

A Continuum of Care: Virtual Reality as Treatment of Posttraumatic Stress Disorder (PTSD) and Other Pain Syndromes.*

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RESUME

Continuité des soins : place de la réalité virtuelle dans le traitement des syndromes de stress post-traumatique et dans d'autres syndromes douloureux.

A l'issue de plus de dix ans de combats en Afghanistan et en Irak, on estime à plus de 300 000 les soldats américains et des forces de l'OTAN qui ont subi des blessures de guerre. Ce terme recouvre les syndromes de stress post-traumatiques, les blessures cérébrales, les suicides associés aux souffrances chroniques, les dépressions, les consommations de drogues ainsi qu'un grand nombre de troubles en relation avec le stress. Nombreux sont les soldats qui restent non traités ou insuffisamment traités en dépit de l'attention soutenue qu'on leur porte partout dans le monde. Les difficultés d'accès aux soins, la crainte d'une stigmatisation associée à certains diagnostics, et des problèmes plus généralement liés au système de santé en général sont autant d'obstacles qui empêchent de fournir des traitements efficaces à nos combattants. Avec un dépistage au plus près, mieux intégré, permettant un traitement et un rétablissement des conditions normales de vie des combattants, on pourrait progresser assez loin à la fois dans l'amélioration du quotidien et dans l'acceptation de structures d'intervention et de traitement. Dans cet article, nous faisons la revue de notre expérience qui intègre les stratégies développées avant le déploiement, sur place et après le déploiement au stade de l'intervention clinique.

KEYWORDS: Stress Inoculation Training (SIT), Posttraumatic Stress Disorder, Virtual Reality, Injury Creation Science (ICS), Pain syndromes.

MOTS-CLÉS : Entraînement par exposition au stress, Syndrome de stress post-traumatique, Réalité virtuelle, Simulation de blessures, Syndromes douloureux.

INTRODUCTION

Since its inception, VR has proven itself as a useful technology for many aspects of behavioral healthcare. It has been used to successfully treat anxiety disorders and other psychological disturbances. It has played a role in the development of both cognitive and physical

rehabilitations. It has proven effective for distraction from painful or anxiety-inducing medical procedures.

And finally, it provides the stimulus necessary for effective exposure therapy for the treatment of PTSD. Of the nearly 20 studies that have been published on using VR exposure therapy to enhance traditional cognitive-

behavioral therapy for PTSD, all but one showed some measure of improvement in participants' PTSD symptoms, with several studies revealing a treatment success rate of 66% to 90%.

1. Virtual Reality for Posttraumatic Stress Disorder (PTSD)

Treating PTSD through VR occurs by virtually exposing the patient to a situation causing anxiety. The process allows for consolidation of the fragmented memories, emotional processing and, finally, desensitization. VR may be more effective than traditional treatments for PTSD (e.g. medication, *in vivo* (in real life) or imaginal exposure).

VR can be used to treat PTSD in conditions related to motor vehicle accidents, natural disasters (e.g. earthquakes), post-deployment in combat or terrorist attacks (e.g. September 11th). Not only does VR alleviate PTSD symptoms, it also enhances individuals' coping techniques that will allow them to better deal with future psychological trauma.

VRMC's VR devices form a comprehensive system. The patients see the VR environment through a HMD (head-mounted display) equipped with headphones, which allows them to have the impression they are surrounded by the virtual setting. They can interact with the world with a cordless keyboard, mouse or joystick. The therapist controls via a menu the added chosen effects, such as sounds or explosions. During the experience, the patient's physiology is monitored in real time with non-invasive sensors (measures are: electroencephalography, electromyography, electrocardiography, temperature, heart rate, respiration, skin resistance). This allows clinicians to monitor sympathetic nervous system arousal and parasympathetic nervous system response and to adapt interventions based on the patient's individual arousal levels.

Different wartime scenarios are available, and therapists can control the degree of exposure as well as the intensity of the stimuli. These scenarios were developed so that patients can re-experience situations they saw while on mission (e.g. ambush, civilian injuries, Iraqi villages, etc.).

1. 1. Virtual Reality Treatment for PTSD

A reason why new treatment methods for PTSD must be explored is the lack of acceptable recovery rate of traditional cognitive-behavioral therapies with medication. Multiple deployments are associated with a higher incidence of PTSD. We are seeing a new type of PTSD that is the result of prolonged and multiple deployments. It is clear that CBT-based single incident treatment protocols may not be sufficient to successfully provide relief in this group of veterans.

