1,614 online participants. Video games are systematically utilized following exposure to stressful

situations, and participants report that the recovery experience is a significant facet of the video gaming experience. Mental disengagement is a key component of recovery, and the high degree of interactivity makes this possible. In contrast to other forms of media entertainment (e.g. television), video games demand active participation and full cognitive capacity, with a continuous exchange between the player and the game's software. This continuous interaction is referred to as input-output loops and literally forces the user to focus their full attention on the game. Gamers report the sensation of spatial presence within the game, and this intense interaction provides an effective way of escaping negative cognitions or ruminations of stress-inducing events. Because of their potential to foster psychological detachment, games have a high potential to focus the player's attention on the game and create a high degree of immersion, and thus support feelings of relaxation and recovery from stress and strain, as shown in Table 5.

Reinecke (2009) asserts that video games, in contrast to non-interactive media, provide users the opportunity to control the progress of events in the game. For example, movies have a predetermined plot and ending, whereas with video games the protagonist's fate largely depends on the player's decisions. The player is manipulating the environment, and these actions produce immediate feedback and the feeling of having an effect on the game environment. Many games provide the opportunity to exert control by choosing or creating an avatar or choosing different missions or quests. This allows the player extensive opportunities to exert control over the gaming environment, which promotes autonomy, contributing to the recovery process (Reinecke, 2009).

In addition to feelings of control, players also develop feelings of mastery in the gaming experience. In most games, players are confronted with opponents they compete with, and

problems they have to resolve. As the game progresses, actions are attributable to the player's skill level. Feedback on the player's performance in the form of high scores or status reports on the players' avatar (energy level) is continually given during play. Successfully progressing through achievement levels, leads to feelings of mastery of the game (Reinecke, 2009).

Older Adult Studies

In a study regarding persistent pain in seniors, Stewart and colleagues (2012) investigated pharmacological strategies (PS) and nonpharmacological strategies (NPS) to identify demographic and healthcare correlations with use of these approaches. The study found that a smaller portion of older adults (one third) are using pain management strategies consistent with current geriatric guidelines. Use of NPS is common and may reflect avoidance of prescriptive drugs as recommended by healthcare providers caring for older adults. Therefore, future studies could build on these findings to more fully understand older people's preferences for pain management strategies to facilitate better compliance and interventions targeting their pain in facilitating clinicians who are recommending pain management strategies, as shown in Table 6.

Systematic Reviews

Primack and colleagues (2012) reviewed 1472 articles and 38 met all criteria for inclusion in their goal to determine whether VGs may be useful in improving health outcomes. In another review of the literature, Kato (2010) provided examples of innovative ways to use existing commercial games for health improvement or surgical training. Tailor-made games have been developed to train physicians how to manage different clinical situations and help patients be more compliant to treatment regimes. Finally, Przybylski and colleagues (2010) reviewed the

literature for research approaches to advance scientific understanding of video game engagement and how psychological processes are influenced. With over 10 million players of the popular online game World of Warcraft, it is inevitable that VGs and VR environments will only increase in popularity; therefore, new theoretical models to explore future applications in healthcare are needed, as shown in Table 7.

Gaps in the Literature

Research findings indicate promising applications and usefulness of video games as behavioral analgesia in patients' self-management of pain. Reinecke (2009) demonstrated that mood management and escapism through entertainment media, such as VG exposure indicate potential in self-efficacy and self-regulatory functions in emotional well-being and physical health. More research is needed to explore the potential of VGs in psychological and physical domains of health and illness.

As described above, Hoffman and colleagues (2011) report that VR analgesia is being utilized to treat a variety of painful procedures such as endoscopic urological procedures, physical therapy for cerebral palsy, dental pain and anxiety, pain during cancer procedures, and pain and anxiety during injections. Results from their study provide evidence for VR analgesia from both subjective pain ratings as well as objective neural correlates of pain (<http://www.ampainsoc.org/pub/bulletin/spr05/inno1.htm>). More research is indicated in these patient populations. Research to investigate distraction interventions most appropriate in different patient populations is needed.

A barrier to VR analgesia is the expense of the equipment compared to other lower cost distraction techniques, such as video games. The costs and benefits of different types of

distraction interventions need to be analyzed. Further investigations are indicated to compare the effectiveness and the potential of nonpharmacological behavioral analgesia with other distraction interventions (Wolitzsky, 2005).

In comparison to VR, video games are inexpensive, engaging, require minimal if any training, and are enjoyed by a wide variety of ages. Additionally, video games provide constantly changing stimuli from different sensory modalities which increase interest in playing for longer periods of time, keeping gamers more engaged (Kolko & Rickard-Figueroa, 1985). Future studies are indicated to explore individual coping styles for the development of individualized pain management programs and NPS promoting improved pain management protocols to improve outcomes and patient self-efficacy.

Implementing a feasibility study to explore the usefulness of video games in patients' self-management of pain may address gaps in the literature for research with NPS for pain management in the acute care setting. Current state of the science supports the need to further research in distraction interventions which may provide patients more alternatives to pharmacologic treatments alone, and provides patients a sense of mastery in self-directed pain management strategies (Windich-Biermeier, et al., 2007).

It is important to note that there is more emphasis placed on entertainment resources in today's hospital environment in an effort to provide more comfort, and improve outcomes for patients and families as they move through the recovery period. More hospitals are providing educational and entertainment resources to the patient through in-room television monitors. Video games are just one of several entertainment resources available to patients. Research comparing the noninteractive to the interactive entertainment resources is needed to determine

the recovery potential of the different modalities. Future research may provide knowledge for the development of a recovery conceptual framework to support interactive patient care (IPC), an emerging care delivery model. This innovative concept is based on the premise that the more engaged the patient, the better the outcomes ([www. Getwell.com/services/interactive-patient-care](http://www.Getwell.com/services/interactive-patient-care)).

Literature Review Tables

Table 1

Adult Studies Utilizing Virtual Reality and Video Games in Pain Distraction

Source	Design, Setting, and Type of Pain Stimulation	Number of Subjects and Inclusion Criteria	Level/Quality of the Evidence and Limitations	Target Population	Distraction Intervention	Implications/Relevance
Cacau, et al., 2013	Randomized into two groups, virtual reality group (VRG) and control group (CG)	102 subjects <75 years of age (mean 49.2 ± 2.6 years)	II a Advanced elderly >75 years were excluded from this study	Adults undergoing elective cardiac surgery (coronary artery bypass grafting and/or valve replacement)	VR	This study demonstrates the benefits of VR as an adjunct treatment to functional restorative treatment protocols in decreasing pain utilizing VR. Pain measured by the Nottingham Health Profile (NHP) was significantly decreased on post op day 3 (10) compared to CG (30) ($P < 0.05$); total length of stay was decreased between the VRG (9 days) and CG (12 days) ($P < 0.05$); six minute walk test distance was increased in VRG = >300 m compared to CG distance = 260 m ($P < 0.05$).
Campbell, et al., 2010	Repeated measures analysis of variance (ANOVA) with between-subjects and within-subjects analysis. All subjects completed the three sessions in randomized order in a laboratory setting. Capsaicin induced pain	32 healthy adults; no pain, no medical or psychiatric disorders, no use of narcotics, antidepressants, anticonvulsants, and muscle relaxants, no history of alcohol or drug abuse.	II b Healthy subjects, young, and undergoing laboratory-based pain-induction procedures; a single type of experimental pain stimulus; not using a naloxone challenge to block the endogenous opioid	Healthy students	Video games	Distraction was associated with substantial reductions in capsaicin pain ratings for all subjects compared to the pain alone group (no distraction). Attentional

			systems.			
Edwards, et al., 2006	Within subjects repeated measures of covariance ANOVAs and MANOVAs (biomarkers of HR, R-wave to PRI) were conducted measuring nociceptive flexion reflex (NFR) thresholds during rest, number repetition, and mental arithmetic using sural nerve (ankle) induced electric pain stimulation.	40 healthy students (28 males, 12 females); mean body mass index of 23.09 kg; refrained from caffeine, alcohol, and exercise for 2 hours, and analgesics for 24 hours before testing.	I Ib Young age of subjects; credit for an undergraduate research methods course given	Healthy young adults, mean age 19.95 years; normal weight	Number repetition, and mental arithmetic distracters	Mental arithmetic and number repetition were both associated with reduced nociceptive flexion reflex thresholds ratings compared to rest states; however, pain ratings were lower in mental arithmetic than number repetition indicating that increased physiological arousal inhibits pain. The findings of this study indicate that NFR thresholds are not a suitable correlate of pain during conditions of increased psychological arousal or load. This is because NFR is a polysynaptic spinal reflex and supraspinal arousal modulates NFR thresholds and pain.
Forys & Dahlquist, 2007	Split-plot factorial; randomized to experimental or control group Laboratory setting	95 No report of Reynaud's phenomenon, no history of chronic pain, no narcotic medication in prior 12 hrs	II a	Healthy Students	Sensation monitoring or arithmetic subtraction groups	
Hoffman, et al., 2006	Randomized to experimental groups (low or high technology VR), or no VR group (control). Laboratory setting	77 healthy volunteers	Laboratory	Healthy subjects	VR goggles with 35 degree vs 60 degree field of vision	Higher technology increases pain distraction; 65% high tech VR goggles showed clinically meaningful reduction in pain compared to 29% for the low technology VR goggles.
Wender, et al., 2009	Randomized double blind, between groups	21	II a Laboratory	Volunteers, ages 18-19 yrs	Noxious thermal pain given to both groups;	Interactivity increased analgesic effectiveness of interactive immersive VR vs non-interactive VR; 75%

					one group was interactive VR vs non-interactive VR	reduction in pain unpleasantness ($p<.005$); 74% reduction in worst pain ($p<.005$).
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Table 2*Pediatric Studies Utilizing Virtual Reality and Video Games in Pain Distraction*

