Managing Pain in Military Populations with Virtual Reality

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Abstract. Pain syndromes are increasingly prevalent in the military and the causes, resulting complications, existing treatment and possibilities for improved care in the future are in need of attention. By constantly being exposed to combat and living in war zones, servicemen and women face increased risk of complicated injuries, including amputations, penetrating wounds, spinal cord injuries, and traumatic brain injuries (TBIs). In addition, many service members may undergo multiple surgical procedures as a result of serious injury. The incidence of pain syndromes is significantly higher when present with Posttraumatic Stress Disorder (PTSD) and other psychiatric disorders such as depression. The combination of these “poly-trauma” events makes the management of both acute and chronic pain in military populations challenging. A multifactorial approach is necessary, and the introduction of new approaches and technology can increase the numbers of tools available to combat this significant health issue in troops.

Keywords. Virtual Reality, pain syndromes, military, Posttraumatic Stress Disorder, cognitive behavioral therapy

Introduction

With a significant population of patients still exhibiting pain even while regularly taking pain medications, it is evident that pharmacologic therapy is only part of the solution to pain management. It is becoming increasingly recognized that pain perception involves multiple areas in the brain. However, pain is not illusion; pain is all too real for over 30% of Americans and dependent on multiple factors. How we individually process these factors determines our subjective and perceptual experience. Advancements in neuroscience have shown that the pain experience, like consciousness, is not located in one area of the brain [1]. Instead, our perception of pain, like its diverse and intersecting influences, is located within various complex pathways in the brain, and occupies the same spaces where emotions, attention, and fear among others, are produced [2]. It is for these reasons that the subjective description of pain is highly variable.

Although an “on” and “off” switch to pain doesn’t exist, the circuitry of pain pathways can be interrupted in various ways. A study funded by the National Center for Complementary and Alternative Medicine (NCCAM), comparing the effects of real and simulated acupuncture on pain, exemplifies this principle perfectly. Forty-eight

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participants were subjected to heated stimuli and underwent either actual acupuncture to reduce their pain or a simulated version that did not penetrate the skin. Pain was reduced in both groups, with no significant difference between the two. However, brain scans revealed that while both methods produced the same results, they did so in different ways. Pain signals in the spinal cord were actually interrupted by real acupuncture, whereas the simulated acupuncture patients’ brain images showed that the areas corresponding with mood and expectation were activated [2].

Cognitive behavioral therapy works in a similar way to shift negative thoughts on pain to positive and empowering ones. Distraction techniques, such as meditation, hypnosis and guided imagery, aim to divert attention away from pain altogether. Virtual Reality (VR) is an especially effective medium for distraction [3], where the borders of reality can be blurred, but where real life effects can be produced. VR systems are also compatible with biosensors and brain imaging devices making a comprehensive assessment of the global effects of pain and chronic pain syndromes possible. Furthermore, witnessing how your own brain reacts to pain, medication, and pain reducing stimuli can help sufferers learn to control how they perceive pain [2]. In addition, learning how the brain processes information will help determine what tactics have the greatest effect on reducing pain, and the malleability of VR will provide patients with individualized treatment. Fusing together VR and brain neuroscience provides tools necessary for the next steps in pain management.

1. Application of Simulation and Virtual Reality for Pain Management

With two-thirds of patients with chronic pain reporting that their pain interferes with their daily activities, pain and how one copes with pain are major factors determining quality of life [4]. Pain syndromes are not just influenced by the pain itself, but by emotions, cognition, beliefs, and attitudes, which can have physical consequences as well. Muscular weakness and withdrawal are common when one feels defeated by their pain, which only intensifies their overall pain and hinders recovery. This multidimensionality of pain, left unaddressed when analgesics and opioids are used to mute rather than relieve pain, suggests that additional modalities when combined with effective pain management can improve clinical outcomes. With advanced technologies, such as cognitive behavioral therapy (CBT) and Virtual Reality (VR), a holistic treatment plan, individualized for every patient and the specific pain that they suffer, is possible.

