Efficacy of Virtual Reality Exposure Therapy for Post-Traumatic Stress Disorder:

A Systematic Review

Nugraha, Ivan Dandy

Cikaro Public Health Center, Majalaya, Indonesia

ABSTRACT

Background: Post-traumatic stress disorder (PTSD) develops as a result of directly experiencing, witnessing, or being repeatedly exposed to aversive details of, a potentially traumatic event such as death, combat, sexual assault or serious injury. It involves a persistent feeling of fear that results from inadequate consolidation of trauma memory. PTSD negatively impacts patients' daily lives and is associated with a higher risk of death. The downside of trauma-focused imaginal exposure therapy is the inability of patient to recall the underlying traumatic event and its effects. The development of modern technology has made it possible to overcome the downside. Virtual reality exposure therapy (VRET) is now available for alternative choice of PTSD therapy. VRET is allowing to create traumatic stimuli that is more controlled and realistic. VRET supports wider methodologies in clinical studies because it supports standardization duration and type of exposure for all patients. This study aimed to verify the efficacy of Virtual Reality Exposure Therapy (VRET) for Post-Traumatic Stress Disorder (PTSD).

Methods: The search strategy was conducted through PubMed, LinkSpringer, and LIVIVO. About 71 articles were retrieved using 'post-traumatic stress disorder' and 'virtual reality exposure' keywords. Further, screening was carried out and resulted in 8 articles. In the end, four articles were included. To be eligible, the articles should be randomized controlled trial articles, published from 2011-2021, and published in English.

Results: Four RCTs included in this study reported that VRET has a significant effecting in reducing CAPS and PTSD symptoms. One study also reported that VRET could help with depressive symptoms and reduce autonomic symptoms such heart rate as a response to trauma cues.

Conclusions: VRET has an obvious and significant impact on alleviating PTSD symptoms, even though if there were a more standardize protocol or more diverse RCT the effect and use of VRET could be even more promising thus makes VRET has more ground to be applied to general population

Keywords: *post-traumatic stress disorder, virtual reality exposure therapy*

Background

According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), post-traumatic stress disorder (PTSD) develops as a result of directly experiencing, witnessing, or being repeatedly exposed to aversive details of, a potentially traumatic event such as death, combat, sexual assault or serious injury.¹ It involves a persistent feeling of fear that results from inadequate consolidation of trauma memory. Posttraumatic stress disorder (PTSD) is a common disease, with prevalence of 6.8% adult population in the United States and 0.6-6.7% in Europe.²

PTSD negatively impacts patients' daily lives and is associated with a higher risk of death. The first choice of treatment of PTSD includes trauma-focused cognitive behavioral therapy (CBT) and eye movement desensitization and reprocessing therapy (EMDR). The downside of trauma-focused imaginal exposure therapy is the inability of patient to recall the underlying traumatic event and its effects. The development of modern technology has made it possible to overcome the downside. Augmented reality exposure therapy (ARET) and virtual reality exposure therapy (VRET) are now available for alternative choice of PTSD therapy. With VRET, patients are able to be exposed to fear stimuli while still in the real world. It fully immerses patients in digital environment, where the patient can view digital environment with a large projection surrounding the patient or by motion-sensitive head-mounted visual display system (HMD). The virtual environment presents fear stimuli using video, audio, or other tangible objects or sensation, e.g. smells. VRET aims to increase sense of realness during exposure therapy therefore increasing the efficacy. The upside of VRET is it doesn't rely much on the patient's imagination and allows to create traumatic stimuli that is more controlled and realistic.^{3,4}

In conclusion, exposure of virtual reality environment supports wider methodologies in clinical studies because it supports standardization duration and type of exposure for all

patients. The purpose of this article is to systematize the studies that have used virtual reality in the treatment of PTSD.²

Method

This study was a literature review with a narrative review approach, and it aimed to verify the efficacy of Virtual Reality Exposure Therapy (VRET) for patients diagnosed with PTSD. The literature searching was done in online databases, i.e. PubMed, LinkSpringer, and LIVIVO. ‘Post-traumatic stress disorder’ and ‘virtual reality exposure’ were used as keywords in a literature search and found 296 articles. Furthermore, the authors select articles based on inclusion and exclusion criteria. The inclusion criteria used included case reports articles, published in English, and published in 2011-2021. While the exclusion criteria in this study were the study sample were theoretical articles, reviews, theses, case studies, and articles that used patients who were not diagnosed with full PTSD. The ranking of articles based on inclusion and exclusion criteria resulted 8 articles.

In the final step, the authors screened the article manually by looking at the title and abstract of the article obtained articles from PubMed, LinkSpringer, and LIVIVO. After the manual screening process, in the end, four articles were found that deserve to be analysed and discussed in this literature study. The overall article screening process was displayed in chart 1.

Chart 1. The articles screening process

Result

Description of studies that has been selected for the article is described in Table 1. Beidel et al (2017) conducted a randomized controlled trial consisted of 92 veteran and active duty personnel who had experienced a combat-related traumatic event during military service in Operation Enduring Freedom, Operation Iraqi Freedom, and/or Operation New Dawn and believe that they were suffering from PTSD. Only 40 participants were able to complete the treatment but later 13 participants were lost in follow-up of study. The treatment protocol was 17 weeks in length with the total of 29 treatments sessions and 43.5 hours of treatment for each patient. Participants were randomized to either Trauma Management Treatment (TMT) or exposure treatment only (EXP). Clinicians and participants were blinded to group assignment until VRET and mid-treatment assessment were completed. The results of this study indicates that VRET decreases in PTSD symptoms with average decrease of 41.7 points on Clinician Administered PTSD Scale (CAPS), with 42%-50% of each group, meaning reliable and clinically significant changes. The outcome of this study is more positive than other published trials that have used the same VR system to treat combat-related PTSD. This varied result may be suggesting that the results may have some connection with the way exposure therapy was implemented.