Source	Design, Setting, Type of Pain or Discomfort Stimulation	Number of Subjects and Inclusion Criteria	Quality/Level of Evidence and Limitations	Target Population	Distraction Intervention	Implications/Relevance
Dahlquist, et al., 2007	Within subjects analysis; laboratory setting; baseline cold pressor pain tolerance less than 4 minutes; parental and patient assent	40	II a Small sample size; laboratory induced pain; subjects had no history of pain or frightening experience; restricted age range (no children under 5yrs)	Healthy Ages 5-13	Interactive VG versus passive Virtual reality (VR)	Post-hoc comparisons indicated lowest pain thresholds with no distraction; highest pain thresholds with interactive distraction ($p < .01$)
Kolko & Richard-Figueroa, 1985	Repeated measures; Setting: pediatric oncology outpatient clinic setting. Type of pain or discomfort stimulation: chemotherapy	3 oncology outpatients receiving chemotherapy; parental consent and patient assent	II b small sample size	Oncology male patients, ages 11, 16, & 17 years	Video games (VG)	Compared to baseline condition, the introduction of VG during administration of chemotherapy reduced self-reported and observer-recorded anticipatory symptoms, and post-treatment distress.
Hoffman & Patterson, 2008	Within subject condition order randomized; Regional burn center setting	11 burn wound debridement patients; pediatric parental consent and patient assent; adult patient consent	II a	Burn patients, ages 9-40 yrs	Immersive Interactive VR	41% reduction in pain intensity in highest pain rating subjects ($n=6$);
Kipping, et al., 2012	Randomized control trial with a parallel group design; Two burn center settings	41 Adolescents ages 11- <18 years, burn unit patients, needing first conscious dressing	IIa Limitations: only pain intensity was measured; blinding of staff and subjects was	11-17 years	VR	Off the shelf VR did not reduce pain levels, length of treatment times, or adverse pain events more than standard distraction. Adolescents exposed to VR had a trend to lower mean pain scores, but the only

		change; TBSA >1%; English speaking; no cognitive impairments; no visual or hearing impairments unable to be corrected; wound location preventing use of VR device	difficult with distraction interventions			statistical significance was during dressing removal. This study highlights the need for customized VR to further understanding distraction and pain reduction in this age group.
Miller, et al., 2011	Randomized to two groups, the standard distraction group, or the multi modal distraction (MMD) group (combined protocol of procedural preparation and distraction)	40 New burn patients; TBSA >1%; outpatient; required standard analgesia only; no cognitive impairment; English speaking	II a Pain scores were recorded retrospectively; depth of burn was based on observation and opinion	Burn patients, ages 3-10	MMD, a hand held device that is interactive games, & preparation for procedure	A combined MMD protocol significantly reduced pain intensity and distress scores ($p < 0.001$) when compared to standard distraction. Length of treatment days to healing and number of pain adverse events were also reduced ($p < 0.05$) with use of the MMD protocol.
Weiss, Dahlquist, et al., 2011	Mixed model design; within-subjects ANOVA; randomly assigned to 1 of 3 experimental groups; cold pressor pain stimulation; Qualitative questions	61 Inclusion criteria: no history of Reynaud's or sickle cell, mental retardation, hearing or visual impairments	IIa Limitations were lack of equal numbers of 3-5 year olds; some too young to maintain optimal engagement; longer pre-immersion acclimation period might facilitate response to distraction	Preschool-aged, 3-5 years	Interactive Winnie the Pooh video game distraction with joystick; passive distraction was viewing footage of video game	Higher pain tolerance during interactive and passive compared to baseline; age positively correlated with pain tolerance in interactive condition $r(58) = .26, p = .02$; older children demonstrated greater improvement from baseline; passive condition only marginally significant $r(58) = .20, p = .06$. Qual results: 43 reported not played game before, 16 had played, and 1 no response. All 60 liked game, 51 would play game again.
Windich-Biermeier, et al., 2007	Intervention comparison group design; randomized to intervention group (standard care plus	50 leukemia, lymphoma, solid tumor, or histiocytosis patients, receiving chemotherapy	II a Small sample size; broad age range; baseline measurements of fear and distress were	Cancer pts, ages 5-18 (mean age 10.5 ± 3.8 years)	Multiple distracters: Bubbles, book, music, VR glasses, or VG	Self-reported color analog scale (CAS) pain scores 0-10, mean 0.28 ± 0.41 in the intervention group ($n=22$) and 0.84 ± 2.21 in the standard care group ($n=28$). The difference was not

	distraction) or to comparison group (standard care only, no distraction). Setting: Children's Hospital	needing a port access/venipuncture; able to speak and understand English, no visual or hearing impairments; experienced at least one previous port access/venipuncture.	not obtained to be sure no differences exist between the two groups.			significant ($P = .68$), however, scores tended to be improved in the intervention group. Parental participation in distracting children during venous port access and venipuncture supported positive clinical outcomes in decreasing fear and distress. Perceived efficacy of distraction was reported by all parents and they would encourage or participate in distraction interventions again.
Wolitzky, et al., 2005	Mixed methods; randomized to experimental or control group with subjective self-ratings and objective physiological and behavioral ratings. Narrative accounts measured how well the child coped with the procedure.	20 oncology patients receiving treatment for cancer; needing venous port-access; parental consent and patient assent parental consent	II a Metropolitan Children's hospital	Oncology patients, ages 7-14 years	Immersive VR	VR was effective in reducing children's pain and distress on all measures compared to the control group. Narrative accounts provided how children are coping with anxiety and stress during painful medical procedures.

Table 3

Functional MRI (fMRI) Brain Scans to Measure Pain-Related Brain Activity during Distraction Interventions

Source	Design, Setting, Type of Pain Stimulation	Number of Subjects and Inclusion Criteria	Level/Quality of Evidence	Target Population	Distraction Intervention	Implications/Relevance
Bantick, et al., 2002	Within subjects design; fMRI imaging using image analysis FEAT; mean reaction times and pain scores across subjects were analyzed and a one-tailed Student's <i>t</i> -tests done to compare significance between the interference and neutral pain intensity scores. Laboratory setting; noxious thermal pain stimulation	8 healthy (6 males, 2 females) right handed volunteers, mean age 30 ± 9 years	II b Limited to thermal pain stimulus	Adults	Modified Stroop task with no verbal response to prevent head movement during MRI scan	Lower pain intensity scores were reported while subjects were engaged in the more cognitively demanding interference Stroop task than the neutral condition (no distraction). Reduced activation of the pain matrix (insula, midcingulate and thalamus) occurred with the distraction task; congruently, increased activation during cognitive interference of the perigenual cingulate and orbitofrontal regions occurred demonstrating the modulation of pain by attention.
Hoffman, Richards, et al., 2004	Within subjects design; laboratory setting with noxious thermal stimulation; fMRI scans of 5 regions (cingulate cortex, primary and secondary somatosensory cortex, insula, and thalamus) during VR analgesia for half of the scan, and	8 healthy male volunteers (originally 14 subjects with 10 males and 4 females with 6 subjects excluded due to excessive	II b Small sample size	Adult volunteers, ages 18-43 years	VR intervention during half the scan and no VR for the other half of the scan.	Neural activity using fMRI brain scans during VR intervention demonstrated a 50% reduction in pain-related brain activity in all five brain pain regions. VR analgesia significantly reduced all subjective reports compared to no VR; 44% reduction thinking about pain, 45% reduction of emotional

	no VR analgesia during the other half of the scan (control condition) ($p < 0.002$).	head movement during fMRI)				pain; 30% sensory pain rating reduction; and increased fun ratings by 79%. A moderately strong illusion of presence in VR (mean 6.38, range 4-8), and mean nausea during VR < 1 (range 0-4) $p < 0.001$.
Hoffman, et al., 2007	Within subjects design; experimental condition randomized. Laboratory setting; noxious thermal stimulation	9 healthy volunteers	II a	Adult	VR	Compared and contrasted opioid analgesia vs VR analgesia, subjective pain ratings, and objective brain activity patterns; VR and opioids each reduced pain ratings and pain-related brain activity. Adding immersive VR to opioids resulted in more reduction of pain than opioids alone.
Tracy, et al., 2002	Using fMRI imagining of the periaqueductal gray region (PAG) while subjects were instructed to attend (A) to pain stimulus versus not attending (NA) to pain stimulus. The two experimental tasks were randomized across subjects during the same imaging session. Noxious thermal pain stimuli were applied.	9 right-handed volunteers; 6 males, 3 females; mean age, 26 ± 2.6 years	II a Small sample size	Healthy adults	Mindfulness of attending (A) to thermal pain stimuli versus not attending (NA) to pain stimuli	A significant decrease in the rating for pain was found during the P + NA condition (mean $\pm$ SE: P + A, 7.8 ± 0.4 vs P + NA, 7.0 ± 0.3 ; $t = 3.51$ ($p < 0.05$). Correlation analysis was done between the total change in VAS rating (intensity and aversiveness) and total change in activity within the PAG for the two conditions. Cognitive processes modulate pain associated activity within the PAG.
Valet, et al., 2004	fMRI neuroimaging; factorial design with categorical and covariation analysis of four conditions	7 subjects (6 males, 1 female); inclusion	II a Laboratory; heat stimulation	Adults, ages 22-44 yrs	Color word Stroop-task; the use of the distraction task (Stroop-task)	Decreased pain perception during distraction was associated with a reduction of activity in

	<p>(innocuous and noxious heat; with and without distraction). Regression analysis was performed to reveal the functional connectivity between a region of interest (Cingulo-frontal cortex) and remote brain regions. Covariation analysis of the BOLD pattern from the cingulo-frontal cortex revealed functional interaction with the PAG and the posterior thalamus.</p>	<p>criteria, right handed with no hx of neurologic disease or psychiatric disease</p>			<p>during pain stimulation reduced subjective perception of pain; 0–100 VAS scale a 16.3% reduction in unpleasantness; paired t-test: $P<0.004$ and for intensity from 8.9% reduction; $P<0.04$.</p>	<p>pain encoding brain areas, while the activation of the cingulofrontal cortex, the PAG and posterior thalamus increased. These brain structures form a network of pain modulation including the activation of the descending inhibitory control system.</p>
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Table 4*Meditation Practices, Music, and Art Interventions in Pain Intensity*

Source	Design, Setting, Type of Pain Stimulation	Number of Subjects and Inclusion Criteria	Level/Quality of Evidence and Limitations	Target Population	Distraction Intervention	Implications/Relevance
Perlman, et al., 2010	Repeated measures, between-subjects and within-subjects during noxious thermal pain stimuli; focutalized attention (FA) versus open monitoring (OM) comparing the long-term meditation (LTM) practitioners compared to the control subjects (no experience in meditation group)	19 9 long-term meditation practitioners and 10 controls with no previous experience with any type of meditation; no history of pain-related disorders and no use of analgesics or psychiatric medications	II b Study subjects knew in advance that they would be asked to rate the pain intensity after each trial, which may have created an intention to maintain attention on the painful sensation.	Long-term meditation practitioners and	Mindfulness meditation	Pain intensity or unpleasantness was significantly lower with a LTM , $F(1, 17) = 10.623$, $p = .005$ compared to control (no experience with meditation) and lower in OM versus FA for the experts, $F(1, 8) = 46.62$, $p = .0001$. There was no main effect of LTM compared to control for both pain and unpleasantness ratings during FA. The intensity ratings for both groups were identical and the unpleasantness ratings were not significantly different.
Mitchell, et al., 2008	Repeated measures, within-subjects design; Setting was a sound attenuated university laboratory; cold pressor pain stimulation	80 44 females; 36 males; mean age 21 years; no previous medical conditions, including heart, circulatory, and blood pressure problems; no	II b Limitations: Healthy, young adults; subjects were paid	Healthy university students and acquaintances, ages 18-38 years	Own preferred music of their choice brought with them and 1 of 15 well-known paintings, or bring their own preferred piece of artwork;	Preferred choice of music significantly improved pain tolerance and perceived control, and reduced anxiety. The visual art was not found to differ from the control condition in efficacy. Pain tolerance: main effect $F(2, 77) = 11.42$, $p < .001$; men tolerated more pain than women $F(1, 78) = 4.14$, $p < .05$. Pain intensity (VAS): $F(2,$

		recent serious injury; no history of chronic pain, diabetes, or epilepsy			control condition was silence with no visual art	76) = 4.43, $p < .05$. No significant effect of sex was found. Anxiety main effect: $F(2, 67) = 9.12$, $p < .001$. Perceived control: main effect $F(2, 72) = 19.30$, $p < .001$.
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Table 5*Video Game Distraction in Recovery from Stress: An Online Survey Questionnaire*

Source	Design and Setting	Number of Subjects and Inclusion Criteria	Level/Quality Of Evidence	Target Population	Distraction Intervention	Implications/Relevance
Reinecke, 2009	Means, standard deviations, & zero-order correlations. Online survey	1,614 online participants completed a 20 minute online questionnaire	II b Self-report measures for both recovery experience associated with game play made it easy for subjects to infer the intention of the study. The sample comprised a high number of frequent players versus casual gamers with lower gaming affinity were underrepresented	Online video gamers, ages 12-56 years	Self-selected interactive video games	VG use in mood management demonstrates the usefulness of self-regulating approaches and use of this technology in the management of well-being and physical health. Future studies are needed to provide new insights in the application of these innovative approaches in today's healthcare.