1.1. The Cognitive Approach

The cognitive approach to pain management focuses on one’s awareness and understanding of their own pain to try and pinpoint the precise causes of pain in order to modify its overall effect. Since pain is often irregular, unpredictable, and uncontrollable, anxiety related to pain lowers a sufferer’s threshold of tolerance, contributing to even more pain [5]. Negative perceptions of pain and recovery also affect outlook concerning the ability to cope with pain. The cognitive approach stems from this idea that one’s response to pain is not solely influenced from the event that initially caused pain, but that resulting behavior and emotions are shaped by their own interpretations of the event [5]. These resulting emotions and behaviors tend to interfere with recovery (e.g., through depression, PTSD, and insomnia). CBT focuses on challenging negative thoughts and behaviors by identifying them and altering the
sufferer’s mindset in order to develop better coping skills. Talk therapy is a common practice of CBT, which helps individuals understand where their thoughts and behaviors are coming from and alter their attitude from feeling helpless to in control. Individuals are encouraged to keep track of their thoughts and feelings and relate them to their pain in order for them to identify the root of their behaviors. Coping strategies are then put into practice, and while the actual pain stays the same, because of improved coping skills, the overall feeling of pain is alleviated and the pain becomes more tolerable [6].

1.2. Virtual Reality

Pain and anxiety are an integral part of being unhealthy. From having a burn wound dressed, to having an abscessed tooth pulled, to receiving a diagnostic spinal tap, or enduring chemotherapy, distress is apparent during a variety of medical procedures. Alleviating that distress is one of the issues healthcare professionals have to deal with every day. In the past, drugs alone have been used to alleviate these symptoms, but have been found to be somewhat ineffective. According to one research study, 86% of patients undergoing wound care from a burn injury reported severe to excruciating pain even with standard levels of opioids [7]. More recently, distraction techniques have been used as an adjunct during unpleasant medical procedures. Examples of these techniques include deep breathing, viewing videotapes, and playing video games. The success of these psychologically-based techniques has led to the innovative use of VR as a distraction technique. VR has been found to be effective in reducing reported pain and distress in patients undergoing burn wound care, chemotherapy, dental procedures, venipuncture, and prolonged hospital visits [8-18].

Many clinical studies have investigated the use of guided imagery as a form of distraction and relaxation during painful or unpleasant procedures. Pain perception has a strong psychological component. In order to experience pain, conscious attention is required. According to the Gate Control Theory certain areas of the spinal cord receive afferent impulses from pain receptors and other skin receptors and efferent impulses from the brain. If the impulses from the brain are active enough the “gate” is closed to pain impulses. Therefore, if the patient is actively using their brain in some way, the perception of pain will not get through [19]. Pain can be interpreted as painful, or not painful, depending on what and how much the patient is thinking. Distraction has been found to take a patient’s attention away from the pain they are thinking about. By encouraging a patient to focus their attention on other things (such as their breathing, or a videotape), less focus is allowed for the pain. The attention we give to the pain we feel often determines not only the level of pain we report being in, but the amount of distress that pain causes us [20, 21].

Distraction works by enabling a patient to focus their attention on stimuli other than the pain sensation. Attention to pain is sacrificed in favor of attention to other stimuli, particularly visual, auditory, and tactile-kinesthetic stimuli. When this happens the perception of pain and the perception of relief of that pain moves into an individual’s conscious and gives them a sense of control over the painful experience. The types of distraction that can be used include play, activity therapy, reading, singing, listening to music, rhythmic tapping, and humor, and have been used effectively with almost every type of pain [22].

Clinical trials involving guided imagery to distract patients from cancer treatment pain and anxiety have found that effective image therapy can lessen the patient’s
distress. For example, in one study 28 patients were randomized into two groups: one that received only pain medication, and an experimental group that received a chemotherapy-specific guided-imagery audiotape in addition to the same amount of medication [23]. The experimental group expressed a significantly more positive experience than those that received only medication, though physical symptoms were not noticeably different between the groups.

Though guided imagery has been proven to have positive effects in pain reduction during medical procedures, only 15% of the population can visualize effectively [24]. Therefore, the other 85% of people may not be able to picture images vividly or realistically enough to reap the benefits of guided imagery therapy.