Before the emergence of VR as a healthcare treatment, imaginal exposure therapy was considered the most effective treatment. Although imaginal therapy can be effective, 85% of the patients seem to be unable to

visualize appropriate to achieve physiological arousal, and many patients still meet the criteria for PTSD after their treatment^{1, 2}.

Providing external, visual, and auditory stimuli, VR-augmented treatment works by better engaging the patient in experiencing reminders of the trauma through immersion. By allowing a patient to re-live anxious scenarios in the safety of the therapy room, VR overcomes the main problem of *in vivo* therapy: duration and intensity are determined beforehand, and multiple, successive exposures can take place in a single session.

VR turns out to be an efficient response in the area of anxiety disorders in general, and in PTSD in particular. VR therapy presents a virtual and therefore safe environment which will enable patients to re-experience their trauma step by step as a way towards desensitization. In our protocols, we feel it is essential to teach coping skills first, and then monitor physiology real-time during treatment, so that the risk of retraumatization is minimal³.

1. 2. Virtual Reality Treatment for War Veterans

Research on the use of VR to treat Iraq and Afghanistan veterans suffering from PTSD (20.3% to 42.4%⁴) is being conducted. The Office of Naval Research funded a program in which VRMC completed the first randomized controlled clinical trial using VR exposure with physiological monitoring and feedback (biofeedback) to treat troops at Balboa Naval Hospital and Camp Pendleton Marine Base in Southern California⁵. Triggering the emotion and anxiety levels needed for a successful treatment was made possible by setting up a virtual environment of Baghdad, for instance, with specific sounds (e.g., a Baghdad market, battlefields, military vehicles burning, helicopters thundering overhead, explosions, prayers from a temple). Researchers held focus groups, and the aforementioned stimuli were, in the case of Marine and Navy veterans suffering from post-combat PTSD, some of the most significant memories returning troops associated with intrusive thoughts⁶. Another study revealed that after VR therapy for Iraqi veterans, all had reduced their PTSD Checklist-Military (PCL-M) scores, and two-thirds of participants no longer met criteria for PTSD following treatment. The participants' mental status was assessed by the lead psychologist (a retired Navy psychologist) and a staff psychiatrist during each session in order to minimize suicide risk. The follow-up treatment included

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a «survival plan» given at the beginning of the treatment, and on-call personnel available to the patients to address any problems⁷.

Table 4 below compares the estimated costs for enrolled clinical corpsmen between the 75% effective VR treatment for PTSD⁸ and the 44% effective usual treatment⁹.

A cost analysis of VR PTSD therapy was conducted for active duty US Navy and Marine Corps war fighters at Naval Medical Center in San Diego and Naval Hospital Camp Pendleton. It is clear that early treatment and intervention can have significant cost savings even when using a newer therapy such as virtual reality. We are now looking at economic analysis of cost savings associated with SIT and stress hardening programs. It is also clear that in-theatre early interventions can successfully return warfighters to their duty stations. Since the technology is both portable and hardened, in-country deployment should be considered routinely.

2. Pain syndromes in the Military

More than half of those with PTSD experience pain syndromes, which requires treating not only the PTSD but issues surrounding chronic pain as well. Chronic pain and psychological comorbidities such as PTSD or depression can sometimes be avoided by treating acute pain properly. This treatment is crucial for military personnel, exposed to situations much more severe than civilians.

Pain intensity and, more particularly, the vulnerability of pain sufferers to comorbid conditions determine the amplitude of pain syndromes. Pain syndromes are more common when combined with comorbid PTSD, depression and/or insomnia.

2.1. PTSD Comorbidity

One important difference in troops that have returned from Iraq and Afghanistan is the average age of those deployed. In addition the age of support personnel, both contractors and government, is much higher than in previous conflicts. We need to be prepared for high levels of comorbid, hypertension, cardiovascular disease, diabetes and dementia in these groups. Enhanced and improved screening protocols need to be implemented.

In a series of Advanced Research Workshops (Table 5) funded by NATO and co-funded by the US Army Medical Research and Materiel Command and Ministries of Defence in Austria and Croatia, Invisible Wounds of War (Suicide, PTSD, Pain, and Traumatic Brain Injury (TBI) were studied. The meetings have identified important issues and topics that must be addressed to fully implement effective care for our troops and their families.