Table 6

Pain Management Survey of Community Urban and Suburban Seniors Utilizing Pharmacological Strategies versus Non-pharmacological Strategies

Source	Design	Number of Participants	Setting	Target Population	Inclusion Criteria	Implications/Relevance
Stewart, et al., 2012	Random sample; door to door recruitment; 3 hour home interview and 3 hour clinic examination; Cross sectional design with associations between pain management strategies pharmacologic (PS) and nonpharmacologic (NPS) modalities were tested using chi-square statistics.	765 (N=599 persistent pain)	Urban and suburban community dwellers	Seniors, ages ≥ 64 yrs	English speaking; able to walk 20 ft or more unaided; no terminal illness; no severe vision or hearing deficits; MMSE score ≥ 18	Results are generalizable to English speaking older adults with pain. Average age = 77.8 yrs; 66% female; 77% non-Hispanic white; 17% black. Brief pain inventory (BPI) = 35% very mild pain, 33% mild pain, 32% moderate to severe pain. Over one third (37.5%) of participants reported using both PS and NPS modalities (recommendations of the American Geriatrics Society [AGS]); 31% reported use of NPS alone (suboptimal use of analgesics per AGS) and 11.5% utilized PS alone. NPS were reported more frequently than PS (68.4% vs. 49%). The findings suggest that older adults are willing to use a variety of NPS strategies to manage pain.

Table 7*Role of Video Games in Improving Health-Related Outcomes*

Source	Quality/Level of Evidence	Number of Articles	Research Question	Health Outcomes	Implications/Relevance
Primack, et al., 2012	III, Systematic Review	38 (9 video games, 6 psychological therapy, 7 health education, 4 disease self-management, 5 pain distraction, 4 increase physical activity, and 3 to improve clinical skills)	Do results from RCTs indicate that video games can be effective interventions in promoting health and/or improving health outcomes associated with established ICD-9 codes?	Clinician Skills: 46% Disease Self - Management: 37% Health Education: 42% Pain Distraction: 42% Physical Therapy: 59% Psychological: 69%	Video games (VG) may have potential for improving health in a wide variety of areas, for a variety of sociodemographic groups.
Ferguson, 2010	VII, Opinion Introduction to special issue on video games	14 Cognition enhancement on visuospatial cognition, educating youth through “serious” games, application of VGs and health-related problems, and use of VGs in improving the outcomes of developmental disorders in youth.	Do VGs have application in healthcare? Scientists are increasingly examining the potential to use VGs in education, health, students with disabilities	VGs applied to therapy with youth; VGs promote civic engagement with massively multiplayer online (MMO) games that may promote socialization and verbal skills.	VGs are immensely popular in education, in health, for students with disabilities, and to foster visuospatial cognition. World of Warcraft, a MMO has more than 12 million players (more than the population of Greece).
Kato, 2010	III, Systematic Review	12	What applications of VGs in healthcare have shown to be useful? VGs have shown improvement with 1) nausea in pediatric cancer; 2) anxiety; 3) physical therapy and physical fitness; 4) burn pain; 5) bladder and bowel dysfunction, IBS; 6)	Tailor-made games help patients be more compliant to treatment regimes and train doctors how to manage patients in different clinical situations.	Tailor-made VGs for health improvement for different disease groups and surgical clinical skill improvement

			<p>adolescents and young adults with cancer; improve hand-eye coordination, visual special performance, and fine motor control for surgical skills; 7) cancer care education called The Oncology Game for medical students to appreciate the multidisciplinary aspects of oncology, and promote teamwork; 8) simulation videos for teaching skills for mass casualty disasters; 9) diabetes; 10) asthma; 11) breast health; 12) pediatric cancer</p>		
Przybylski, et al., 2010	III, Systematic Review	47	<p>Advances a theory-based motivational model for ways VGs shape psychological processes and influences well-being</p>	<p>New theoretical models and statistical tools to explore these domains are needed and could meaningfully inform more effective health and education interventions.</p>	<p>Self-determination theory (SDT) and VGs can enhance wellness, at least short term to satisfy needs for competence, autonomy, & relatedness.</p>

Chapter Three

Methods

In recent years, there has been an increasing international interest in effective non-pharmacological strategies (NPS) of pain management. New technologies developed for applications in healthcare enhance the distraction approaches available to patients, and provide for improved clinical outcomes. This chapter describes the methodological approach to this study.

Specific Aims

The overall purpose of this study was to examine the effects of video game use (VGU) on pain perception, pain interference perception, and perceived self-efficacy in pain management in a group of adult inpatients in a progressive care unit (PCU) and an orthopedic acute care unit.

The specific aims of this study were to:

1. Describe the demographic variables (age, gender, race/ethnicity, educational level, admitting diagnosis, day of hospitalization, and length of stay [LOS]); pain location, analgesia variables (timing/type/dosage); and VG variables (type of VG and length of time engaged in VGU), and total time researcher engaged with subjects of the sample.
2. Describe self-efficacy and PROMIS PI perception following VGDT.
3. Compare changes in pain perception prior to and following VGDT.
4. Identify factors that predict changes in pain perception following VGDT.

In order to meet the above specific aims, a pre- and post-intervention repeated measures design was utilized. The study was conducted on an adult inpatient progressive care unit (PCU) and an orthopedic acute care unit at a large metropolitan hospital in southern California that is

equipped with patient access to video games via the GWN. The following sections describe the study sample, measures, data analysis, and human subjects' considerations.

Sample

A group of 30 adult patients in an inpatient progressive care unit and orthopedic acute care unit were recruited by the researcher who provided the participants with a brochure describing the study. If the potential participants expressed an interest, a telephone number was provided for contacting the researcher. An initial appointment was made by the researcher to answer any questions regarding the study and obtain written, informed consent.

Criteria for Inclusion and Exclusion

The following criteria were utilized for inclusion in the study:

1) Age 18 or older; 2) Currently hospitalized in the PCU of a Southern California metropolitan hospital; 3) Post-op day two or more; 4) Able to speak and read English; 5) Interested in and able to manipulate the controls of a video game. Exclusion criteria include not meeting one or more of the above criteria.

Power Analysis

A goal of 30 participants is based upon a power analysis as described by Cohen (1988) with power =.8, with a moderate (0.25) effect and a significance level of 0.05. Feasibility study sample sizes between 24 and 50 have been recommended by Sim and Lewis (2012) and Julious (2005). Given the high patient census and that other studies of video game participation reflect high participation rates, it was anticipated that the total of 30 participants would be easily obtained in this setting.

Measurement

The concepts of interest in this study and their respective measures are described in this chapter. Demographic variables (age, gender, race/ethnicity, educational level, admitting diagnosis, LOS); analgesia variables (timing/type/dosage of analgesia administration); VG variables (type of and length of time engaged in VGU), and total time researcher spent with each subject participant, was measured by the Demographic, Analgesia, and Video Game Variables Form (Appendix A.) This 12-item data collection form was developed by the researcher and contains spaces to record each variable from the appropriate source (participant, electronic medical record, and video game usage), as well as observational notes.

Knowledge of pain types and domains of pain allows for the appropriate selection of pain assessment tools. The patient may have more than one type of pain to assess (acute and chronic) at any one time. This study focused on acute pain and explored most of the domains of the pain experience, but not all. The domains of pain are listed as follows:

- pain location: asking the patient to point to their pain;
- pain intensity: measured numerically on a scale from zero to ten and supported by adjectival descriptors from no pain to worst pain imaginable;
- pain affect: what feeling is associated with the pain experience and the impact on the patient's emotions;
- pain quality: what words can best describe the nature of the pain (aching, throbbing, sharp, stabbing);
- exacerbating or relieving factors: are there positions/actions/remedies that reduce the pain sensation;

- Interference of the patient's pain experience on different domains of quality of life and how the patient's pain experience interferes with the different domains of their quality of life (Wright, 2015).

Pain perception and pain intensity was measured by the Visual Analog Scale Measuring Patients' Self-report of Pain Levels (Appendix B). This pain assessment tool was developed by the researcher and is based upon the work of Breivik and co-authors (2008), and is a combination of the Visual Analog Scale (VAS), Verbal Analog Scale, and the Numeric Pain Intensity Scale (also called the Number Rating Scale, NRS). According to Wright, 2015, the VAS carries a greater psychological burden of comprehension than the NRS. Visual Analog Scales indicate higher failure rates in the clinical setting and patients prefer the NRS and Verbal Analog Scale to the VAS alone. The scale has an 11 point line with zero on the far left representing no pain, and 10 on the far right representing worst pain imaginable. Ratings on the NRS range from 1 to 3 representing mild pain, ratings of 4 to 6 representing moderate pain, and ratings from 7 to 10 representing severe pain (Jensen, 2010) and asks the participant to place a mark on the appropriate location of the line. It was administered prior to and following the implementation of the video game intervention by the researcher.

Perception of self-efficacy in pain management was measured by the Visual Analog Scale Measuring Perception of Self-Efficacy in Pain Management (Appendix C). This visual analog scale (VAS) was also developed by the researcher and is based upon the work of Breivik and co-authors (2008), and is a combination of the VAS, Verbal Analog Scale, and the NRS. The scale has an 11 point continuum line with a zero on the far left representing not at all effective, and ten on the far right representing most effective, and asks the participant to place a mark on

the appropriate location of the line. It was administered following the implementation of the video game intervention by the researcher.

Perception of Pain Interference was measured by the PROMIS Pain Interference Assessment Questionnaire (Appendix D). (National Institutes of Health. Accessed at <http://www.nihpromis.org/measures/instrumentoverview> on 1/7/15). The Patient-Reported Outcomes Measurement Information System (PROMIS[®]) instruments use modern measurement theory to assess patient-reported health status for physical, mental, and social well-being to reliably and validly measure patient-reported outcomes (PROs) for clinical research and practice. PROMIS instruments measure concepts such as pain, fatigue, physical function, depression, anxiety and social function. PROMIS has constructed item banks (a collection of questions measuring the same thing that can be administered in short forms or adaptively through computerized adaptive testing). For the purposes of this study, the Pain Interference Assessment Questionnaire (Appendix D) consisting of 8 questions was utilized. Each question requires the participant to choose a response (not at all; a little bit; somewhat; quite a bit; very much) along a continuum in response to a stem question (Example: “How much did pain interfere with your ability to concentrate?”) in reference to the last 24 hours. The PROMIS Pain Interference Assessment Questionnaire has demonstrated utility and validity in multiple populations, including the assessment of multiple dose analgesia in post-operative patients (Mendoza et al., 2004). The questionnaire (paper and pencil) was administered following the implementation of the video game intervention by the researcher.