This is where VR can help. In VR environments, the image is provided for the patient in a realistic, immersive manner devoid of all possible distractions. VR utilizes up-to-date technology and software to display virtual environments to users. These advanced systems allow users to interact at many levels with the virtual environment, utilizing many of their senses, and encouraging them to become immersed in the virtual world they are experiencing.

Immersion is one of the concepts that allows VR environments to distract patients undergoing various medical procedures in ways that are above and beyond other techniques. Immersion relates to how present the user feels in the world, and how real the environment feels. When immersion is high, much of the user’s attention is focused on the virtual environment, leaving little left to focus on other things such as pain.

As shown by previous VR therapy studies for phobias [25], the subject becomes fully immersed in the virtual environment, eliciting the appropriate physiological and emotional responses. For that reason, VR may be an effective medium for reproducing and/or enhancing the positive effects of guided imagery for the majority of the population who cannot visualize successfully. Since the degree of pain which is experienced during hospitalization has been linked to post-hospitalization mental and physical function/dysfunction [26], it has been suggested that in addition to the humane reasons for providing burn wound pain management, there may indeed be practical reasons as well.

1.2.1. Uniqueness of VR as a Method

VR, an immersive 360-degree interactive 3-D computer display technology, is used to surround the patients with a virtual world that serves as a distraction from the medical procedure at hand. VR has been constructed to induce a strong feeling of “presence,” or the experience of actually being in the simulation. As technology continues to improve, the difference between the virtual world and the “real” world will become less distinct.

Non-invasive physiological sensors continuously monitor individual reactions of patients. This serves several purposes: a) variations in the patient’s response within and between sessions can be quantified without self-report biases; and b) on the level of the therapist-patient alliance, acknowledging bodily responses of patients helps keep the therapist “in touch” with any concerns the patient may have. It lets the patient know that they are being monitored by the clinician, and it also allows the patient to see the level of their physiological arousal.

In the current state of therapeutic VR development, the situations allow some degree of adjustment by the therapist to best synchronize them with the individual patient’s situation, e.g., the intensity of accompanying sounds can be regulated. In
future, more developed products, it will be possible to control a wide variety of cues that might add specific meaning for individual patients.

VR serves as an experiential medium. Users of VR don’t just sit and stare at a screen; they become a part of the story. The story doesn’t proceed without their active involvement. Because of this, they can be more directly engaged in the effects of the distraction technique than they are when passively receiving traditional distraction methods, thus resulting in a lower level of pain perception.

VR is a metamedium. All previous media forms can be replayed within a VR experience – film, video, photography, etc. Not only can they be replayed, they can be staged in spatial arrangements that provide a contextual engagement. This can provide for an analytical and critical reading of a media form that is more powerful than when we see the same media form in a strictly temporal contextual engagement.

VR is a heightened experience of human-computer interaction, which allows the patient to become an active participant in exposure, and results in staying “on task” versus drifting off or becoming bored, events which lessen the effectiveness of a distraction technique.

1.2.2. VR Distraction for Chronic Pain Patients

The Virtual Reality Medical Center (VRMC), which has studied the effectiveness of VR distraction on chronic pain patients, conducted a pilot study among 16 patients suffering from pain syndromes such as fibromyalgia, lower back pain, migraine headaches, temporomandibular joint dysfunction, and reflex sympathetic dystrophy. Two treatment conditions were presented: a pain focus, wherein patients were asked to describe and rate their pain at three separate intervals; and VR, in which patients explored the “Icy Cool World” virtual environment and were then asked to rate their pain subjectively. Non-invasive physiological measurements were recorded throughout both sessions and at baseline. Results show significantly lower pain ratings while in VR than during the pain focus session (p = 0.028). Furthermore, the peripheral skin temperature of patients was significantly higher in VR (p = 0.027) than during the pain focus session, indicating greater relaxation during VR. These results suggest that VR can act as an effective addition to standard pain management techniques.