2.2. Virtual Reality for Pain Management

As we have previously mentioned, pain syndromes are perceived through emotions, cognition and attitudes,

Table 4: Estimated training cost (ETC) savings due to VR exposure therapy (VRET) at Naval Medical Center San Diego and Naval Hospital Camp Pendleton vs. treatment as usual (TAU) for combat-related PTSD (n = 12) and ETC savings for 5 clinical psychologists to treat 200 warriors with VRGET.

ETC for 12 VRET Participant	ETC Savings with TAU with 44% Treatment Effectiveness	ETC Savings with VRET with 75% Treatment Effectiveness	ETC Savings: VRET vs. TAU	ETC Savings of VRET vs. TAU minus Cost of Clinical Psychologist (i.e., \$21,600)	ETC Savings of VRET vs. TAU minus Cost of Clinical Psychologist (i.e., \$21,600) for 5 Clinical Psychologists to treat 200 warriors per year
\$439,000	\$193,160	\$329,250	\$136,090	\$114,490	\$1,908,167

Table 5: Advanced Research Workshops and Training Courses funded by NATO.

NATO Invisible Wounds of War (WoW) I: Suicide	October 2007	IOS Press Book 2008 ¹⁰
NATO Invisible WoW II: PTSD	October 2009	IOS Press Book 2010 ¹¹
NATO Invisible WoW III: TBI	February 2011	IOS Press Book 2011 ¹²
NATO Invisible WoW IV: Pain Syndromes	October 2011	IOS Press Book 2012 ¹³
NATO VR & Physio for PTSD: Clinician Training	June 2012	IOS Press Book 2013 ¹⁴
NATO Medical Training	Tentative: March 2015	
NATO WoW V: Substance Abuse	Tentative: October 2015	
NATO WoW VI: Family Issues	Tentative: October 2016	

sometimes leading to physical consequences. Recovery is increasingly hampered as the patient feels helpless against their pain, withdraws and further increases pain secondary to inactivity. More effective pain management can improve clinical outcomes. A comprehensive treatment program consisting of cognitive-behavioural therapy and VR, combined with progressive physical therapy, is beneficial.

The benefits of cognitive-behavioural therapy lie in that it balances and even shifts negative thoughts to positive ones. Among distraction methods, such as meditation, hypnosis and guided imagery, VR is a powerful medium to shift the focus onto something other than pain. The attentional component of pain allows for distraction to occur in VR and may be explained by previous pain mechanisms¹⁵.

Often narcotics alone are not effective at relieving severe pain or chronic pain. One research study revealed that 86% of patients treated for a burn still reported excruciating pain under medication (opioids)¹⁶. VR, along with other distraction techniques, has been found to reduce subjective pain and distress in patients undergoing burn wound care, dental procedures, chemotherapy, venipuncture, and prolonged hospital visits¹⁷⁻²⁷.

Since 85% of the population cannot visualize effectively, VR is much more efficient than imaginal therapy for most patients. The advanced systems used for VR allow many interactions with the virtual setting that actively involve the user's senses. Consequently, they become immersed or present in the virtual world, and escape the real world, including their pain.

2. 2. 1. VR Distraction for Chronic Pain Patients

VRMC conducted a pilot study with 16 patients suffering from pain syndromes such as fibromyalgia, lower back pain, migraine headaches, temporomandibular joint dysfunction, and reflex sympathetic dystrophy. The patients were presented with two different conditions, the first one being a pain focus, wherein patients had to describe and rate their pain at three separate intervals, and the second one VR, wherein they had to rate their pain after experiencing the «Icy Cool World» environment. The «Icy Cool World» places the individual in a cold, icy setting, with hills covered in snow and penguins imprisoned in ice cubes, which they can melt to free the penguins. Patients were physiologically monitored before and during both sessions. It appears from the study that pain was perceived as lower in the VR sessions than in the pain focus. Higher levels of relaxation were also reported during VR as patients' skin temperatures were notably increased. This clinical study supports the use of VR as an adjunct to other pain management methods^{28, 29}.