Data Collection

Following informed consent, study participants were individually instructed by the research investigator on how to access and play the pre-selected video games via the GWN. Although video games are available via the GWN for all inpatients in this setting, study participants were given extra instructions as needed by the research investigator on how to access and play video games. Furthermore, the research investigator explained to all subjects that they will receive standard care and their pain medication will be given as ordered and needed, and that video games are not meant to replace their pain medications. Prior to initiating the intervention, the researcher obtained the pre-intervention data by administering the Visual Analog Scale Measuring Patients' Self-report of Pain Levels (Appendix B).

Patients self-selected their choice of attention demanding arcade-style (classic) or card style video games. Video games are rated for all ages and involve simple motor tasks. Study subjects were offered the opportunity to play video games once daily during their hospitalization for this feasibility study.

Demographic variables (age, gender, race/ethnicity, educational level, admitting diagnosis, LOS, and analgesia variables (timing/type/dosage of analgesia administration) were obtained from the electronic medical record. Video game variables (type of and length of time engaged in VGU) were recorded by the research investigator. Post the intervention the researcher administered the post-intervention measures utilizing the Visual Analog Scale Measuring Patients' Self-report of Pain Levels (Appendix B), the Visual Analog Numeric Rating Scale Measuring Perception of Self-Efficacy in Pain Management (Appendix C), and the PROMIS Pain Interference Assessment Questionnaire (Appendix D).

If a study subject starts and then stops playing the video games for a particular session or day, but did not withdraw from the study, the reason for not playing video games was documented (for example, too much pain). If the patient withdrew from participating in the study, the reason was documented. Outcome data was analyzed to explore the feasibility of video games in pain management and implications for future research study designs.

Data Analysis

Data was entered into SPSS files and analyzed using the latest available version of SPSS. In order to achieve specific aim #1 (Describe the demographic variables (age, gender, race/ethnicity, educational level, admitting diagnosis, day of hospitalization, and length of stay [LOS]); pain location, analgesia variables (timing/type/dosage); and VG variables (type of VG and length of time engaged in VGU), and total time researcher engaged with subjects of the sample, descriptive statistics were utilized. In order to achieve specific aim #2 (describe self-efficacy and pain interference perception following VGDT), descriptive statistics were utilized in a similar manner. Cronbach alpha was employed to measure for internal consistency of the PROMIS PI Likert scales, and Levene's Test for homogeneity of variances. In order to achieve specific aim #3 (Compare changes in pain perception prior to and following VGDT) appropriate inferential statistics were utilized, including paired t tests. To achieve specific aim #4 (identify factors that predict changes in pain perception following VGDT), Pearson's correlation coefficients and Spearman's rho were utilized to examine possible predictor variables following VGDT.

Human Subjects Considerations

Permission for the performance of this study was obtained from the research site's Institutional Review Board. Approval from the University of San Diego IRB was also obtained prior to beginning the study (See Appendix F). All participants were given the opportunity to ask questions about the study and were given informed, written consent. The researcher retained signed consent forms separate from study data in a locked file. No personal identifiers were present on study data and all findings were reported in the aggregate.

Chapter Four

Results

The increasing popularity of computer technologies, including video games, has the potential as a complementary and alternative medicine (CAM) therapy in healthcare.

Complementary and Alternative Medicine therapies offer patients and families additional options in pain management (AHRQ, 2010). The National Institute of Nursing Research (NINR) has implemented a Strategic Plan supporting the design and use of new patient care technologies focusing on health promotion and disease prevention. This plan focuses on integrating the biological and behavioral sciences to improve patients' quality of life through self-management and symptom management using new technologies (NINR, 2011). Behavioral scientists have demonstrated the effectiveness of distraction therapy as a behavioral technique for pain management in both clinical and experimental settings.

The purpose of this study was to examine the effects of video game use (VGU) on pain perception, pain interference perception, and perceived self-efficacy in pain management in a group of adult inpatients in a progressive care unit (PCU) and orthopedic acute care unit. This chapter will present quantitative analysis to address each of these aims.

Specific aims addressed by this study were to:

1. Describe the demographic variables (age, gender, race/ethnicity, educational level, admitting diagnosis, day of hospitalization, and length of stay [LOS]); pain location, analgesia variables (timing/type/dosage); and VG variables (type of VG and length of time engaged in VGU), and total time researcher engaged with subjects of the sample.
2. Describe self-efficacy and pain interference perception following VGDT.

3. Compare changes in pain perception prior to and following VGDT.
4. Identify factors that predict changes in pain perception following VGDT.

Descriptive statistics were calculated to address study aims one and two. Parametric *t* tests were calculated to address aim three, which determined if pain perceptions were different in the sample following VGDT. Finally, aim four was addressed through a two-step process; first, correlations were employed to identify candidate factors that correlated with changes in pain perception. Change in pain perception was calculated by subtracting each subject's post-intervention pain perception (Post VGDT) from their pre-intervention pain perception (Pre VGDT). Factors found to significantly ($p < .05$) correlate with changes in pain perception were then entered into a regression equation to identify significant predictors of change in pain among the sample.

Findings Related to Study Aims

Aim 1: Describe the demographic variables (age, gender, race/ethnicity, education level, admitting diagnosis, day of hospitalization, and length of stay); pain location, analgesia variables (timing/type/dosage), and video game variables (type of VG and length of time engaged in VGU), and total time researcher engaged with subjects of the sample.

Demographic Variables

Table 8 presents descriptive statistics of the continuous variables reported by the sample. Mean subject age was 41.47 ± 17.52 years. Day of hospitalization was 4.20 ± 4.03 days. Length of stay mean was 6.13 ± 5.50 days. The total time study subjects were engaged in video games

varied from 28 to 70 minutes, with a mean of 50 ± 11.18 minutes. The total time the researcher was engaged with subjects varied from 35 minutes to 90 minutes, with a mean of 63.03 ± 13.10 .

Table 9 presents the descriptive statistics of the discrete variables reported by the sample. There were twenty-two males (73.3%) and eight females (26.6%). Study subjects self-identified their race as four African American (13.3%), one Asian (3.3%), 18 Caucasian (60%), four Hispanic (13.3%), five Pacific Islander (6.7%), and one Jordanian (3.3%).

Study subjects reported their education level as less than high school, high school graduate, some college, with no degree, college graduate, master's degree, or doctorate. There was one subject with less than high school (3.3%), 11 subjects were high school graduates (36.7%), nine subjects with some college, no degree (30.0%), five college graduates (16.7%), one subject with a master's degree (3.3%), and three subjects with doctorate degree (10.0%).

Admitting diagnoses were six orthopedic trauma (20%), three multiple trauma (10%), two chest trauma (6.7%), three abdominal trauma (10%), three facial/jaw trauma (10%), five neck trauma (16.7%), five medical diagnoses (16.7%), two hip total joint replacement (6.7%), and one knee total joint replacement (3.3%). Admitting diagnoses are outlined in Table 9.

Pain Location

Table 9 also presents the location of the study subjects' pain with seven subjects reporting head/face pain (23.3%), seven reporting chest pain (20.0%), four with hip/pelvis pain (13.3%), five each reporting abdominal pain (10.0%), and five reporting neck pain (16.6%). Four subjects reporting back/spine pain (13.3%), two reporting knee pain (6.7%), one reporting elbow pain (3.3%), one reporting lower leg (3.3%), one reporting cardiac pain (3.3%), two reporting

upper arm pain (6.7%), one reporting lower arm pain (3.3%), and one reporting upper leg pain (3.3%).

Analgesia Variables

Analgesia variables for this study were type and name of analgesic, timing of analgesic pre and post VGU, dosage of analgesic, and more than one analgesic (multimodal) administered, as outlined in Table 10. The most common oral analgesic administered was oxycodone 5-15 mg and acetaminophen 325 mg (N = 10; 33%). Of the 30 participants, 16 received multimodal analgesia. Time of analgesia administration was collected for the 29 subjects prior to VGU, with one participant given no analgesia. Analgesia timing for the 29 subjects ranged from 3 minutes to 882 minutes (14.7 hours) before the intervention of VGU, as illustrated in Appendix G.

Video Game Variables

Video games (VG) were provided through the Get Well Network (GWN), the hospital's media provider service. Two types of games were available, classic VGs and card VGs. Study subjects self-selected the VGs of their choice; half selected classic video type games (50.0%) and half selected card video type games (50.0%). The mean time engaged in VGU for total subjects was 50.73 ± 11.18 minutes, ranging from 28 to 70 minutes. Total time the researcher was engaged with study subjects (N = 30) varied from 35 minutes to 90 minutes, with a mean of 63.03 ± 13.10 , as illustrated on Table 8.

Table 8

Demographic, Video, and Total Time Engaged with Study Subjects Variables

	Mean	SD
Age	41.47	17.52
Day of Hospitalization	4.20	4.03
Length of Stay	6.13	5.50
Total Time Engaged in Video Game Use	50.73	11.18
Total Time Researcher Engaged with Patient participants	63.03	13.09

Table 9

Demographic, Pain Location and Video Game Type Variables

Subject Characteristics	N	%
Gender		
Male	22	73.3
Female	8	26.6
Race/Ethnicity		
African American	4	13.3
Asian	1	3.3
Caucasian	18	60.0
Hispanic	4	13.3
Pacific Islander	5	6.7
Jordanian	1	3.3

Table 9

Demographic, Pain Location and Video Game Type Variables, Continued

Subject Characteristics	N	%
Education Level		
<High School	1	3.3
High School	11	36.7
Some College, no degree	9	30.0
College Graduate	5	16.7
Master's Degree	1	3.3
Doctorate	3	10.0
Admitting Diagnoses		
Orthopedic Trauma	6	20.0
Multiple Trauma	3	10.0
Chest Trauma	2	6.7
Abdominal Trauma	3	10.0
Facial/Jaw Trauma	3	10.0
Neck/Spine Trauma	5	16.7
Medical	5	16.7
Total Joint, Hip	2	6.7
Total Joint, Knee	1	3.3
Pain Location		
Head/face	7	23.3
Chest trauma	7	23.3
Abdomen	5	16.6
Back/spine	4	13.3
Neck	5	16.6

Table 9

Demographic, Pain Location and Video Game Type Variables, Continued

Subject Characteristics	N	%
Elbow	1	3.3
Hip/pelvis	4	13.3
Knee	2	6.7
Lower leg	1	3.3
Cardiac	1	3.3
Upper arm	2	6.7
Lower arm	1	3.3
Upper leg	1	3.3
Video Game Type		
Classic Video Games	15	50.0
Card Video Games	15	50.0

Table 10 presents the analgesia variables of type, name, dosage, and more than one analgesic (multimodal) administered. Multimodal analgesia combines two or more analgesic agents or techniques that act by different mechanisms to provide analgesia. The researcher reviewed the medication administration record (MAR) to identify multimodal analgesia medications 48 hours prior to the intervention for all study subjects. The last analgesia administered (name and timing) prior to the intervention was also noted. The most common oral analgesic administered was oxycodone 5-15 mg and acetaminophen 325 mg (33.3%). Of the 30 subjects, 16 received multimodal analgesia (53.3%), as outlined in Table 10. Analgesia timing for 29 participants, with one participant given no analgesia varied from 3 minutes to 882 minutes before the intervention of VGDT, as illustrated in Appendix F.