VR has also been used to reduce discomfort during surgical procedures. Dr. Jose Mosso from the Regional Hospital No. 25 of the IMSS in Mexico City conducted a study published in 2007, using VRMC’s virtual scenarios projected through a head mounted display (HMD) to reduce discomfort during ambulatory and obstetric surgeries in 27 patients. The majority of patients experienced less discomfort during the surgical procedures while immersed in the VR scenario than with no distraction, and in the patients who underwent ambulatory surgeries there was a reduction in medication dosage as well. Dr. Mosso has used VR to replace general anesthesia with local anesthesia in over 500 patients during minimally invasive surgical procedures [27].

VR hypnosis (VRH) has also shown to be an effective form of distraction for chronic conditions. A case study conducted by the University of Washington School of Medicine examined VRH for treating chronic neuropathic pain in a patient who experienced numerous failed treatments in the past. During a six month VRH trial, the patient’s pain intensity and unpleasantness ratings dropped on average 36% and 33% respectively. Although reductions in pain failed to persist long-term, no pain and reduced pain were reported on average 3.86 hours and 12.21 hours respectively, after the treatment sessions [28].
Another study performed by the University of Washington, published in 2010, tested the analgesic efficacy of adjunctive VRH on patients who experienced physical trauma. In a randomized, controlled study, the subjective pain ratings of 21 hospitalized trauma patients were measured immediately after an adjunctive standard care and VRH session and eight hours later. Compared to the control groups (standard analgesic care, and adjunctive standard care and VR without hypnosis), adjunctive VRH patients reported less pain intensity and unpleasantness.

In addition to producing positive results for pain management, VR distraction has also been used to alleviate the side-effects of chronic diseases, such as pruritus. The Department of Dermatology at Hadassah University Hospital conducted a study published in 2009 that used VR immersion (VRI) and audiovisual distraction (AVD), in the form of an interactive computer game using a visor or computer screen, to reduce chronic pruritus in 24 patients. Pruritus intensity was measured through self-reports during the game and 10 minutes afterwards with the visual analogue scale (0-10). Scratching was also observed and documented throughout the exposure treatment. During both the VRI and AVD, pruritus intensity was greatly reduced and scratching was either mild or absent. These distraction techniques provided patients with temporary relief from itching, further proving that distraction is effective in diverting attention, thus relieving pain and irritation. Furthermore, the results of this study reveal VR distraction’s potential for treating a number of different diseases and symptoms.

1.2.3. VR and Phantom Limb Pain

Pain experienced in a phantom limb is one of the most stubborn forms of chronic pain and very hard to treat. However, a novel twist to Dr. Ramachandran’s mirror box device, for easing pain in phantom limbs, utilizes VR and motion capture technology to detect motion directly from the stump itself. An arm avatar is then created in a VR environment that can be moved and controlled within the virtual setting. A study conducted by the Department of Clinical Neurophysiology, Poole Hospital, published in 2009, examined the phantom limb pain of a group of subjects (seven participants with arm amputations and seven with leg amputations) while using the VR system. Pain was measured before and during the exercise, and the participants were interviewed afterwards about their experiences. Five out of seven in each group felt that their phantom limb was being moved by them in the VR, felt movement sensations within the limb, and reported a reduction in pain in their phantom limb.

The Okayama University Graduate School of Medicine and Dentistry, also using VR mirror visual feedback therapy, tested five patients suffering from complex regional pain syndrome once a week for five to eight weeks with the system. Four out of five patients expressed that their pain was reduced by greater than 50%, showing that VR mirror feedback provides a nonpharmacologic alternative to pain management. The system, which is also relatively cheap and portable, will allow treatment to enter into the home as well.

1.2.4. VR Distraction Studies with Burn Patients

Dr. Hunter Hoffman and his colleagues have taken the lead in conducting several studies on the use of VR as a distraction technique during painful procedures. Much of his work has been done with burn patients, of whom 86% reported severe to
excruciating pain with standard levels of opioids while undergoing wound care after a burn injury [7]. In the first published study in 2000, Hoffman, Doctor, and Patterson et al. compared VR and a video game as distraction interventions for two adolescent deep flash burn patients undergoing wound care and staple removal. Both patients showed dramatic decreases in pain ratings during VR distraction as contrasted to very small decreases during video game sessions [12,13].