A study conducted by the University of Washington also showed that, by using VR hypnosis on a patient suffering from chronic neuropathic pain, the pain intensity and unpleasantness ratings dropped on average 36% and 33%. Pain reduction lasted a few hours after

the sessions³⁰. Another study of the University of Washington gave similar results with trauma patients³¹, and a study from the Department of Dermatology at Hadassah University Hospital discovered that VR could also alleviate pain of chronic diseases such as pruritus³².

2. 2. 2. VR Distraction Studies with Burn Patients

VRMC also carried out VR studies, funded by Las Patronas Foundation, with UCSD Regional Burn Center to distract child and adolescent burn patients from their pain. In collaboration with the Region's Hospital in Minnesota and Naval Medical Center, San Diego, two other studies were performed with adult populations, funded by National Institute of Drug Abuse (NIDA), National Institutes of Health.

Here again, patients experienced the «Icy Cool World» through a HMD. They had to try to free as many penguins as possible without time limit. As patients discovered the virtual world, they were asked to rate their pain. All of them reported significantly lower levels of pain in comparison with their initial symptoms. Pain kept decreasing as patients further became familiar with the virtual world. Furthermore, VR allowed them to think much less about pain, which is helpful in breaking the pain cycle.

2. 2. 3. VR and Thermal Pain

Another study conducted by VRMC concerned VR distraction on thermal pain and involved twelve participants. Subjects placed one hand in ice water; some received VR distraction (with the «Enchanted Forest» world), while others did not. Among those who underwent VR, some viewed the world via a flat panel display (FPD) while others viewed the world through a head-mounted display (HMD). Results showed that participants in the HMD condition felt significantly lower levels of pain than those not distracted by VR, whereas those in the FPD condition had an intermediate score. Compared to the control measurements recorded at the beginning of the experiment, participants going through the «Enchanted Forest» saw their heart rate decrease. We also observed lower delta and theta waves from the electroencephalogram for participants using HMDs in relation to FPD users or baseline level, possibly indicating a higher level of immersion through the HMD.

2. 2. 4. Dental pain

Another common problem is the anticipatory anxiety and dental phobia seen by many patients. VRMC conducted a VR distraction study, in collaboration with Scripps Center for Dental Care in La Jolla, California, on 50 patients. Interventions included crown replacements, fillings, root canals, and cosmetic dental work. The «Enchanted Forest» was the virtual world patients viewed through a HMD. Psychological measurements, such as anxiety scales and questionnaires, were implemented along with physiological measurements, such as electrocardiograms, skin temperature, skin conductance, and respiratory rate.

VR proved effective in reducing discomfort and pain and in stabilizing heart and respiration rates. Immersion was further suggested by patients' altered perception of time: 70% of them thought they had spent less time in the procedure chair than they actually had. These results underline VR's high potential as an addition to pharmacologic treatments for dental pain³³.

CONCLUSION

In conclusion, we have discussed several important aspects of a continuum of care model developed over the past two decades at our clinical centers. We must work toward extending our initial evaluations to longer-term longitudinal studies. We are at present evaluating how best to follow a group of 500-plus National Guard members who were studied pre-deployment, in-theatre and post-deployment from Afghanistan. Our protocols are specifically designed to be complimentary to existing training and treatment exercises in the military. Some of our initial success in treating PTSD is that we have removed much of the stigma associated with this condition. Many troops trained in simulation easily adopt and accept treatment with virtual environments. The opportunity to provide a seamless solution to support our troops is now a reality.

ABSTRACT

After more than a decade of combat operations in Iraq and Afghanistan, it is estimated that there are over 3,000,000 U.S., Coalition and NATO forces with Wounds of War. These signature Wounds of War include Posttraumatic Stress Disorder, Traumatic Brain Injury, Conditions Chronic Pain Syndromes Suicide, Depression, Substance Abuse and a large number of Stress-related conditions. Many service members continue to go untreated or undertreated despite nearly continuous worldwide attention given to this important situation. Access to care, perceived stigma associated with some diagnoses, and problems with the healthcare delivery system in general are some of the barriers that exist to providing effective treatments for our warfighters. Clearly closer and more fully integrating assessment, treatment and recovery into the normal and everyday aspects of the warfighters daily activities and lifecycle could go a long way in both normalizing these conditions and providing an encouraging and accepting venue for early intervention and treatment. In this paper we will review our experience providing a continuum of care involving the predeployment, in theatre and postdeployment strategies for clinical intervention.

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