Table 10

Name, Dose, and Type of Analgesia (N = 30)

Analgesia Variables	N	%
Type/Name/Dose of Analgesia		
Morphine 1–2 mg IV	3	10.0
Dilaudid 2 mg IV	1	3.3
Fentanyl 75 mcg IV	1	3.3
Oxycodone with Acetaminophen		
5–15 mg PO	10	33.3
Oxycodone 10 mg, 15 mg,		
20 mg (No Acetaminophen) PO	3	10.0
Hydrocodone with		
Acetaminophen 5-10 mg PO	6	20.0
Ketorolac 30 mg IV	2	6.7
Tramadol 50 mg PO	1	3.3
Acetaminophen 650 mg PO	1	3.3
Acetaminophen 1000 mg IV	1	3.3
No analgesia administered	1	3.3

Table 10

Name, Dose, and Type of Analgesia (N = 30), Continued

Multimodal analgesia		
IV Opioids	2	6.7
Oxycodone 5 mg	1	3.3
Oxycodone 10 mg	2	6.7
Bupivacaine Liposomal IntraLesional 266 mg	3	10.0
Ketorolac 15 mg IV	1	3.3
Ketorolac 30 mg IV	2	6.7
Q Pump Bupivacaine SQ 0.375 mg	1	3.3
PCA (Dilaudid)	1	3.3
Acetaminophen 650 mg PO	1	3.3
Acetaminophen 1000 mg IV	1	3.3
Oxymorphone 5 mg PO	1	3.3

Aim 2: Describe self-efficacy and PROMIS PI perception following VGDT.

Table 11 presents the sample's self-efficacy perception, and PROMIS PI perception collected following the VGDT intervention. The subjects' self-efficacy perception in pain management mean scores following VGDT equaled 6.97 ± 2.30 . The mean PROMIS PI scores are also presented in table 11. For PROMIS PI question "How difficult was it for you to take in

new information because of pain,” the sample scored $M = 3.14 \pm 1.39$. “How much did pain interfere with your ability to concentrate,” the sample scored $M = 3.53 \pm 1.31$. “How much did pain interfere with your enjoyment of recreational activities,” the sample scored $M = 3.83 \pm 1.23$. For PROMIS PI question “How much did pain make it difficult to fall asleep,” the sample scored $M = 3.30 \pm 1.26$, and “How often was your pain so severe you could think of nothing else,” the sample scored $M = 3.23 \pm SD = 1.04$. For PROMIS PI question “How often did pain make you feel discouraged,” the sample scored $M = 3.03 \pm 1.13$, and “How often did pain make you feel anxious,” the sample scored $M = 2.90 \pm 1.21$.

Table 11

Self-efficacy Perception and Pain Interference Perception Following Video Game Distraction Therapy (N = 30)

	M	SD
Self-efficacy Perception	6.97	2.30
PROMIS PI Questions		
“How difficult was it for you to take in new information because of pain”	3.14	1.39
“How much did pain interfere with your ability to concentrate”	3.53	1.31
“How much did pain interfere with your enjoyment of recreational activities”	3.83	1.23
“How often did pain make you feel depressed”	2.83	1.23
“How often did pain make it difficult to fall asleep”	3.30	1.26
“How often was your pain so severe you could think of nothing else”	3.23	1.04
“How often did pain make you feel discouraged”	3.03	1.13

“How often did pain make you
feel anxious”

2.90

1.21

Cronbach’s alpha was calculated to measure internal reliability or consistency of the eight PROMIS PI Likert scale questions. The alpha coefficient indicates that the eight items exhibited a high degree of internal consistency (.87). This degree of internal consistency supports combining these items into a composite score for PROMIS PI in a future study if this level of internal consistency can be maintained in a larger sample.

Aim 3: Compare changes in pain perception prior to and following VGDT.

Pain Level Perception

Subjects self-reported their pre and post VGDT pain levels utilizing the combined VAS/NRS instrument. Descriptive statistics calculated the means and standard deviation for each of these measures. Subjects’ pain perception prior to the intervention of VGDT mean scores were 4.93 ± 2.49 , and post pain perception mean scores were 3.17 ± 2.23 . Total pain level means decreased following VGDT. Paired t tests were calculated to determine if the pre VGDT pain scores were different than the post VGDT scores. The *t*-value for this calculation was $t = 5.70$, $p < .00$. The observed decrease in pain between pre and post of 1.77 was significant (See Table 12).

Table 12

Pre and Post Video Game Distraction Therapy Pain Levels (N = 30)

Pain Perception	Mean	SD	Paired t value
Pre VGDT	4.93	± 2.49	5.70*
Post VGDT	3.17	±2.23	
Pain Change score	1.77	±1.69	

* $p < .00$

Aim 4: Identify factors that predict changes in pain following VGDT.

Correlations of the continuous interval/ratio level variables were calculated to determine possible predictor variables of pre to post pain levels. Spearman's correlations of the ordinal level variables and the point bi-serial correlations of the nominal level variables did not reveal any significant relationships with pre to post pain levels.

For this sample, it was necessary to create an artificial dichotomy and group non-Caucasians ($N=15$, 50%) in one group, and Caucasians ($N=18$, 60%) in a second group for correlational data analysis. Point bi-serial correlations to measure the association between race/ethnicity (dichotomized) and the continuous variables were calculated. No significant predictor variables were identified for changes in pain (See Table 13).

Table 13

Factors that Predict Changes in Pain Level Perception following VGDТ (N = 30)

Correlations between Pain Change Scores and Possible Predictor Variables

Pain Change	r	p
Age*	.34	.06
Gender^	.08	.65
Day of Hospitalization*	-.21	.26
Length of Stay	-.22	.23
Time of Last Analgesic Administered*	-.20	.27
Total Time VGU*	.01	.95
Total Time Engaged with Patient	.05	.76
Race Dichotomized^	-.15	.41
PROMIS PI Questions		
“How difficult was it for you to take in new information because of pain”#	-.14	.48
“How much did pain interfere with your ability to concentrate”#	.20	.30
“How much did pain interfere with your enjoyment of recreational activities”#	.21	.26

Table 13

Factors that Predict Changes in Pain Level Perception following VGDТ (N = 30), Continued

“How often did pain make you feel depressed”#	.15	.45
“How often did pain make it difficult to fall asleep”#	-.02	.94
“How often was your pain so severe you could think of		

nothing else”#	.11	.55
“How often did pain make you feel discouraged”#	.14	.45
“How often did pain make you feel anxious”#	.19	.31

$p < .05$

Note: *indicates Pearson’s r , # indicates Spearman’s r , ^ indicates point bi-serial r

Conclusion

The analysis of aim one provided means and standard deviations for the continuous demographic variables of age, day of hospitalization, LOS, total time engaged in VGU, and total time the researcher was engaged with study subjects. Analysis of the discrete demographic variables provided the means and standard deviations for gender, race/ethnicity, education level, admitting diagnoses, pain location, and video game type. The analysis of analgesia variables indicated the frequencies of the name, type, and dose prior to the intervention of VGDT. The analysis of aim two provided the sample mean scores with standard deviations for self-efficacy perception and PROMIS PI perception following VGDT. The analysis of aim three indicated pain perception before and after VGDT means and standard deviations were significant. Paired t tests demonstrated pre VGDT pain scores were different than the post VGDT pain scores. Finally, the analysis of aim four was to determine correlations with pre and post pain levels, demographic variables, PROMIS PI variables, and race/ethnicity, dichotomized. No significant predictor variables were identified for changes in pain.

Chapter Five

Discussion of Findings

This chapter includes three broad sections. First, the empirical evidence provided by this feasibility study will be used to address the aims and evaluate the plausibility of a future study. Following this discussion, the study findings will be discussed to confirm the conceptual model is useful as a framework for this feasibility study and future studies with consideration of the prevailing literature and the study rationale provided by Self-efficacy Theory (Bandura, 1995). Finally, the implications for the findings for research and theoretical considerations will be discussed.

Data was prospectively collected from late March to early June, 2015 at an adult acute care hospital in the southwestern United States. The researcher completed the Demographic Variable Form by reviewing the electronic medical record and interviewing the study subjects. Pre and post VGDT pain levels, post VGDT PROMIS PI survey questions, and post VGDT self-efficacy perception in pain management rating scales were completed by study subjects.

Aims of the Study

Aim1: Describe the demographic variables (age, gender, race/ethnicity, educational level, admitting diagnosis, day of hospitalization, and length of stay [LOS]); pain location, analgesia variables (timing/type/dosage); and VG variables (type of VG and length of time engaged in VGU), and total time researcher engaged with subjects of the sample.

Quantitative analysis included thirty patients, and their ages varied from 19 to 78 years of age. This wide age range is supported by market analysts that report the average age of VG

players is increasing in the U.S. As of 2014, the average VG player is now 31 years of age. Over 150 million people are playing VGs on their mobile devices and this number will continue to rise (NPD Group, 2014).

For this study, subjects represented six different race/ethnic groups. According to the Pew Research Center (2015), about half of U.S. adults report playing video games on a computer, television, game console or mobile device. Greater patient interest in VGDT was found to be more towards the end of hospitalization. Future study design could further explore day of hospitalization, pain levels on specific days, and type of analgesia on specific days, to identify associations and possible predictor variables which may influence interest, as well as effectiveness in VGDT.

Pain locations were obtained and widely varied for the sample. Analgesia timing, type, and dose were also collected from the sample, and just over half of the sample received multimodal analgesia. Just over half of the 30 study subjects received multimodal analgesia. Further exploration of analgesia variables are needed to understand their influence on pain perception, pain interference, and self-efficacy in pain management.

Study subjects played two types of games, classic VGs and card VGs. As well as VG type, timing of VGU was collected. Comments from subjects were noted by the researcher and indicated that many would have preferred more complex, sophisticated games. This will be discussed under future study design later in this chapter.

Total time the researcher was engaged with study subjects ($N = 30$) varied from 35 minutes to 90 minutes, with a mean of 63.03 ± 13.10 . This included recruitment, informed and written consent, collection of data before and after the VG intervention, and demonstrating to

subjects how to access the VGs on the hospitals entertainment system, as well as how to play the games for those older patients that had never played VGs. This data will provide the necessary information for allotment of time for future studies.

Aim 2: Describe self-efficacy and pain interference perception following VGDT.