A second study also published in 2000 by Hoffman, Patterson and Carrougher compared VR as a distraction technique for adult burn patients undergoing physical therapy to a no distraction control setting. Each patient served as their own control, spending three minutes of physical therapy in VR, and three minutes without a distraction. All twelve patients reported less pain when distracted with VR, and time spent thinking about pain dropped at a statistically significant rate from 60 to 14mm on a 100mm scale [12].

The VRMC has also conducted a number of VR distraction studies in burn patients. A pediatric study, funded by Las Patronas, was conducted at the UCSD Regional Burn Center, and two studies involving adult participants and funded by National Institute of Drug Abuse (NIDA), were performed at Region’s Hospital in Minnesota and Naval Medical Center, San Diego. In these studies, burn patients were placed inside “Icy Cool World,” a virtual world developed by VRMC specifically for burn patients, and navigated through the virtual environment using a HMD (I-glasses). The goal of the simulation was to try to free as many penguins from the ice cubes as possible while navigating through an artic like environment. No time limit was imposed, and participants were asked to rate their pain while inside the virtual world. All patients reported less pain when distracted with VR as compared to baseline. The magnitude of pain reduction by VR was statistically significant, and patients were seen to have further reductions in pain as their ability to navigate the environment improved. In addition, time spent thinking about pain during physical therapy decreased significantly.
Hoffman and colleagues have also explored the synergy of standard analgesics and VR distraction, addressing the fact that opioids alone and VR by itself may not be enough for some individuals experiencing severe pain. In an early study testing the adjunctive use of opioid analgesics and immersive VR, nine healthy subjects underwent four different treatment conditions while receiving thermal pain stimulation: a control condition with no analgesia; opioid administration; immersive VR distraction; and a combined opioid and VR condition. Subjective pain reports and an MRI measuring pain-related brain activity revealed that while opioid administration and VR distraction both separately reduced pain, their use together in the fourth condition was the most effective in reducing pain and pain-related brain activity [33].

After establishing the efficacy of this new multimodal approach to relieving pain, Dr. Christopher Maani from the Brooke Army Medical Center, along with Hoffman, began testing the method in a clinical setting. In a study published in 2011, the adjunctive use of standard pharmacological analgesics and VR immersion was tested on a group of soldiers with combat-related burn injuries during wound debridement, a procedure that is typically described as being especially severe and excruciating. Twelve US soldiers received half of their treatment, roughly six minutes, with standard analgesics and the remaining half while immersed in VR using robot-like arm mounted VR goggles, the first of its kind to be tested. Worst pain, pain unpleasantness, and time spent thinking about pain were all measured using a graphic rating scale (0-10). On average, patients’ worst pain was reduced from 6.25 to 4.50 out of 10, pain unpleasantness dropped from 6.25 to 2.83, and time spent thinking about pain was reduced by 54%. While the adjunctive use of opioids and VR for treating pain, especially in patients experiencing the most severe pain, is novel within itself, the effectiveness of the method using a portable arm mounted VR system will provide military personnel with an effective and convenient form of relief on the battlefield [34].

Maani and Hoffman et al. were also the first to test the use of ketamine in an adjunctive VR treatment trial, also published in 2011. In a dual case study involving one military and one civilian severe burn wound patient, a dose of 40 mg of ketamine was administered intravenously to each patient for wound pain during debridement. Half of their treatment was performed with this alone, and half was conducted while also immersed in VR. Both patients reported that the portion of their treatment with combined ketamine and VR distraction substantially reduced pain and unpleasantness during the procedure and even described the VR as being “pretty fun.” Moderate
amounts of ketamine combined with VR could be crucial as well for military populations in combat, as it provides a new method for reducing pain where resources and medical personnel are scarce [35].

1.2.4.1. Relevance of Content of Virtual Worlds

There are multiple publications on the effectiveness of VR distraction in reducing pain perceptions, but few investigations have been made on whether the content of virtual worlds affect levels of pain perception. Mühlberger et al. have conducted an experimental study on 45 female students, ages 18 to 26 years old, at the University of Würzburg to determine how influential hot and cold environments are in reducing pain coming from cold and hot stimuli, respectively [36].

