The Effects of Virtual Reality Applications in Mental Health

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

Virtual Reality technology is applicable and supplementary to many different fields of work such as in education and training systems, image guided surgery, and diagnostics. Although virtual reality devices are envisioned as tools for entertainment purposes, they hold unique opportunities for use in health care. Applications of Virtual Reality (VR) have shown great potential in better mental health. VR applications have been studied and shown to improve mental health by reducing symptoms of diagnosis and fear, distracting individuals from pain, and having higher accuracy in medical practices conducted by health professionals in operation rooms. In addition, studies have found that VR applications will not only be effective to patients individually but also be cost-efficient to the patients.

Even though there are many micro-scaled studies that showed successful applications of VR in better mental health and financial effect, VR application in health industry lacks in framework of ethical, feasible, and tolerable standards. In this research paper, there will be a discussion of why VR is being included in healthcare and used in mental health and how disruptive technological innovations are used in clinical practices. Additionally, an augmentation of VR in fear and pain management will be discussed along with the benefits that the augmentation brings to the stakeholders.

Virtual Reality in Healthcare

VR has drastically altered the landscape of the healthcare industry, from providing an opportunity for realistic training software for surgeons, to immersive 3D environments for soothing pediatric patients. The transition for VR "gradually broadened from teaching simple tasks to the acquisition of complex skills, such as abstract reasoning, visualization and management of complex information spaces" (Mantovani et al., 2003).

One key feature that elevates VR from a simple entertainment experience to an immersive limitless potential tool for treatment is the ability to interact with the created environment, with the experience reacting to the user's motions and movements. VR is also useful in training surgeons and other medical staff. Some of the most critical uses range from allowing remote operations to creating virtual environments to treat anxiety (Moline, 1997).

VR technology allows for a wide range of flexible tools for mental health treatment as well, as the endless possibilities of stimuli with the option to measure the user's reaction opens the door for a variety of stimuli treatment for afflictions like anxiety, depression, or ADHD. Mantovani et al. (2003) lists a few of the wide range of applications for VR in healthcare; controlled virtual environments could serve to modify eating disorders, distract dental patients from work being done, relax users while monitoring pulse rate, or in rehabilitation it could pit a user on a stationary bike against the computer, allowing for a changing difficulty while monitoring their form,

pace, heart rate, etc. This is in addition to the various cost-saving benefits from this technology application, from a possible replacement for anesthesia to telepresence limiting the physical presence needed for specialists to be present in trauma units. Finally, it can help through improving surgical and physician training methods and visualizing specific surgery scenarios, such as simulating a 3D environment responsive to user's touch to help train finding cancerous tissues (Giuseppe & Wiederhold, 2015).

VR offers the opportunity to completely shift the healthcare industry's method of operation, through offering more effective treatment options, alternatives to more expensive anesthetic specialists through VR sensory stimulation, and flexibility of physician's schedule in treatment of patients.

Disruptive Technological Innovations in Clinical Practices

The most striking and influential force that shaped people's daily life today is technology. Technology has turned into a requirement rather than wealth. Technology is the result of innovation, to some extent, because there is no technological breakthrough without innovation. That is to say, innovation is the key in taking the disruptive approaches well. It is important to embrace disruptive approaches through innovation, collaboration and technology. The approaches to be adopted are disruptive because they are not at all similar to those before. Or rather, one might call them innovative methods. However, in order to take these disruptive approaches, it is important to embrace innovation and technology.

Healthcare has been largely immune to disruptive technology; the US healthcare system is the world's most expensive system per capita, according to Clayton Christensen (2017). This is accompanied by 75% of total spending being due to chronic conditions such as heart disease and diabetes. Christensen, Waldeck & Fogg (2017) say that the disruptive technology always supplants the incumbent market leader: "long-standing coexistence is not classically in keeping with true disruption". This disruption may not be so simple for the fate of VR in the healthcare industry. The healthcare industry is attempting to preserve its institutions in the face of the disruptive nature of VR in the industry, as every industry challenged by a disruptive technology does.