Study subjects' self-efficacy perception following VGDT was overall favorable, scoring 6.97 ± 2.30 on the VAS/NRS, with the 7-10 range as "most effective." Soderlund and Sterling, 2016, in their study exploring verbal persuasion on self-efficacy and pain with subjects suffering from chronic neck pain, reported a significant increase in self-efficacy over time from time before manipulation to time after testing ($p = .04$). Time after manipulation, to time before testing of sensory tests ($p=.02$) was also significant. A study by Stewart, et al., 2012, indicated that use of meditation, relaxation, and massage were associated with higher self-efficacy for pain management (OR = 1.19, 95% CI = 1.09, 3.11).

Stewart and colleagues, 2012, conducted multivariate-adjusted analysis to determine health factors associated with combined use of pharmacologic strategies (PS) and NPS in pain management in older adults. Study subjects who reported moderate to severe pain were five times more likely to use multimodal approaches compared to those reporting mild pain. A random, cross-sectional sample size ($N = 765$) was recruited and data was collected utilizing six different instruments. Multinomial logistic regression modeling was used to determine independent associations between characteristics and pain management groups. This same technique was used to determine independent associations between characteristics and individual NPS pain management approaches. Pearson's chi-square test of between-group differences for categorical variables and pairwise *t*-test for continuous variables (age and anxiety score) were

employed. The random, cross-sectional large sample design identified significant between-group differences in pain management strategies according to the demographic and health characteristics analyzed. In comparing this feasibility convenience sample study, which included only thirty subjects, statistical significance and data analysis was limited and not inferential.

Study subjects completed the eight question PROMIS PI questionnaire. Sample mean scores ranged from 2.83 to 3.83. Pain interference question “How much did pain interfere with your enjoyment of recreational activities” scored highest (3.83), and question “How often did pain make you feel depressed” scored lowest (2.83). According to Amtmann, et al., 2010, pain interference is increasingly recognized as important for both understanding patients’ experiences and as a key outcome in pain clinical trials. The eight items selected from the bank by the researcher allows for a more precise measurement of the phenomena of interest. A priori expectations for what constitutes a psychometrically sound item bank for measuring PI include providing reliable scores (Cronbach’s $\alpha > .85$) with minimal respondent burden, and minimal items. The alpha coefficient for this study indicates a high degree of internal consistency (.87) which lends support for combining these items into a composite PROMIS PI score in a future study if the level of consistency can be maintained (Polit, 2010).

Aim 3: Compare changes in pain perception prior to and following VGDT.

Pain perception prior to the intervention of VGDT mean scores were 4.93 ± 2.49 , as compared to *post* VGU pain perception mean scores which were 3.17 ± 2.23 . Paired differences of pre and post VGDT indicated a 36% decrease in pain ($M = 1.77 \pm 1.69$) and was significant

($p = .00$). However, these results may be influenced by other factors. Polit, 2004, posits that if study subjects are the types of people who have a strong need to ‘look good’ they are more likely to distort their responses.

Distraction and relaxation are thought to decrease pain by their influence on central nervous system center processes and resultant inhibitory impulses to close the gate and prevent amplification of pain impulses (McCaffery & Wolff, 1992). In a study by Wiederhold, et al., 2014, a virtual reality intervention as a distraction technique in chronic pain patients indicated that pain tolerance scores were significantly higher during interactive distraction than passive distraction. The child engaged with the distracter for a significantly greater proportion of time during the interactive distraction relative to the passive distraction. Sil and Dahlquist, 2013, performed a single-subject design study to evaluate the feasibility of a passive and interactive VG distraction on behavioral distress for a preschool-aged child receiving repeated burn dressing changes. Results of their study revealed significantly lower behavioral distress and greater cooperation during interactive VG distraction, and appears to be a feasible and effective pain management strategy. These studies support the effectiveness of interactive VGDT in pain management.

Aim 4: Identify factors that predict changes in pain following VGDT.

Correlational analyses were conducted for the continuous (interval/ratio level) variables, and the ordinal level variables. Point bi-serial correlations to measure the association between race/ethnicity (dichotomized) and the continuous variables were also calculated. No significant predictor variables were identified for changes in pain calculated for the nominal variables. Correlations of the continuous interval/ratio level variables were calculated to determine possible

predictor variables of pre to post pain levels. Again, there were no significant relationships with the pre to post pain levels. However, age approached significance ($r = .343$, $p = .064$).

In a pilot study by Wiederhold, et al., 2014, with six chronic pain patients, ranging in age from 22 to 68 years, utilized a head-mounted display with physiological sensors. All six participants reported a decrease in pain while in the virtual environment (VE), pain reduction from the VR compared to the pain focus condition was large (75.8%) and significant. A nonparametric Wilcoxon signed rank test indicated that the mean pain rating during the VR condition was significantly lower than the session with no distraction ($n = 6$; $p = 0.028$). Each participant exhibited higher mean skin temperature when engaged in VR than when in the pain focus condition. A paired t test also indicated that the overall mean temperature was significantly higher when participants were using VR ($df = 5$; $p = 0.004$). A higher average temperature in VR suggests a reduced level of discomfort and anxiety, substantiates the self-reported pain ratings, and suggests VR is an effective method of reducing pain and anxiety. Wiederhold's study demonstrates analyses of pre and post data with predictor variables identified (higher temperatures and lower pain ratings). Perhaps predictor variables could have been identified in this study with a larger sample size, more sensitive measures and collection of pre and post data.

Results Integrated into Conceptual Model

The following discussion presents study findings to confirm the model is useful as a framework for this feasibility study and future studies with consideration of the prevailing literature and the study rationale provided by Self-efficacy Theory (Bandura, 1995). The conceptual model illustrated in Appendix E guides the research regarding the phenomena of self-efficacy in patients' self-management of pain with VGDT.

The conceptual model in Appendix E, based on Self-efficacy Theory (Bandura, 1995) depicts the antecedent, the intervention, the defining attributes of distraction therapy, and the consequences based on the concept analysis process and theory construction by Walker and Avant (2005). The antecedent of the concept of distraction therapy with use of VGs in patients' self-management of pain is pain itself. The common pain interference symptoms of anxiety, insomnia, and depression, all common stressors of hospitalization were not addressed in this study, and therefore eliminated from the model. The defining attributes of mastery and control, social observations, positive appraisals, and social supportive relationships lead to self-efficacy in pain management through the meaningful and attentional demanding interactive use of video games. The consequences or desired effects of patients' self-management of pain through use of VGDT leads to decreased pain level perception, or behavioral analgesia. Research results are presented, which support the Conceptual Model of Video Game Distraction Therapy in Patients' Self-Management of Pain.

Antecedent

As indicated above, the study was limited to pain as the only antecedent addressed, with the antecedents of anxiety, insomnia and depression eliminated from the model. Study subjects pain level perception prior to the VGDT intervention was higher than post VGDT scores. Paired *t* tests were calculated to determine if the pre VGDT pain scores were different than the post VGDT scores. The observed decrease in pain between the pre and post was significant. Walker and colleagues, 2014, investigated the efficacy of VR distraction in patients needing flexible cystoscopy. Forty-five male patients' were randomized into a control group (23) or the virtual reality (VR) group (23). A 100 mm visual analog scale (VAS) to measure preprocedure and postprocedure pain, anxiety, and time spent thinking about pain was utilized. The *t*-test was used

to compare the different groups. Overall pain scores were lower in both groups; however, there were no significant differences in pain or anxiety. Hoffman, et al., 2008, demonstrated that VR distraction is effective with burn patients undergoing wound debridement. Average pain scores were severe (>75 mm) in the control group, and moderate pain scores (51 mm) in the VR distraction group. These study results support the model as a useful framework for guiding studies utilizing VGDT in pain management.

Intervention of Video Game Distraction Therapy

Study subjects self-selected video games of their choice. There were two types of video games, classic and card VGs. Total time in VGU ranged from 28 minutes to 70 minutes, with a mean time of 50.73 ± 11.18 minutes, ranging from 28 – 70 minutes. Campbell, et al., 2010, demonstrated that pain was rated significantly lower during the distraction session with use of VGs, compared to the pain alone session, lending additional support for this intervention.

Defining Attributes

The defining attributes following the intervention of distraction therapy with use of video games are (a) mastery and control; (b) social observations; (c) positive appraisals; and (d) social relationships, presented in Appendix E. To examine these attributes, pre and post VG intervention pain levels, PROMIS PI questions following VGDT, and study subjects' self-efficacy perception following VGDT were analyzed utilizing the visual analog scale (VAS) to measure subjective pain levels, pain interference utilizing the PROMIS Pain Interference scores, and patients' perceived self-efficacy of video games utilizing an adapted VAS, as well as total time engaged in VGU.

Mastery and Control. To foster feelings of mastery, level of difficulty is raised gradually over the course of the game, and participants are confronted with levels of challenge and increasing performance. Most games provide scores on the participants' performance, with score totals immediately visible. With the increasing demands and performance, feelings of mastery and competence occur (Reinecke, 2009; Granic, 2014). Video games on the market today adjust dynamically with the level of difficulty continuously being calibrated to players' ability through increasingly demanding reaction times and more challenging and complex solutions. Having VG players work toward meaningful goals, persevere after multiple failures, and celebrate triumphs with challenging tasks, provide the motivational benefits of VGs (Granic, et al., 2014) and develop mastery and control.

The longer the user is engaged, the consequence of developing a sense of self-efficacy in pain management occurs, and supports the defining attributes of mastery and control. This concept was further supported from observations by the researcher, which revealed high video game scores obtained with some study subjects focusing on achieving higher and higher scores as they were interactively engaged in VGDT.

Social Observations. The researcher demonstrated how to access the video games on the hospital's entertainment system. After instructional support was given, and by observing the researcher play a VG, study subjects quickly learned how to operate the equipment. Most study subjects were 19 – 39 years of age, 50% of the sample, and were experienced and skillful once they selected the games of their choice.

Positive Appraisals. Video game scores and increasing performance levels of difficulty over the course of the game provides users with immediate performance or status reports, leading

to feelings of mastery and competence. Verbal positive appraisals during VGU were given by the researcher during the training sessions as study subjects developed their skill level and achieved high scores. The researcher, nursing, and the interprofessional team members encouraged the patients as they engaged in VGDT.

Social Supportive Relationships. Nurses, interprofessional team members, family, friends, and the researcher provided the social supportive relationships for study subjects. It is important to discuss that social interactions are an integral feature of video games today, compared to their predecessors of 10 to 20 years ago. In the past, the average gamer was often socially isolated. However, over 70% of VG consumers use VGs with a friend, either cooperatively or competitively according to Entertainment Software Association, 2012. The best examples of these modern games, e.g. World of Warcraft, are multiplayer fantasy game set in a massive virtual world with 12 million regular players, and Farmville, one of the most popular social networking games on Facebook, which hosted over 5 million daily users in 2012 (Gill, 2012). Given these immersive social contexts, VG players are rapidly learning social skills and prosocial behavior that might generalize to their peer and family relations outside the gaming environment (Gentile & Gentile, 2008; Gentile et al., 2009). According to Granic, et al., 2014, VGs provide social interactions in a way never before imagined, and “players are gaming online, with friends, family, and complete strangers, crossing vast geographical distances and blurring not only cultural boundaries but also age and generation gaps, socioeconomic differences, and language barriers (p. 76).”