Three VR conditions were presented to represent a cold, warm, and neutral environment. Both the cold and warm VR environments were extracted from the VR world “Enchanted Forest” wherein the cold environment was represented by the same forest but in winter season (e.g., icy) and the warm environment was represented by the warm colors of the autumn season (e.g., yellow and red leaves). The neutral environment, which served as the control condition, was a still picture of a wide, spatial landscape of hedges which gave neither a cold nor warm impression. Temperature stimuli were delivered using a Somedic MSA thermal stimulator and peltier thermode with an active surface of 25 × 50 mm. Temperature stimuli were administered for three seconds with a 3˚C temperature change per second. Heat stimuli ranged from 40-48˚C and cold stimuli ranged from 7-13˚C. On a scale from 0 to 10, participants verbally rated on pain intensity and on pleasantness (valence).

Results of this study indicate that although VR distraction equally reduced pain intensity and unpleasantness when perceiving pain in both the warm and cold environments, the content of the environment had no interaction with the type of pain stimulus. With regards to pain intensity, the relationship between the virtual environment and temperature of the stimulus was not significant (p = 0.94). Similarly, when considering pleasantness (valence), the relationship between VR environment and temperature was also deemed insignificant (p = 0.87). These findings suggest that the common use of cold virtual worlds (e.g., “Icy Cool World”) does not enhance pain reduction in a non-patient population the way it does for burn patients. Perhaps, because of their trauma, burn patients perceive pain differently and therefore require different stimuli for distraction.

1.2.4.2. Relevance of Presence and Interaction within VR Worlds

While content may not be a major factor in reducing pain, how “present” one feels in a virtual world and how active the interactions are within the world’s environment have been found to have an effect.

Dr. Lynnda Dahlquist et al. from the University of Maryland, Department of Psychology studied how viewpoint and presence in a VR environment might influence pain reduction. The study, published in 2010, measured the pain tolerance of 41 undergraduate students ranging in age from 18-23, during a cold pressor test (set at 1˚C) while immersed in VR. The participants underwent two different types of VR distraction environments: one with a first-person view where the participants experienced the game through the eyes of the character they were controlling, and one in a third-person view where the participants viewed their character from a distance.
Pain tolerance during both VR versions was measured and compared to the baseline (no distraction). The participants were also asked to rate how “present” they felt in both VR modes. The results revealed that both VR modes greatly reduced pain, with no difference between the two VR settings, but a stronger feeling of presence was recorded during the first-person condition compared to the third-person condition [37].

Although viewpoint did not significantly affect pain, Dr. José Gutiérrez-Maldonado and colleagues at the University of Barcelona discovered, through a number of studies, that it is the level of interaction allowed within a VR world that affects pain tolerance. What has been found is that the more control one has on the VR environment they are in, the more “present” they feel, and thus more distracted they become from their pain. In one such study published in 2011, 68 healthy students endured two consecutive cold pressor tests both with a limit of five minutes (water set at 6°C): the first without VR, and the second while immersed in the VR environment “Surreal World.” In addition, participants were randomly assigned to an interactive VR condition that allowed multiple interactions within the environment, or a passive VR condition where the participants simply observed the actions performed by the interactive users within the Surreal World. After each trial, pain intensity ratings were gathered by all participants along with a rating of the degree of presence felt in the virtual environment. In the interactive VR distraction, the majority of participants reported less pain intensity than with no VR. In the passive VR distraction, however, less that 6% of the participants reported a decrease in pain intensity compared to the control. Similarly, presence was higher in the interactive VR than in the passive VR mode, further illustrating the correlation between presence and level of interaction [38].

When one is actively interacting with a VR environment, there is a greater demand placed on central cognitive processing. The more the brain has to think and engage, the more distracted from pain they become. A study conducted by the Department of Psychology at the University of Maryland, published in 2011, demonstrates just this. After completing a baseline cold pressor test, 79 children aged 6-15 years old underwent two more cold pressor tests while immersed in a videogame through a VR helmet. The two tests consisted of one interactive distraction where the participant used voice commands to play the videogame, and one passive distraction where the participants could only observe the videogame. As predicted, the greatest improvements in pain tolerance were experienced during the interactive distraction, compared to both the passive distraction and the control, due to the increased level of cognitive activity. These findings are vital in the quest to produce the most effective VR distraction techniques for managing pain [39].

