Virtual Reality & Augmented Reality Systems

The Impact on Clinical Care

Walter Greenleaf PhD
Medical VR/AR Systems – Overall Status and Opportunity

Current technologies and concepts are founded on more than 30 years of research and development.

Recent changes in cost and access make clinical VR systems affordable.

After years of study and use by early adopters – validated systems are moving out into mainstream healthcare.

On the horizon - enhanced, ubiquitous, informative and integrated.
Extended Reality Immersive Systems

+ AR + MR = XR
VR/AR systems are currently used for:

- Functional Training
- Objective Assessments
- Improved Interventions
- Facilitated Adherence
- Distributed Care Delivery
- Prevention and Wellness
Digital Health Revolution

- Mobile Health / eHealth
- Machine Learning
- Wearable Sensors
- Patient Centered
- Leverages Internet:
  social, quantitative, collaborative
Digital Health Platforms deliver interventions to patients, and parse data for enhanced analysis.
Virtual Reality & Augmented Reality Technology

Immersive Systems
Other Dimensions of Sensory Input - Enhanced Immersion

Scentware

- 9 scent actuators with interchangeable cartridges
- Library of over 250 scents
- Custom scent creation

Aaron Wisniewski
Virtual Humans For Education, Training, Support

“Smart Avatar” with a virtual voice, image and mannerisms via AI
5G connections will surpass one billion by 2023

Single-digit millisecond latencies with Edge Computing
Cloud-Rendered AR and VR content
Real-time Analytics for Machine Learning, Predictive Modeling
Virtual Worlds – Multiuser Immersive Experiences

Cloud-based 3D real time rendering
VR Technology Has Evolved

1987

First general purpose and commercially available VR systems.
Academic research has indicated that Virtual Reality can effectively treat a wide variety of clinical problems – ranging from addictions, to stroke, to PTSD.
More Than 327 Clinical Application Areas

Targeting Multiple Clinical Sectors and Specific Indications

- Acute Pain
- Addiction Medicine
- ADHD
- Anxiety Management
- Autism Spectrum Disorder
- Chronic Pain

- Cognitive Assessments
- Depression
- Disability Solutions
- Emergency Medicine
- Medical Education & Training
- Ophthalmology

- Orthopedics
- Palliative Care
- Patient Education
- Phobias PTSD
- Physical Medicine and Rehabilitation
- Preventive Medicine

- Respiratory Medicine
- Senior Care
- Stroke & TBI
- Surgical Procedure Planning
- Surgical Skill Training
- Uncomfortable Procedure Distraction
Clinical VR/AR Systems Have Impact

Learning & Retention

Presence & Context

Muscle Memory

Motivation/Engagement

Increased Cognitive Engagement

Improved Clinical Adherence
High Dropout Rates for Mental Health Apps

More than 1/2 of the participants in mental health app studies drop out in week #1

Lack of engagement is the primary reason

*High dropout rates present a threat to the validity of RCTs of Mental Health Apps*

*Dropout rates in clinical trials of smartphone apps for depressive symptoms: A systematic review and meta analysis*

December 2019

*Journal of Affective Disorders* 263
Current Examples of XR Systems Applied to Clinical Care

Functional Training
Objective Assessments
Improved Interventions
Facilitated Adherence
Distributed Care Delivery
Prevention and Wellness
Medical Education and Training

Clinical Skill Training
Surgical Skill Training
Interpersonal Skill Training
Use of Equipment and Tools
Team Training:
   Emergency Department
   Surgical Team
Hospital-Wide Emergency Response Training and Rehearsal
VR simulation to train medical students and staff to respond in high-stakes, low-frequency pediatric emergencies.

Pediatric Resuscitation
Virtual Standardized Patient Simulators

Standardized patient simulators offer medical educators a powerful way to enhance both technical and interpersonal skills.

- Increasing the effectiveness of therapy skills of psychologists
- Enabling prospective nurses to master giving an effective patient history and coaching interview
- Allowing pediatric healthcare providers to train in scenarios involving a parent and an elementary-age child
- Enhancing the debriefing skills of a surgical team
Preparation and Training for Difficult Situations

Improving the communication skills of a doctor delivering a negative diagnosis
VR/AR Technology Provides for Objective Assessments

Functional Training

Objective Assessments

Improved Interventions

Facilitated Adherence

Distributed Care Delivery

Prevention and Wellness
Improved Assessments

Activities of Daily Living Assessments

Physical Medicine – OT / PT
OBJECTIVE ASSESSMENTS

Cognitive Function

Neuropsychological Assessments

Behavioral Medicine
Psychology, Psychiatry
Uncovering the signals that index cognitive load

1. Headset captures data via sensors
   - Eye tracking
   - Pupilometry
   - Heart rate
   - Face cam

2. HP Omnicient software transforms data

   Machine Learning
   - Cognitive load
     Determining how much "brain power" a user is exerting on the task at hand
   - Other exciting features coming in the future

3. Adaptive XR experiences
   - Training
   - Wellbeing
   - Creation
   - Collaboration

*VR application compatibility required
XR Technology Provides for Improved Clinical Interventions

Functional Training
Objective Assessments
**Improved Interventions**
Facilitated Adherence
Distributed Care Delivery
Prevention and Wellness
New Approaches to Physical Medicine & Rehabilitation

Stroke and Traumatic Brain Injury
Physical / Occupational Therapy
Neuro Cognitive Rehabilitation

Penumbra
Virtuleap
REAL
NEURO REHAB VR
MIERON
Urgent Need for New Approaches to Mental Healthcare
Virtual environments are used clinically to treat mental and behavioral health problems:

- Generalized Anxiety Disorder
- Phobias
- Addictions
- Social Anxiety Disorder
- Depression
- Chronic Pain
- Autism Spectrum Disorder
- ADHD
- Obsessive Compulsive Disorder
- Anger Management
- Schizophrenia
Interactive virtual environments significantly reduce pain from as much as 44% during the most painful procedures (ex: burn wound treatment)

Diverts patient attention away from perceiving and feeling pain; (selective attention theory)

Decreases pain-related brain-activity

Reduces need for anesthesia, opioid medication

No pharmacological side effects
PTSD, Phobias, 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.
XR Systems to Support Therapy For Addictions

Refusal skill training
Risk avoidance training
Situational confidence training
HEALTH AND WELLNESS

- Promote Exercise & Weight Management
- Stress Management
- Mood and Resilience
- Disability Solutions
- Addressing Isolation
- Grief Counseling
In Summary
Medical VR/AR Systems – Overall Status and Opportunity

Current technologies and concepts are founded on more than 30 years of research and development.

Recent changes in cost and access make dynamic assessment and intervention systems affordable.

After years of study and use by early adopters – validated systems are poised to move to the mainstream.

On the horizon - enhanced, ubiquitous, informative and integrated.
thank you