Consequences

Self-efficacy in Pain management. Self-efficacy in pain management was measured by the VAS/NRS following VGDT with a mean score of 6.97 ± 2.30 for the sample. The seven to ten range represented “most effective” as illustrated in Appendix C. Self-efficacy perception results support the conceptual model’s consequences of self-efficacy in pain management, a desired outcome measure for this study. As previously discussed, results from this study support the defining attribute of mastery and control, with the desired consequences of self-efficacy in pain management through cognitive interactive engagement VGs.

Behavioral Analgesia. Providing patients with attentionally demanding interactive VGDT leads to decreases in pain level, through cognitive activities and is referred to by behavioral scientists as behavioral analgesia. Pre VGDT pain perception mean scores equaled 5.0. Post VGDT pain perception mean scores equaled 3.0. Pain change score equaled 1.77 and was significant ($p < .00$). Encouraging the implementation of interactive distraction in NPS for patients’ self-management of pain is supported by the results of decreased pain levels for this sample.

Overall, the conceptual model proved a useful guide for this feasibility study. A future study could include more precise measurements of the associated symptoms of pain, such as anxiety, insomnia, and depression, common stressors of hospitalization, as presented in Chapter One. This conceptual model is an initial step in integrating the literature with the empirical evidence and observations in understanding the phenomena of VGDT, and the potential to develop desirable changes in behavior or health, by providing patients and families safe, cost-effective NPS and options in pain management (Polit, 2004).

Study Strengths and Limitations

The major purpose of a feasibility study is to identify and correct any problem areas before a larger future is implemented. This provides researchers opportunities to evaluate instruments, data collection tools, time estimates required, and strategies of performing research activities that are least disruptive to patient care and make necessary adjustments. Problems identified allow for solutions before implementing a full study (Mateo and Kirchhoff, 1999). Acceptability of the intervention to clients, and ease of integrating the intervention or manipulation in the clinical setting provides information as to the success of the intervention and elements needing modifications (Polit & Beck, 2004). The following discussion addresses the study strengths and limitations, which will provide information to guide future study design.

Strengths

This feasibility study was carried out a large metropolitan hospital with patients experiencing pain related to surgical intervention or trauma and using the hospital's media entertainment system. Video games were accessed through this television monitors in patients' rooms. This provided a realistic setting to explore the use of video games as distraction therapy. Another strength of this study was finding that a significant difference occurred in pre to post changes in pain perception. Pain decreased 36% following VGDT. There was also a high mean score of self-efficacy perception for the study sample. This feasibility study also provided extensive amounts of data related to patients' experience of hospitalization, environmental factors affecting acute pain, and use of pain medication. It identified areas to be addressed in a future study such as narrowing the inclusion criteria, targeting variables that might be controlled, identifying the limitations of measures and responding to patient preferences.

Limitations

According to Munro, 2005, study subjects are rarely random samples from a population, which is a limitation of this study. Due to the small sample size, typical of feasibility studies, the level of statistical significance is greatly affected. Thus, this is a limitation of this study with results not inferential to the population.

The following criteria were used for inclusion in the study with limitations discussed:

- 1) Age 18 years of age or older was a limitation of this study. Occasionally, older teenage patients are admitted on the trauma PCU, and at the time of data collection, there was one 17 year old that would have liked to participate in the study. The consent process is more tedious and complex with pediatric patients so the adult age limit was determined to be more appropriate for this feasibility study.
- 2) Current hospitalization in the PCU or orthopedic acute care unit during the study. Initially, the PCU was the only department included in the IRB application. However, once data collection was in progress, it became apparent to the researcher that including another inpatient unit would improve subject recruitment, due to lower census at the time of data collection. By adding the orthopedic acute care unit, with approval from the IRB, recruitment was improved.
- 3) Able to speak and read English was a limitation of the study. Non-English speakers require a more complex informed consent and the decision was made to exclude non-English speakers.
- 4) Interested in and able to manipulate the controls of a video game was also a limitation of the study. The VG equipment supplied by the hospital's entertainment

service provider is limited by design for cleaning and durability, and was not compatible with more sophisticated VGs, and a limitation of the study.

A common limitation of video game research is the higher number of male participants versus female participants. These gender differences are well-documented in the literature; however, these differences are becoming less common as more females are engaging in VGU. Age disparity is also becoming less common as older adults are using video games (NPD Group, 2014). For a future study, the total joint population is older and this would address this issue. To address gender disparity, recruiting subjects prior to hospitalization may result in recruitment of more female subjects.

Frequent interruptions were observed by the researcher throughout the course of this study. These interruptions included intra and interprofessional team members (nurse practitioners, physicians, physical therapy technicians, social workers, discharge planners, speech therapists, lab technicians, radiology technicians, and dietary personnel), as well as visitor interruptions, and phone calls. Signage outside the room informing staff as well as visitors that therapy is in session may help; however, delays in treatment, as well as delays in the discharge process are to be avoided. To address frequent interruptions, study subjects would need the opportunity to initiate their use of VGs when there are fewer interruptions, e.g. late evening and early morning hours. Recruiting research assistants that are *not* responsible for direct patient care, such as integrative therapy interns, as well as healthcare students interested in participating in research studies would be an important planning for future studies.

Visual analog scales are commonly used to measure the intensity, strength or magnitude regarding individuals' subjective feelings to specific stimuli or engaging behavior (Waltz, et al., 2010). The VAS correlates positively with the NRS and verbal numerical rating scales (Wagner,

et al., 2007), both of which were incorporated in the design of the measurement instrument for this study. This instrument is utilized to measure dyspnea, fatigue, nausea, health-related quality of life, as well as pain. For this study, a pre and post repeated measures of the subjects' perception of pain levels were scored by study subjects from 0, no pain, to 10, severe pain, using an 11-point VAS and NRS instrument designed by the researcher and based on Breivik's design (2008).

According to Waltz, Strickland, and Lenz (2010), a given VAS should "be used to only measure one dimension of a phenomenon at a time (p.320). For this study, the VAS/NRS was used to measure subjective pain levels as well as the participant's perception of self-efficacy of VGDT in their self-management of pain. When using multiple VAS instruments to measure different dimensions of a given phenomenon simultaneously, there is a tendency for participants to place marks at similar positions on the scale, usually near the center according to Gift, 1986 (as cited in Waltz, et al., 2010). To avoid this risk, it will be imperative to utilize a different instrument to measure the patient's perception of self-efficacy in pain management for future study design.

A limitation and challenge reported by study subjects was in the hospital's entertainment service provider's peripherals, the keyboard in particular, which was very awkward for patients to use. Another difficulty for study subjects regarding peripheral equipment was the lack of a mouse or gaming pad, which was quite different from what study subjects are used to using with their personal systems. To avoid these limitations, subjects would bring their own laptops or notepad devices to the hospital with the peripheral equipment they are accustomed to. Study subjects would be utilizing games already installed or would access the cloud, avoiding the

limitations with the hospitals entertainment system. Study subjects would play the games of their liking and skill level.

Limitations of this study were the many pain locations typical in the trauma population. Future study design with the total joint replacement patient population would address this issue and permit correlational analyses related to precise pain locations. Additional pain domain variables such as quality of pain would also be explored (Wright, 2015). To address the limitations of this study in-depth planning will be needed for future study design. Evaluation of the appropriate instruments to evaluate pain interference symptoms, as well as self-efficacy perception will need to be done before implementation of a future study. Based on the results of this study, PROMIS PI perception and self-efficacy perception will need to be measured prior to and following the intervention of VGDT for identification of predictor variables in patients' self-management of pain, which may impact the conceptual model's design. Although this study did not specifically explore the stressors of hospitalization related to anxiety, insomnia, and depression, future studies would be designed to explore these common symptoms of pain (pain interference). Research is needed to further explore the effectiveness of VGDT in different patient populations to contribute to the State of the Science in patients' self-management of pain. These limitations will be further discussed in the implications for future research.

Implications for Future Research

Results from this feasibility study provided important information for planning a future study. This information begins with the recruitment of study subjects before hospitalization. This would allow for more adequate time regarding informed, verbal and written consent, as well as

the collection of data prior to hospitalization and prior to the intervention. This avoids data collection burden for study subjects, and saves time for the researcher with study recruitment.

Multilevel model design would produce more meaningful research results that would depict real life use of VGDT. For future study design, 50–100 study subjects would be recruited. The MLM design would capture use of VGU multiple times per day over the course of hospitalization. This is a complex study design that will require in-depth planning, based on the results of this study.

Future studies with use of VGs in patient's self-management of pain would focus on the prescheduled, total joint replacement patient population, where patients attend a class prior to their scheduled surgery date and would be recruited to participate in the study prior to their hospitalization. This would allow study subjects the opportunity to complete self-efficacy perception and PROMIS PI survey questions prior to hospitalization and prior to the VGDT intervention. This semistructured interview method is efficient and yields a high rate of completed questionnaires. Collecting data prior to hospitalization decreases study subject burden and questionnaire fatigue compared to collecting questionnaire data immediately before and following the intervention (Polit, 2010). Once study subjects are hospitalized and continue to meet the inclusion criteria, a brief review of the intervention, instruction on how to access the VG equipment if using the hospital's entertainment system, would be done, with collection of pre and post intervention data.

Subjects would also be encouraged to bring their own computers or mobile devices to the hospital, avoiding the challenges and limitations associated with the hospital's entertainment system. This next step is based on comments reported by study subjects, which included "the

video games were too basic, not current, or not challenging enough.” It is important to emphasize that subject recruitment would not be limited to those with their own computers and mobile devices. Study subjects would still be recruited who would use the current hospital entertainment system’s video game selection.

Encouraging patients to bring their own devices to the hospital would address the limitation and challenge reported by study subjects regarding the hospital’s entertainment service provider’s peripherals, the keyboard in particular, which was very awkward for patients to use. Another difficulty for study subjects regarding peripheral equipment was the lack of a mouse or gaming pad, which was quite different from what study subjects are used to using with their personal systems. To avoid these limitations, subjects would bring their own laptops or notepad devices to the hospital with the peripheral equipment they are accustomed to. Study subjects would be utilizing games already installed on their own devices, or would access the cloud, with no limitations to type of game selected and support the more sophisticated games of their liking and skill level while in the hospital. The pain management effects of different game genres would facilitate more in-depth analyses of the more interactive VGs. Multilevel model design would support the study subjects’ ability to use video games as often and as much as they desire, and would provide research results depicting ‘real life’ behavior. With subjects able to play at their convenience and when there are fewer interruptions from the interprofessional team, subjects would hopefully experience more of the defining attributes of VGDT, and experience more mastery and control resulting in pain relief (behavioral analgesia).

The quality and reliability of the PROMIS PI questionnaire were confirmed with the Cronbach’s Alpha coefficient, which supports possible refinement for inclusion in a future study. Results were greater than .80, which is highly desirable. Based on the results of this study,

PROMIS PI perception and self-efficacy perception will need to be measured prior to and following the intervention of VGDT for identification of predictor variables in patients' self-management of pain, which may impact the conceptual model's design, as previously discussed. Accessing the survey questions online could be considered for future study design (PROMIS, 2013), versus paper pencil survey questions.

