Virtual Reality in Medicine

Michelle LaBrunda
Cabrini Medical Center, USA

Andrew LaBrunda
University of Guam, USA

INTRODUCTION

Virtual reality is a collection of technologies that enable people to use their senses to experience sensory input provided from a source other than the immediate environment. These events may occur in real time, can be a simulation, or can be completely fictional. Virtual reality (VR) has progressed beyond its military beginnings and is progressively making its way into people's daily lives. The most prevalent implementation of VR can be found in many forms of modern entertainment such as computer games or IMAX (image maximum) theaters.

VR has received little publicity but has enormous potential in the realm of medicine. The utility of VR is starting to be appreciated by the medical community. It is slowly being adopted and implemented in the surgical, medical, and psychiatric specialties.

Medical uses of VR are primarily directed toward the simulation of visual, audio, and tactile input. With the aid of VR doctors will be able to perform specialized surgery on a patient from the other side of the world. Students are able to simulate and experience surgical procedures without compromising a patient's health. Finally, VR can heighten a doctor´s senses and allows input that would be absent without the aid of VR, such as relative bone positions and tissue temperature.

SURGERY

Surgery is especially conducive to the use of VR due to the spatial nature of the specialty. VR is currently being used most notably for laparoscopic procedures, but also for trauma, orthopedics, obstetrics/gynecology, and minor procedures such as colonoscopies. VR may soon allow specialized surgeries to be performed by leading specialists remotely. Student training may also be improved through VR. Meta-analysis has shown that first training physicians on simulators significantly increases skill and decrease the length of time required for novices to perform true surgery (Haque & Srinivasan, 2006).

Laparoscopic surgery is a relatively new technique which is still being expanded and refined. In place of making a large surgical incision, several small surgical openings are made and instruments are passed through these openings. The surgery is guided by a camera passed through one of the incisions. Laparoscopic surgery has the advantage of leaving much smaller surgical incisions and damaging the body less than in traditional surgery. Unfortunatly, it is a much more complicated technique and years of additional training may be required. Due to the three-dimensional nature of laparoscopic surgery, VR has been developed for this technique earlier than for other specialties. Sim-Mentor is one of the earliest VR programs available in medicine and is currently being used to teach surgeons laparoscopic techniques (Rotnes, Kaasa, Westgaard, Erikson, Hvidsten, Strom et al., 2002). This minimizes the risks to patients while allowing physicians in training to practice and perfect their abilities.

Trauma medicine is a unique field in which multiple medical problems must be assessed and prioritized in an exceptionally short period of time. Lack of proper training or experience can result in loss of life or increased morbidity. VR programs have been developed to simulate trauma situations. One of the available software simulators is called Trauma-Teach (Ong, Vijayan, Koh, Lai, Lim, Loke et al., 2005). Trauma-Teach is an interactive VR program in which a patient can be selected from a trauma database. The virtual patient must be stabilized, less than obvious medical conditions diagnosed, and proper medical and surgical therapy initiated. The simulator is designed to respond to therapy as would a real patient under the given set of circumstances. Trauma-teach and like programs are relatively recent developments and their effectiveness

as teaching tools have yet to be fully evaluated. They are likely to be successful in teaching lifesaving skills to novice physicians preparing them for effective and successful patient management in the trauma setting.

Orthopedic surgery is also starting to utilize VR as a teaching tool for surgical residents. Orthopedic surgeries consist of repair and replacement of bony structures, including joints. Fluoroscopy is a technique common in orthopedics in which X-rays are used during a procedure to visualize internal structures, especially bones. Fluoroscopy requires special training to minimize the exposure of the patient and medical staff to radiation while providing the required information. VR simulators allow physicians in training to practice fluoroscopic techniques while avoiding unnecessary radiation exposure (Jaramaz & Eckman, 2006). There are currently very few orthopedic simulators available, but as technology becomes more accessible and the effectiveness of simulators is more completely assessed, additional orthopedic VR software options will become available.

PSYCHIATRY

The character of psychiatric illnesses makes them amenable to treatment with VR. VR is being used as a treatment modality in many psychiatric illnesses including phobias, eating disorders, and male sexual dysfunction. One important project in the utilization of VR in the treatment of psychiatric illness is VEPSY. VEPSY is a European Union funded research project for telemedicine and portable virtual environments for clinical psychology. It started January 1, 2001, and continues at this time. VEPSY brings together an international group of researchers and industrialists with the common goal of exploring the possible uses of VR in the treatment of psychiatric illness.

A phobia is an irrational fear of a specific object or situation. Some of the most common phobias are fear of a specific animal, fear of flying, agoraphobia (fear of having a panic attack in public), fear of public speaking, and fear of heights. Many VR and augmented reality programs are being utilized to treat phobias. VR in the treatment of phobias is a very new field. While papers proposing the treatment of flying phobias and agoraphobia/social phobia using VR have been around since 2002, the first documented case of VR used to treat a phobia was done in Spain for a cockroach phobia in 2005 (Notella, Juan, Banos, Alcaniz, Guillen, & Rey, 2005). Little research has been published evaluating the efficacy of VR treatments of phobias, but it is being used more and more frequently and there is great potential for the development of new treatment software. VR exposes patients to the situation that causes their phobias in a carefully controlled setting.

VR has been proposed as a treatment for male sexual dysfunction. Erectile dysfunction can be defined as the repeated inability to get or keep an erection firm enough for sexual intercourse. It may be purely organic, but frequently involves a psychological component. Only one study has been done to date utilizing VR in the treatment of erectile dysfunction. Response to therapy was comparable to that of conventional therapy and may have the advantage of a shorter treatment period (Optale, Pastore, Marin, Bordin, Nasta, & Pianon, 2004). This same study found that men who suffer from premature ejaculation can also be treated with VR.

A third group of psychiatric illness that is being investigated for VR treatment is eating disorders. Currently, eating disorders are treated by cognitive behavioral therapy. This therapy is limited due to the length of treatment and associated costs. Preliminary reports on therapies involving VR suggest that VR is as effective as conventional therapy but has the advantage of being more accessible (Riva, Baccetta, Cesa, Conti, & Mokinari, 2004). Research is also being done attempting to combine the traditional therapy with VR. The preliminary results from all VR treatment studies are promising.

OTHER SPECIALTIES

VR is most commonly found in the surgical specialties, but has been becoming more and more common within the medical specialties such as neurology, gastroenterology, and cardiology. Neurologists are using virtual reality to help stroke victims recover motor abilities (You, Jang, Kim, Hallett, Ahn, Kwon et al., 2005). Patients with multiple sclerosis are receiving gait training using VR to improve walking ability (Baram & Miller, 2006). Colonoscopy is now part of the routine physical exam for people over 50 years of age. AccuTouch and similar software allow gastroenterologists colonoscopy training without having to practice on live patients (Ahlberg, Hultcrantz, Jaramillo, Lindblom, & Arvidsson, 2005). Cardiac catheterization simulators (Gallagher & Cates,

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