How Virtual and Augmented Reality Will Transform Healthcare

Walter Greenleaf PhD
Political Conflict

Global Warming

Depletion of Resources / Pollution

Healthcare Crisis - Aging Populations
Healthcare Crisis: Aging Populations
Digital Health Revolution

• Mobile Health / eHealth
• Wearable Sensors
• Patient Centered
• Leverages Internet: social, competitive, collaborative
New Technologies for Healthcare

Major Trends:

• Transformation from analog to digital
• Transformation from location-based and time limited to any location, and available 24/7
• Patient focused - patient engaged in their own care
• Emphasis on prevention and behavior change
The Quantified Self Movement: Early Adopters

Leveraging built-in sensors
Every medical device reinvented
Digital Health Platforms deliver interventions to patients, and parses data for enhanced decision-making.

**Patient Facing Applications**
- Assessments
- Reminders
- Badges
- Interventions
- Graphics

**Mobile Backend**
- Access codes
- User auth
- Device mgmt
- App provisioning
- Restful API

**Analytics**
- Data tracking
- Engagement
- RT analytics
- Content store
- Metrics

**Messaging**
- Push notification
- Mail service
- Batch/scheduling

**Storage**
- Transactional store
- Real time event store
- Data warehouse
- Data store

**Infrastructure**
- Log aggregation
- Monitoring
- Deployment agents

**Dashboards**
- Physician
- Payor
- Admin

**SDK**

**Wearable sensors**

**Data**

**Direction**

**Access/Analysis**
Digital Health Platforms deliver interventions to patients parse data for enhanced decision-making

Objective data
Behavior and activities
Linked to intervention
Population trends
Digital Health Revolution

Medical Applications of Virtual Reality Technology
Current technologies and concepts are founded on more than 30 years of research and development.

Recent changes in cost and access make VR affordable.

VR tech is currently used for prevention, evaluation, treatment and chronic disease management.

After years of validation and use by early adopters - VR technology is poised to move to the mainstream.

On the horizon: enhanced, ubiquitous, informative and integrated.
VR and AR technology will significantly impact Medical Care

- Prevention and Wellness
- Objective Assessments
- Improved Adherence
- Facilitated Behavior Change
- Distributed Care Delivery
- Management of Chronic Conditions
VR Technology Has Evolved

First general purpose and commercially available VR systems.

Now, after more than 30 years of research and development…
Virtual Reality Technology
On the way to becoming a commodity – available at consumer prices
Now is the time for VR

VR technology is now affordable, scalable and accessible to the marketplace. The VR category is attracting interest and investments from major players.

- Samsung - GearVR
- Facebook - Oculus
- HTC - Vive
- Sony – PlayStation VR
- Microsoft - HoloLens
- OSVR
Within **6 years**, VR will likely be adopted by 40-70 million users.

Initial adoption will be driven through game console, PC gaming and mobile phone bundling.

Within **3 years**, VR will likely be adopted by **15-30 million users**.
Although entertainment, social connection and gaming will drive the initial adoption of VR technology, the deepest and most significant market for VR will be in clinical care and in improving health and wellness.

The list of clinical interventions made possible by VR is long. VR technology also facilitates clinical assessments and medical training, as well as providing for improved surgical skill training and procedure planning.

Personal health and wellness can be improved by using VR to engender better nutrition, promote healthy lifestyles, and to reduce stress and anxiety.

As the cost of healthcare rises, VR technology can serve as an effective telemedicine platform to reduce costs of care delivery, and improve clinical efficiency.
Academic research has demonstrated that Virtual Reality can effectively treat a wide variety of clinical problems—ranging from addictions, to stroke, to PTSD.
MEDICAL APPLICATIONS OF VR

- Health & Wellness
- Medical Training
- Clinical Assessments
- Medical Interventions
Medical Training

- Clinical Skill Training
- Surgical Skill Training
- Interpersonal Skill Training
- Use of Equipment and Tools
- Team Training - eg: Emergency Department, Surgical Team
- Emergency Response Training and Rehearsal
- Empathy
Rapidly becoming the standard for training…

…and soon to be part of the standard of care.
DIAGNOSTIC ASSESSMENTS

• Medical Image Review
• Neuropsychological Assessments
• Activities of Daily Living Assessments
• Physical Medicine – OT / PT
• Behavioral Medicine – psychology, psychiatry
Digitized Neurocognitive Tool Set

This product evolves traditional paper and automated evaluations to a more sophisticated level.

It also produces a robust intervention that challenges cognitive skills.
A LONG LIST OF MEDICAL INTERVENTIONS

- Physical Therapy and Rehabilitation
- Neuro-rehabilitation - Stroke and Traumatic Brain Injury
- Speech Therapy
- Optical Rehabilitation – Strabismus, Amblyopia
- Acute and Chronic Pain
- Surgical Planning
Virtual environments are used clinically to treat several important mental and behavioral health problems:

- Drug and alcohol abuse
- Schizophrenia
- Post-traumatic stress disorder (PTSD)
- Generalized Anxiety Disorder
- Mood Disorders - Depression
- Mild Cognitive Impairment
- Autism Spectrum Disorder
- ADHD
Virtual environments are used clinically to treat several important behavioral health problems

- Phobia and anxiety disorders
- Obsessive Compulsive Disorder (OCD)
- Developmental disabilities
- Conduct disorders
- Anger management
- Eating disorders
- Impulsive disorders
- Learning disabilities
- Neuro-cognitive disorders
HEALTH AND WELLNESS

• Weight Management
• Cognitive Function Training – Sequencing, Situational Awareness, Decision Making
• Exercise

• Stress Management
• Disability Solutions
• Addressing Isolation
• Grief Counseling
• Mood and Resilience
Over 40 years of academic research and over 3000 studies demonstrate that VR can improve behaviors, attitudes, and health.

Until now, the technology was expensive, bulky, and difficult to use. Today, we have the advancements to bring VR to scale in healthcare.
Portable Telemedicine Platform
Virtual Humans For Training, Confidential Interaction, and Telemedicine Support
Some Examples
PTSD, Phobias, and Anxiety Disorders

• Exposure-based treatments can be conducted in the safety and comfort of an office setting
• Effective tools for treating a variety of clinical problems, in particular anxiety and addictive disorders
• Fully immersive environments, with include the use of a head mounted display, 3D sound, tactile stimulation via shaking platform, and olfactory stimulus are used for PTSD therapy
RISK AVOIDANCE TRAINING

Refusal skill training for those who need help with addictions
Stress Inoculation – Risk Preparation
Virtual hospital tours could be used to relieve pre-procedure anxiety
Build Empathy for Underserved Populations
VR can be used to help train doctors and staff to better understand the patient perspective.
How does it work?
VR can promote behavior change by taking advantage of the way our brain’s learning and reward systems function.

VR systems can:

- Activate neuroplastic change via reward systems
- Shorten the feedback loop – show progress
- Leverage mirror neuron systems
The Neuroscience of How VR Promotes Behavior Change

- It is necessary to activate the associated brain system to enable neuro-plasticity
- Repetition is required
- It is critical to engage the brain's reward systems

- **Attention** drives Cholinergic system
- **Novelty** drives Noradrenergic/Serotonergic system
- **Reward** drives Dopaminergic system
Leveraging Mirror Neurons

Ability to change attitudes and behavior after “being” one’s future self.
Your Future Self

- Students interacted with 3-D avatars of future self.
- Asked to allocate $1K between present expenses, a fun splurge, checking account, & retirement account.
- Participants who interacted with future self put more than twice as much money into retirement account.
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