Future study design to explore the stressors of hospitalization related to pain, specifically pain interference of anxiety, insomnia, and depression, would provide empirical evidence for nursing practice related to the patients' pain experience and associated symptoms. Data analyses to identify predictor variables are needed to strengthen, support, or refute the conceptual model. Future studies based on the results of this feasibility study will explore NPS to support the state of the science in promoting self-efficacy in pain management and CAM therapies.

As previously discussed, the Centers for Medicaid and Medicare's Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) is requiring hospitals to provide the healthcare consumer with innovative approaches to manage the stressors associated with the hospital experience, as well as address their recovery at home. Introducing patients to VGDT while hospitalized will hopefully promote its application after discharge for their recovery at home. Future study design could include a self-efficacy questionnaire to examine study subjects' self-efficacy of pain management with VGDT following discharge.

Frequent interruptions were observed by the researcher throughout the course of this study. These interruptions included intra and interprofessional team members (nurse practitioners, physicians, physical therapy technicians, social workers, discharge planners, speech therapists, lab technicians, radiology technicians, and dietary personnel), as well as visitor interruptions, and phone calls. Signage outside the room was helpful; however, delays in

treatment, as well as delays in the discharge process were to be avoided, and the researcher made every effort to not delay a subject's discharge. To address frequent interruptions, study subjects would need the opportunity to initiate their use of VGs when there are fewer interruptions, e.g. late evening and early morning hours. Recruiting research assistants that are *not* responsible for direct patient care, such as integrative therapy interns, as well as healthcare students interested in participating in research studies would be an important design feature for future studies.

Visual analog scales are commonly used to measure the intensity, strength or magnitude regarding individuals' subjective feelings to specific stimuli or engaging behavior (Waltz, et al., 2010). The VAS correlates positively with the NRS and verbal numerical rating scales (Wagner, et al., 2007), both of which were incorporated in the design of the measurement instrument for this study. This instrument is utilized to measure dyspnea, fatigue, nausea, health-related quality of life, as well as pain. For this study, pre and post pain levels were scored by study subjects from 0, no pain, to 10, severe pain, using an 11-point VAS and NRS instrument designed by Breivik, 2008.

Reliability of the VAS has been assessed investigating the reproducibility of previous ratings at various points on the line, and appears to be more accurate at the extremes versus the middle scales, the length and position of the line, the position of the subject participants (e.g. patients in bed), visual and motor abilities of subjects, and the influence of the subjects previous ratings (Waltz, et al., 2010), all limitations of the instrument.

The validity of the VAS has been examined correlating the instrument to other measures of the phenomenon. Concurrent or convergent validity has been substantiated for the active states of dyspnea, insomnia, and fatigue, as well as the sensation states of nausea, anxiety, depression,

and pain (Bijur et al., 2003; Good et al., 2001; Winkelman, et al., 2008). Visual analog scales are easy to design and administer, and easy for the subject to understand and score, and are considered among the most popular measurement instruments in nursing research. However, they are less often used to measure attitudes and opinions when engaging in specific behaviors. According to Waltz, Strickland, and Lenz (2010), a given VAS should “be used to only measure one dimension of a phenomenon at a time (p.320). For this study, the VAS/NRS was used to measure subjective pain levels as well as the participant’s perception of self-efficacy of VGDT in their self-management of pain. When using multiple VAS instruments to measure different dimensions of a given phenomenon simultaneously, there is a tendency for participants to place marks at similar positions on the scale, usually near the center according to Gift, 1986 (as cited in Waltz, et al., 2010). Due to this limitation, and to avoid this risk, it will be imperative to utilize a different instrument to measure the patient’s perception of self-efficacy in pain management for future study design. Soderlund and Sterling, 2016, utilized a study specific method to measure self-efficacy based on Bandura’s Self-efficacy Theory (1995) with a numeric rating scale.

Minor improvements to the data collection instrument were identified and include the following:

- Financial number (visit number) added to the demographic section
- Primary language
- Name and type of VGs expanded to include more names and types;
- Pain location and quality;
- Times and doses of analgesics administered, including (multimodal);
- Planetree Care partner variables;

- Patient comment section;
- Observational notes (interruptions [type, and length of time], challenges, etc.);
- Study personnel identification section

Finally, limitations of this study were the many pain locations typical in the trauma population. Future study design with the total hip and knee joint replacement patient population would address this issue and permit correlational analyses related to precise pain locations. Additional pain domain variables such as quality of pain would also be explored in a future study (Wright, 2015).

Conclusion

Results from this study support the plausibility of future study design. A MLM design would include 50 – 100 study subjects and incorporate the lessons learned from this feasibility study. While anecdotal evidence exists regarding nurses' use of distraction therapy and activities in pain management, little empirical research data is available. To improve pain symptom management, decrease complications associated with pain and hospitalization, and create more healing environments in the acute hospital setting, more research is needed to explore CAM therapies and other innovative modalities. The potential that VGs hold for interventions that promote well-being have been demonstrated by the behavioral scientists. With an average of 31 years of age for VG players in the U.S., there is a need for interprofessional teams of psychologists, clinicians, and game designers to work collectively to develop innovative approaches to health and well-being (Granic, et al., 2014).

According to Meleis (2007), nursing science requires a theoretical basis to establish efficient and effective clinical therapeutics in achieving positive patient outcomes. This research

study applied Bandura's (1997) Self-efficacy Theory to guide its exploration of the relationship between VGU, pain perception, pain interference perception, and perception of self-efficacy in pain control. By creating a beginning knowledge base, this study will constitute an initial step in offering patients and their families more options for effective pain control that can span the continuum of the acute hospital setting to the home. Thus, congruent with the research priorities of NINR, this study will provide data that are the beginning basis of more effective symptom management approaches.

Video games are interactive and future research may provide knowledge for the development of a recovery conceptual framework to support interactive patient care (IPC), an emerging care delivery model. This innovative concept is based on the premise that the more engaged the patient, the better the outcomes in an effort to provide more comfort for patients and families as they move through the recovery period. Patients' self-management of pain is safe and cost effective, and future research is needed to explore the self-management of pain with VGDT.

Appendix A

Demographic, Analgesia, and Video Game Variables Form

Date: _____

Time: _____

End time: _____

Demographic Variables

- 1) Age: _____
- 2) Gender: _____
- 3) Race/ethnicity: _____
- 4) Educational level: _____
- 5) Admitting diagnosis: _____
- 6) Length of stay (LOS): _____

Analgesia Variables

- 1) Time last analgesic administered: _____
- 2) Type/name of last analgesic administered: _____
- 3) Dose of last analgesic administered: _____

Video Game Variables

For EACH use of video game,

- 1) Type of video game (arcade or card type): #1 _____; #2 _____; #3 _____
- 2) Length of time engaged in video game use:

Start Time#1 _____; End time: _____
 Start Time#2 _____; End time: _____
 Start Time#3 _____; End time: _____ Total Time engaged in VGU: _____

Total Time Engaged with participant: _____

Observational Notes:

Appendix B

Visual Analog Scale Measuring Patients' Self-report of Pain Levels (Breivik, H., et al., 2008)

To the Participant: Please mark the place on the line that indicates your level of pain right now.

Visual Analog Scale										
0	1	2	3	4	5	6	7	8	9	10
 None	 Mild Pain			 Moderate Pain		 Severe Pain				
 No Pain = 0 Worst Pain imaginable = 10										

Appendix C

Visual Analog Scale Measuring Perception of Self-Efficacy in Pain Management

(Adapted from Breivik, H., et al., 2008)

To the Participant: Please mark the place on the line that indicates how effective you feel in managing your pain right now.

Visual Analog Scale										
0	1	2	3	4	5	6	7	8	9	10
Not at all effective	A little effective		Somewhat effective			Most effective				
<hr/> <p> Not effective = 0 Most effective = 10 </p>										

Appendix D

PROMIS Pain Interference Assessment Questionnaire (PROMIS Assessment Center [n.d.], National Institutes of Health)

Please answer the following questions by circling the response that best fits the question for the past 24 hours.

PI 1

1. How difficult was it for you to take in new information because of pain?

Not at all A little bit Somewhat Quite a bit Very much

PI 8

2. How much did pain interfere with your ability to concentrate?

Not at all A little bit Somewhat Quite a bit Very much

PI 10

3. How much did pain interfere with your enjoyment of recreational activities?

Not at all A little bit Somewhat Quite a bit Very much

PI 16

4. How often did pain make you feel depressed?

Never Rarely Sometimes Often Always

PI 19

5. How much did pain make it difficult to fall asleep?

Not at all A little bit Somewhat Quite a bit Very much

PI 29

6. How often was your pain so severe you could think of nothing else?

Never Rarely Sometimes Often Always

PI 32

7. How often did pain make you feel discouraged?

Never Rarely Sometimes Often Always

PI 37

8. How often did pain make you feel anxious?

Never Rarely Sometimes Often Always

Appendix E

Figure 1. Conceptual Model of Video Game Distraction Therapy in Patients' Self-Management of Pain

Appendix F

Institutional Review Board Project Action Summary

Action Date: March 12, 2015

Note: Approval expires one year after this date.

Type: ☐ New Full Review ☒ New Expedited Review ☐ Continuation Review ☐ Exempt Review
☐ Modification

Action: ☒ Approved ☐ Approved Pending Modification ☐ Not Approved

Project Number: 2015-03-188

Researcher(s): Janet D. Donnelly Doc SON

Dr. Jane Georges Fac SON

Project Title: Use of Video Games in Patients' Self-management of Pain: A Feasibility Study

Note: We send IRB correspondence regarding student research to the faculty advisor, who bears the ultimate responsibility for the conduct of the research. We request that the faculty advisor share this correspondence with the student researcher.

Modifications Required or Reasons for Non-Approval

None

The next deadline for submitting project proposals to the Provost's Office for full review is N/A. You may submit a project proposal for expedited review at any time.

Dr. Thomas R. Herrinton
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Appendix G

Time of Last Analgesic Administered to Start Time of Video Game #1 with Mean Pre and Post Pain Levels (N=30)

Participants	Time Interval of Analgesia to Start Time of Video Game #1 (3 minutes to 882 minutes)	Pre Pain Level	Post Pain Level
1	465	2	0
2	3	7	7
3	124	3	2
4	470	1	0
5	740	3	1
6	759	8	6
7	52	8	4
8	21	2	1
9	269	4	0
10	No analgesia administered	3	2
11	127	4	3
12	44	7	5
13	184	8	4
14	37	6	5
15	119	2	2
16	265	6	2
17	6	2	1

Time of Last Analgesic Administered to Start Time of Video Game #1 with Mean Pre and Post Pain Levels (N=30), Continued

Participants	Time Interval of Analgesia to Start Time of Video Game #1 (3 minutes to 882 minutes)	Pre Pain Level	Post Pain Level
18	882	5	5
19	119	6	4
20	229	10	7
21	213	2	0
22	79	3	2
23	136	3	4
24	47	2	4
25	8	8	7
26	6	7	1
27	180	7	3
28	81	5	2
29	167	7	5
30	19	7	6

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