Bisson et al (2020) explore the potential efficacy of multi-modular motion-assisted memory desensitization and reprocessing (3MDR) in British military veterans with treatment-resistant service-related PTSD. Forty-two total participants with whom are all male were randomized with 83% retention at 12 weeks and 86% at 26 weeks. It was observed that improvements were maintained at 26-week follow-up. 3MDR was found to be acceptable to most participant, but unfortunately not all participants. There may be several factors that impact the efficacy and acceptability of 3MDR. Despite all it can be concluded that 3MDR is a promising new intervention for treatment-resistant PTSD.

Georgina et al (2014) presents preliminary efficacy data in a controlled study of virtual reality treatment for PTSD for criminal violence. Twenty participants diagnosed with PTSD were randomly assigned to a virtual reality prolonged exposure treatment group or an imaginal prolonged exposure treatment group. Treatment session was delivered in 12 session with 90 minute of individual sessions conducted twice a week. Five VR models were used for this PTSD exposure therapy. The result of this study confirmed that VR prolonged exposure

technique was effective in reducing clinical severity of PTSD, and participants reported a preference and acceptance for this new intervention.

Loucks et al (2018) conducted a study consisted of 15 veterans (26% male) with military sexual trauma (MS) that had a relation with PTSD. Assessment of PTSD, depression, and psychophysiological indicators of distress occurred at pre-treatment, post-treatment, and in 3 month follow-up. Treatment itself included 6-12 VRE sessions. There were significant reductions in pre- to post-treatment PTSD, including CAPS severity. There also was a significant pre- to post-treatment reduction in heart rate as a response to a trauma cue. These findings indicate that VRE can be safely delivered as a promising treatment for MST-related PTSD.

Table 1. Study and treatment characteristic

Author, Year	Type of study	Participant s (n)	VR treatment	Control group	Results
Bisson et al, 2020 ⁵	RCT	British military veterans who attended NHS clinics in South Wales, n=42	3MDR (VRET + EMDR + walking on a treadmill)	Waitlist control (received 3MDR with a delay of 12 weeks)	3MDR reduce traumatic stress symptoms in military veterans with treatment-resistant service-related PTSD
Beidel et al, 2017 ⁶	RCT	War veterans and active duty personnel with past Iraq and Afghanistan deployment Combat-related PTSD symptoms, n= 92	VRET with TMT	VRET with psychoeducation	Significant decrease on the CAPS for both treatment groups. According to the authors there were no significant differences between the groups. Treatment gains were maintained at 6 month follow up

Georgina, 2013 ⁷	RCT	Victims and witnesses of crime in Ciudad Juarez, n=40	VRET	Imaginal Exposure Therapy (IET)	Successful in reducing CAPS from pre-treatment to post-treatment
Loucks, 2018 ⁸	RCT	Military veterans from all military service eras who completed an initial phone screen to identify probable diagnosis of PTSD due to MST, n=15	VRET	Waitlist control (received with a delay of 6 weeks)	Significant reductions in CAPS and depressive symptoms, and also significant reduction in heart rate response to trauma cue

From 4 randomized controlled trials that were reviewed in this article, all reported that VRET has a significant effect in reducing CAPS and PTSD symptoms. One study also reported that VRET could help with depressive symptoms and reduce autonomic symptoms such as heart rate as a response to trauma cues.

Discussion

Most of randomized controlled trials (RCT) involving VRET have military-related personnel as subjects. The high utilization of this population may be due to the high financial and social cost of wars where people return home with PTSD. Moreover, the spike over the last 10 years in the US from battlegrounds in Afghanistan and Iraq with traumatic injuries has made military-related personnel become the primary focus of PTSD management, hence the increased advancement in technologies and methodologies of PTSD management for military-related personnel.^{1,9} These large population and focus has also made a lack of diversity of subjects of VRET RCTs. This is contradictory to the fact that even though most RCTs involve men with military background, the prevalence of PTSD is higher in women, although there is a difference in types of events that men and women experience. Women are more likely to report or experience the death of a relative or close person, sexual abuse and assaults, whereas men are more likely to be exposed to accidents, natural disasters, and nonsexual assaults or combat.¹⁰

Even though, most RCTs have a focus on military-related personnel. They are considered to be a resistant sample. Thus, the results obtained may have even been more promising if using non-military-related personnel. VRET itself have a high financial cost, hence it is almost impossible to follow an idiosyncratic method, or in other world a more personalized trauma environment for each subjects. The lack of standardization also becomes a problem because it makes it hard to evaluate the efficacy of VRET protocol.¹

Regardless, VRET has an obvious and significant impact on alleviating PTSD symptoms, even though if there were a more standardize protocol or more diverse RCT the effect and use of VRET could be even more promising. Further studies are needed to be done with more inclusive population, involving women or non-combat related population who have PTSD so VRET as a PTSD management has more ground to be applied in general population.^{1,10}

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