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# Using Cybertherapy to Reduce Postoperative Anxiety in Cardiac Recovery Intensive Care Units

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## Abstract

Surgical anxiety creates psychological and physiological stress, causes complications in surgical procedures, and prolongs recovery. Relaxation of patients in postoperative intensive care units can moderate patient vital signs, reduce discomfort, and shorten length of stay. This study explores the use of virtual reality cybertherapy to reduce postoperative distress in patients that have recently undergone cardiac surgery. Twenty-two patients were monitored at IMSS La Raza National Medical Center within 24 hours of cardiac surgery. Patients navigated through a 30-minute virtual reality simulation designed for pain management and stress reduction. Results were analyzed through comparison of pre- and post-operative vital signs and Likert scale survey data. Likert test data showed that 21 of 22 subjects reported less discomfort after navigating through the virtual environment. Physiological data generally supported the Likert data, with 64% of patients lowering respiratory rate, moderated blood carbon dioxide levels, and decreased diastolic blood pressures in another 64% of patients. Thus, due to the innocuous and non-invasive nature of cybertherapy, virtual reality demonstrates promise in reducing postoperative anxiety.

**Keywords:** Surgical anxiety; Postoperative distress; Virtual reality; Cybertherapy; Immersiveness; Pain management

## Introduction

Anxiety and acute distress has become widely accepted within patients that undergo surgery due to increasing demands for efficiency in hospital operations and less time for healthcare professionals to ascertain patients of their well-being. Patients often report a psychological fear of surgical failure, anesthesia, or the "unknown" [1]. Many factors can contribute to the level of surgery-related distress including sociodemographic variables, psychological variables, and previous hospital experiences [2]. Surgical distress is not only obstructive towards the mental state of patients, but it also has an adverse effect on surgical procedures and postoperative recovery [3]. Patients' physiological states are stressed when surgery is accompanied by anxiety. Even patients with low disposition for anxiety showed signs of physical and psychological changes such as increased heart rate, breathing rate, blood pressure, vasoconstriction, nausea and vomiting, and gastric stasis [4]. Immune functions are commonly down-regulated due to the activation of the sympathetic nervous system, relating to increased glucocorticoid levels and depressed natural killer T cells [5]. In addition, intensity of surgical distress has been shown to correlate with postsurgical pain, which can further down-regulate immune function [3].

Relaxation of surgical patients has become a significant factor in today's healthcare setting. Hospitals would experience improved surgical procedures and reduced length of patient stay in post-surgical recovery, but more importantly, patient well-being would be improved both psychologically and physically. Current efforts have been focused on reducing preoperative anxiety. Medical interventions, such as the administration of midazolam, have shown effectiveness, but are limited. Therapeutic attempts such as using music to relax patients in surgical waiting rooms have mixed results [6].

Recently, improvements in technology have improved the use of virtual reality in reducing surgical anxiety, specifically in postoperative intensive care units (ICUs). A group from Johns Hopkins University studied the feasibility of utilizing video games to complement physical therapy for patients in ICUs, concluding that the method is safe and useful [7]. Moreover, the use of virtual reality can be an effective complement to pain medications for pain distraction. In a study conducted at the Virtual Reality Medical Center, it was shown that immersion in a virtual world causes much of the patients' attention to be focused on the virtual environment, leaving little attention left to focus on other things, such as pain [8]. Furthermore, evidence has shown that immersiveness into a virtual environment has beneficial effects on heart rate, breathing rate, peripheral skin temperature, and skin resistance levels [9].

We recognize the relaxing effects virtual reality can have on patients that undergo surgery, especially in postoperative patients. In this study, we observe the effects of utilizing virtual reality in reducing distress of cardiac recovery patients in ICUs.