However, we will more than likely see a gradual shift away from these more traditional treatment methods to ones that are entirely virtual, meeting a physician in the virtual space for a checkup. Christensen, Bohmer & Kenagy (2000) even go so far as to say, in a Harvard Business Review Article that it is very likely "the health care system can be transformed only by creating new institutions that can capably deliver the vast majority of such care".

In this case, VR as a disruptive technology indicates an even greater shake up for the industry given that it offers the potential shift the experience of patient services from a physical checkup to a virtual one, among its numerous other benefits. This disruption only takes place in an

environment where consumers face high costs and uneven levels of access. This is the prime industry for a disruptive technology to dominate through offering a low cost, high efficiency solution to the problems that the old technology does not serve. VR demonstrates the enormous benefits associated with larger adoption throughout the industry, due to the complementary nature of the headsets across care providers. This type of destructive innovation could pose a challenge for the industry as it shifts from one standard to another; the interim period of this transition creates instability.

Augmentation of Virtual Reality: Fear and Pain Management

Current trends for pain management in virtual reality in healthcare largely include helping patients manage the anxiety that comes with painful medical procedures that may incite such anxiety and fearful reactions. According to Boeldt et al. (2019), "anxiety disorders are among the most common of mental disorders affecting nearly 18.1% of adults". In the process of helping patients deal with anxiety, these VR procedures often involve what is known as exposure therapy, or "involving gradual and repeated exposure to feared stimuli with resultant changes in cognitions, behaviors, and emotional and physical responses" (Boeldt et al., 2019). VR has already been used in studies in an attempt to aid patients with general phobias and stress-inducing situations, including a study conducted in 1995

by Rothbaum et al., which successfully treated children with their fears of flying (Gershon et al., 2003).

Along with helping treat patients with generalized anxiety and phobias, the usage of VR has been seen more frequently in helping patients prepare, and overcome the mental stress associated with medical surgeries and other procedures that induce large amounts of anxiety, stress, and fright. Gershon et al. (2003) also mentioned VR was used to help manage the stress of children undergoing a procedure including the insertion of a needle in order to help treat various forms of cancer. According to the study done by Gershon et al. (2003), those children who underwent the procedure in the immersion of VR had lower mean pulse rates prior to, during, and post port access with the needle. Along with lower pulse rates, children were reported to have "reduced psychological arousal, lower ratings of pain by the nurse, and reduced behavioral indices of distress" (Gershon et al., 2003).

Beyond using VR to aid patients with phobias or anxieties, as well as the fear and pain associated with single procedures, many studies have also shown the effectiveness of using VR in helping patients manage the stresses associated with chronic pain. In a study done by Fowler et al. (2019), VR was used to help veterans deal with chronic pain. This study described chronic pain as a road towards "fear of movement," which stemmed from the fact that "[p]eople with chronic pain mistakenly believe that pain sensations signal harm" which may result in people fearing that certain

specific movements may be harmful, when in reality, they are not (Fowler et al., 2019). In this sense, VR was used as a method of "pain distraction" as well as "graded exposure" in that it was not meant as an immediate source of relief, but rather as a management tool used to help veterans learn to better deal with their fears of movement and kinesiophobia (Fowler et al., 2019). The study produced results indicating that "a small effect size improvement was observed for the primary outcome fear of movement," and as for secondary pain measures "67% of Veterans experienced MCID for patient-specific functional outcomes, thus indicating the most promising outcome measure in this small study (Fowler et al., 2019).

Though the study suggests that VR may be more effective as a method of dealing with stress, phobias and single procedures, there is a promise that VR may be a viable method of reducing the stresses and fears of chronic pain and illnesses in the future. To date, there has been limited research conducted on the usage of VR as a method of pain/fear management. However, despite numerous questions that must be tested and answered, VR has been a surprisingly effective method for managing acute, as well as chronic pain (Li et al., 2011). As research continues, scientists have become interested in following the usage of VR not solely in deactivating "critical pain regions in the pain matrix," but also other hypothesized areas, including the "frontal lobe/pain inhibitory pathways, critical nerve gating mechanisms and/or other neurochemical processes" (Li et al., 2011).