1.2.5. VR and Thermal Pain

The VRMC has also explored the effectiveness of VR distraction on thermal pain. Twelve participants each put one hand in ice water and were subject to either VR (“Enchanted Forest”) or no VR distraction. Those with VR were able to navigate the virtual environment using either a flat panel display (FPD) or a HMD. As a result, self-reported pain scores were significantly lower among participants using HMDs than among participants with no VR ($p = 0.045$). The level of pain distraction in the flat panel group was lower than the control, but not as low as the HMD group. The mean heart rate decreased and the mean respiratory rate increased when navigating through “Enchanted Forest” as compared to baseline measurements. In an initial pilot group, delta and theta waves from the EEG were higher when in HMD than in FPD and
baseline, which may suggest a higher level of immersion in the HMD. The higher level of immersion may be correlated with an increased level of relaxation and engagement.

1.2.6 Dental Pain

Despite the advancements in dental technologies and treatment, many people still avoid or delay dental care because of fear and anxiety. Stemmed from negative experiences with dentists as a child or with uncaring, unskilled or incompetent dentists, fear and anxiety cause up to 15% of all Americans to avoid regular dental care. Previous distraction techniques for reducing stress in patients show that visual techniques are more effective than audio programs.

Figure 9. VR setup at the dental clinic

Funded by the National Institute on Drug Abuse, VRMC, acknowledging the severity of this problem, performed a VR distraction study on 50 dental patients at Scripps Center for Dental Care in La Jolla, CA. These patients were receiving a variety of dental services, such as crown replacements, fillings, root canals, and cosmetic dental work. Patients wore a HMD and explored “Enchanted Forest,” a virtual world developed by VRMC. Psychological measurements, such as anxiety scales and questionnaires, were implemented along with physiological measurements, such as electrocardiograms (ECG), skin temperature, skin conductance, and respiratory rate.
As a result, patients reported lower levels of discomfort and pain while immersed in VR. Heart and respiration rates exhibited an increase in stabilization with VR exposure. In addition, perceptions of length of time were altered while in VR, indicating immersion. Seven out of 10 patients estimated their time in VR to be significantly less than actual time spent. These results suggest that immersive VR merits more attention as a potentially viable, non-pharmacologic addition for procedural dental/periodontal pain.

1.2.7. Transition to Mobile Devices

Recent improvements in the graphics capabilities in both cell phones and handheld devices has allowed for the transition of graphic rich environments to these portable platforms. VRMC has conducted a number of studies using VR content on cell phones for the relief of both procedural and chronic pain. Several studies have shown that although the screens are small, a certain level of immersion is possible. Patients exhibited a significant reduction in pain levels when compared to pain focus or when compared to baseline levels. Dr. Mosso has experimented with VR and mobile phones for reducing anxiety during surgery, using a VR scenario presented through a cell phone connected to a HMD. In a randomized controlled study, the anxiety levels of a group of patients undergoing ambulatory surgery with local or regional anesthesia was tested while immersed in the mobile VR system and with no distraction. Anxiety was significantly reduced 45 minutes into the surgery in the patients distracted with VR, whereas the control group experienced no relief at that point [40]. These results suggest possible augmentation with clinic-based pain interventions that transition to the home environment. In addition, the results support the idea that focus and immersion on smaller screens may be achieved to meet clinical goals.

Conclusion

The increasing prevalence of pain syndromes in the military demands a multi-dimensional treatment approach to pain management. Increased funding, attention and support will result in the implementation of diverse, non-traditional treatment methods resulting in lower rates of opioid misuse and addiction. On a larger scale, better management of pain syndromes could reduce the expenditures and related healthcare costs each year to manage chronic pain. Together we can better address and manage
pain syndromes and secure an improved quality of life for our servicemen and women around the world.

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