## Methodology

The study took place in the cardiac surgery department of IMSS La Raza National Medical Center from May 2006 to January 14, 2007. Patients (n=2, 7 female and 15 male) were aged between 34 and 70 and were monitored in hyperacute units within 24 hours of their cardiac surgeries. The operations included: mitral valve replacement, aortic valve replacement, tricuspidvalve replacement, coronary stent insertion, coronary revascularization, tricuspid valvuloplasty,

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ventricular communication repair, and bridge tricuspid resection. Every patient was conscious during the cybertherapy, had normal vision, free movement of arms and hands, and did not have airway intubation nor hemodynamic comprimise. Clinical staff included 4 physicians, nurses, and technicians.

Members of the clinical team delivered the same procedural instructions to the patients after they were admitted to the ICU. Consent to participate and demographic information were collected and simulation equipment was prepared, which included setup of an eMagin[1] head-mounted display (HMD), Dell[2] laptop, and a projector. After registration, a clinical professional recorded relevant vital signs and administered Likert scale test to measure discomfort. Physicians installed the HMD on the patient's head and displayed a virtual reality simulation on the display. The projector displayed the same simulation on the unit wall to share the simulation with the clinical team and patient family members. Patients were able to explore a variety of environments in five cybertherapy simulations for 30 minutes (developed by the Virtual Reality Medical Center in San Diego, CA, USA): Cliff-FINAL, Dream Castle, EM-Runtime, Enchanted Forest, and South Pole Fantasy. After 30 minutes, the HMD was removed and vital signs and Likert test were recorded for post-therapy data collection (Table 1).

## Results

Data analysis is composed of comparisons between pre- and post-cybertherapyvital signs and Likert scale results. Complications included a female patient of age 68 that experienced cardiac arrhythmia during treatment, and 3 patients that presented signs of nausea and vertigo that interrupted the cybertherapy session. Below is a list of each patient, including their cardiac surgical case and as well as figures that compare their Likert test results and significant physiological data.

Likert scale tests show that 21 of the 22 patients (95%) reported less discomfort after navigating through the virtual environment. Breathing rate was reduced in 64% of patients. In addition, several other physiological variables were affected by navigation through the cybertherapy simulation. Blood pH levels tended to moderate for patients that showed signs of alkalosis or acidosis. Similarly, patients showed moderation of carbon dioxide levels. Of the 9 patients that showed abnormal carbon dioxide retention, 4 patients returned to normal levels, 2 moderated toward the normal range within the 30 minutes, and 1 showed no change. Blood pressure widened after cybertherapy, while 64% of patients reduced their diastolic pressure. Bicarbonate levels and oxygen saturation levels did not show consistent change. Heart rate did not indicate enough sensitivity, and suggests that heart rate variability may be a better measure (Figures 1 and 2).

## Discussion/Conclusion

After cardiac surgery, it is common for patients to show symptoms of worry, apprehension, and depression. The melancholic state can last many weeks and disrupt recovery, both psychologically and physiologically. Patient relaxation can reduce post-surgical pain, improve overall well-being, and prevent pneumonia and other complications. This clinical study has shown that navigating through a virtual environment can reduce psychological stress. Physiological data also correlates with the Likert scale data, with 64% of patients reducing their respiratory rate and a moderation of blood pH and carbon dioxide levels. Improvements could be made to the therapy content or procedure to benefit those who did not report positive changes in vital signs or discomfort, although we recognize that cybertherapy may not be suitable for some patients.

Virtual reality has shown to be a non-invasive and innocuous procedure to improve post-surgical distress in ICUs. Using this technology allows patients to interact at many levels with the virtual environment, using multiple senses, and encourages to become immersed in the virtual world they are experiencing. In this way,

[1]eMagin Corporation. 3006 Northup Way Suite 103, Bellevue, WA 98004, USA. http://www.emagin.com/.
[2]Dell Inc. 2300 Greenlawn Blvd, Round Rock, TX 78664, USA. http://www.dell.com/.