Though currently expensive, the rapid development of technology and VR in general suggests that such treatments may become readily available for numerous patients, doctors, and institutions as a means of helping others deal with pain and stress. The ever-changing aspect of technological advancements means that VR is effective and person-specific and adaptive, meaning that it may provide a more personalized means of treatment for each individual patient, available for personal use in homes, as well as in hospital/clinic settings (Li et al., 2011).

The Adoption, Modification of Virtual Reality in Healthcare

The adoption and success of biomedical devices around VR applications and mental health are defined in the added benefits from their mass adoption relative to other conventional medical techniques. There is a large body of evidence supporting the idea that VR simulation is applicable in a wide variety of treatments. Simulation is increasingly taking a larger share of clinical training and, as a cheap alternative, VR offers standardized clinical training in a cost-effective, repeatable way (Pottle, 2019). The future for VR applicability rests in the hands of administrators to integrate it in curricula and the ability to share simulated clinical experiences. Its integration facilitates the transformation of how education is delivered to future clinicians.

VR provides distinct benefits for uses in the health system. The simplicity of its setup offers the ease and safety of use with no supervision

(Pillai & Mathew, 2019), additionally, Pottle (2019) stated that this "allows other simulation activities to take place in a place while VR simulation is occurring. This can include more faculty focus on advanced communication skills or in situ simulation, neither of which is well-suited to VR." This particular benefit is large enough and not confined to an expensive setup budget; thus, it allows for much flexible and broader access for users and providers. These distinct benefits have the characteristics of being flexible in ways of accessing the applications. This simulation-based device can be integrated into everyday practice, have repeatable scenarios: allowing leaners to make mistakes safely and learn through deliberate practice and improve. Also, Pottle (2019) claimed that VR application in health is psychologically safe, and the "enjoyable nature and potential for gamification of VR encourages engagement and autonomous learning."

Most studies using VR are paid by per course hour. McIntosh et al. (2006) study concluded that "Set up cost was US$876,485 [£758,300] (renovation of existing facility, equipment). Fixed costs per year totalled $361,425 [£275,000]. Variable costs totalled $311 [£237] per course hour" and Iglesias-Vázquez et al. (2007) stated that the "cost of ALS [advanced life support] simulation for a 4-day course is €1,320 [£1,140] per passed participant." The costs of VR are comprised of two main parts: hardware and software. Hardware is a cost for a setup of laptop and the headset and the software varies depending on the quality of the product and the provider,

but the difference between different providers and qualities is “frequently under one-tenth” (Pottle, 2019). Comparing the costs from both McIntosh et al. (2006) and Iglesias-Vázquez et al. (2007) studies, setup of VR in healthcare building can bring substantial amount of savings financially.

The increase of VR applications in healthcare buildings can generate larger performance data which can be valuable for statistics among users and healthcare professionals where they can identify struggles of those who may gain from further training. The reduction in cost and access allows technology for simulations to be distributed globally, and from a global health perspective this is an exciting prospect for VR application.

Discussion

Although VR technology has advanced to the point where it can now assist global health care providers and their patients, it continues to lack in a solidified framework to demonstrate its benefits. Though proven to be beneficial if used properly, VR is not always implemented properly in the treatment of patients. The improper implementation of this technology can produce strong negative emotional experiences to the users, with worst case scenarios resulting in psychological harm and intensified emotions resulting in physiological changes such as heart rate, blood pressure, and stress levels (Lavoie et al., 2021).

While there may be harmful consequences stemming from the incorrect usage of VR in the medical setting, healthcare professionals and

engineers have taken steps to improve the efficacy, safety, and practicality of VR usage in the medical treatment of patients. In order to use VR on a larger scale, it is vital to ensure that VR experiences do not leave the users with negative emotional/psychological effects.

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