| # | Sex | Age | Surgery and diagnosis | Simulation |
|---|---|---|---|---|
| 1 | M | 64 | Revascularization | Enchanted forest |
| 2 | F | 58 | Aortic valve replacment, tricuspid valvuloplasty. Infarct, hypertension, diabetes mellitus, cardiomyopathy rheumatic. | Enchanted forest |
| 3 | M | 72 | Revascularization 4 bridges. Hypertension, Infarct, coronary artery disease. | Enchanted forest |
| 4 | F | 34 | Tricuspide valve resection. interventricular closure. Endocarditis. | Cliff final |
| 5 | M | 36 | Mitral valve replacement, mitral valvuloplasty, rheumatic cardiomyopathy. | Enchanted forest |
| 6 | M | 57 | Revascularization, infarct, auricular fibrillation, dyslipidemia. | Cliff final |
| 7 | M | 59 | Revascularization, hypertension, ischemic cardiomyopathy. | Cliff final |
| 8 | F | 50 | Mitral valve rechange, thrombocytopenia, mitral lesion | Enchanted forest |
| 9 | M | 62 | Aorto coronary revascularization, 3 bridges. Infarct, Ischemic cardiomyopathy. | Enchanted forest |
| 10 | M | 55 | Revascularization, 3 bridges. Inferior and lateral infarct. Renal insufficiency. | Enchanted forest |
| 11 | M | 58 | Mitral valve replacement. Mitral lesion, congestive heart failure, asthmabronchitis, | Enchanted forest |
| 12 | F | 68 | Transluminal coronary angioplasty, 3 stents. Inferior infarct. | Enchanted forest |
| 13 | M | 50 | Revascularization. Patient re-vascularized, diabetes mellitus. | Enchanted forest |
| 14 | F | 45 | Mitral valve replacement. Cardiomyopathy | Enchanted forest |
| 15 | M | 69 | Coronary arteries revascularization, bridge aorto-coronary. Ischemic | Enchanted forest |
| 16 | F | 58 | Valve mitral replacement. Ischemic cardiomyopathy. | Enchanted forest |
| 17 | M | 60 | Aorto-coronary vascularization. Ischemiccardiomyopathy. | Enchanted forest |
| 18 | M | 67 | Aortic valve replacment. Aortic deficiency, both aortic lesion. | Cliff final |
| 19 | M | 56 | Mitral valve replacement. Valvuloplasty degenerative, disease rheumatic. | Enchanted forest |
| 20 | F | 44 | Aortic and mitral valve replacment. Active rheumatic fever. | Cliff final |
| 21 | M | 70 | Aortic valve replacemet. Ischemic cardiomyopathy. | Enchanted forest |
| 22 | M | 60 | Coronary artery dilitation, 2 BRIDGES. Cardiomyopathy ischemic. | Cliff final |

**Table 1:** List of patient demographics, surgical case, and simulation environment.

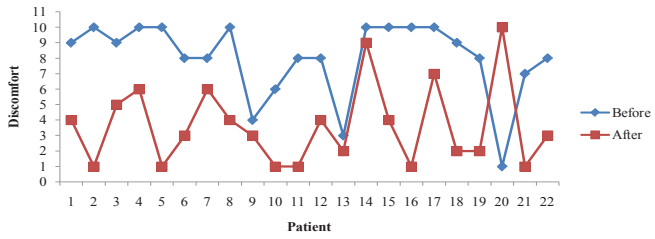


**Figure 1**: Comparison of Patient Discomfort Pre- and Post-cybertherapy.

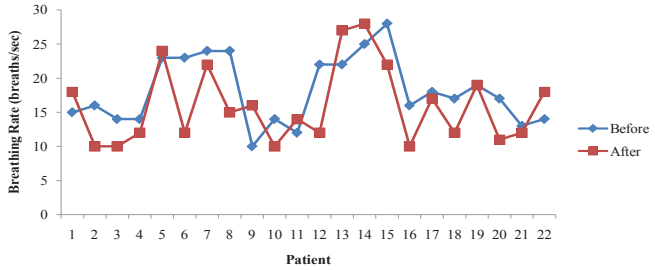


**Figure 2**: Comparison of Breathing Rate Pre- and Post-cybertherapy.

virtual reality provides an effective medium for reproducing and/or enhancing the distractive qualities of a pain treatment. Virtual reality in ICUs represent a tremendous social impact in patients that are in critical condition by acting as additional support to avoid and reduce postsurgical distress.

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