Disclosure: Conflict of Interest

- Employee of Samsung Electronics America
- Some solutions involve use of Samsung Products
Agenda

• Therapeutic XR
• Clinical Validation
• Virtual Care Programs
Extended Reality (XR)
AR/ MR in Healthcare

- Pre-Surgery Training/ Education
- Procedure Guidance/Assist
- Real-time Information (Medications)
How to insert an image

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Virtual Reality in Healthcare (Traditional Use Cases)

- Entertainment
- Training
- Education
- Tours
- Distraction Therapy
Virtual Reality

Pain reduced by 52%

Anxiety reduced by 60%

Ref: Cedars-Sinai Medical Center. Applied VR
Improving Health Outcomes Through Greater Patient Engagement
Virtual Reality Impact on Pain

These images from an fMRI scan show areas of the brain affected by pain, and how they shrink when the patient is immersed in a virtual reality world. (Dr. Sam Sharar/University of Washington)
THE LOW VISION PROBLEM

Millions of people around the world live with the challenge of Low Vision.

They struggle with:

- Living Independently
- Seeing loved ones
- Accessing Information (Reading, TV)
- Working a normal job
- Participating in mainstream education
- Using Smartphone or Computer

Opportunity Size

<table>
<thead>
<tr>
<th>Low Vision Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
</tr>
<tr>
<td>5 Million+</td>
</tr>
<tr>
<td>Europe, Canada, Australia,</td>
</tr>
<tr>
<td>20 Million+</td>
</tr>
<tr>
<td>Global</td>
</tr>
<tr>
<td>200 Million+</td>
</tr>
</tbody>
</table>

There are around 500K new cases of Low Vision in US
VR for Blindness

VR improves vision for macular degeneration, RP, glaucoma and other conditions.
Macular Degeneration

PRL: Preferred Retinal Locus
(1) Magnify, (2) Contrast, (3) Adjust for Photophobia
## Results from Johns Hopkins Study

### Results – Minimal Clinically Important Difference (MCID)

<table>
<thead>
<tr>
<th>Domain</th>
<th>MCID frequency % of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals</td>
<td>69.0%</td>
</tr>
<tr>
<td>Visual Info</td>
<td>86.2%</td>
</tr>
<tr>
<td>Reading</td>
<td>85.7%</td>
</tr>
<tr>
<td>Outside Home</td>
<td>78.6%</td>
</tr>
<tr>
<td>Inside Home</td>
<td>72.4%</td>
</tr>
<tr>
<td>Mobility</td>
<td>45.5%</td>
</tr>
<tr>
<td>Visual Motor</td>
<td>44.0%</td>
</tr>
</tbody>
</table>
Retinitis Pigmentosa

Normal Scene

Viewed by RP patient  Corrected by “Minification”
Virtual reality helps eight paralysed people feel their legs

Spinal Cord Injury: 8 chronic (3–13 yrs) paraplegics

- Long-term training (12 months) with a multi-stage BMI based gait neurorehabilitation:
  - Intense immersive virtual reality training
  - Enriched visual-tactile feedback
  - Walking with two EEG controlled robotic actuators (with exoskeleton)

Results:
- All eight patients had improved somatic sensation & voluntary motor control
- Four (50%) were upgraded to incomplete paraplegia classification.
Spinal Cord Injury – New Rehab Tools

Recovery of Over-Ground Walking after Chronic Motor Complete Spinal Cord Injury

Claudia A. Angeli, Ph.D., Maxwell Boakye, M.D., Rebekah A. Morton, B.S., Justin Vogt, B.S., Kristin Benton, B.S., Yangshen Chen, Ph.D., Christie K. Ferreira, B.S., and Susan J. Harkema, Ph.D.

- Epidural Stimulation
- Exoskeleton
- VR
- Wearables (biometrics)
VR for Concussion Management

Eyes following circular target

Eyes relative to target

Concussion Sample

Normal

Abnormal

During Recovery

SD radial error = 0.36285
SD tangential error = 0.44856
Average phase = 2.5275

SD radial error = 1.2442
SD tangential error = 3.1175
Average phase = 12.0196

SD radial error = 0.686
SD tangential error = 1.4457
Average phase = 3.0556
VR for Concussion Management

- 0s: Select Assessment
- 30s: Test/Train Individual
- 60s: Automated Analysis

Smooth Pursuit
Key to fast recovery from concussion

1. Cardio exercise
   20min 130bpm 4days/week

2. Sleep (REM)

3. Patient education
   Not a brain injury
   Full recovery expectation

4. Visual orientation training
VR for Seniors

Clinical Use Cases

- Memory Care
- Prevent Agitation
- Prevent Sundowning
Digital Pain Kit

powered by Samsung, Bayer and appliedVR

Bio-Sensor for Breath Capture

Samsung Galaxy

Samsung Gear VR

Aleve Tens

Samsung Gear Fit2 Pro
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Opiate Prescribing (In-Hospital)
- Patient Education
- Pathway/Protocol via EH R
- Virtualist
- DC instructions

Pain Management (Program)
- Mindfulness techniques
- Identify triggers
- Structured Program: Counsel or, buddy, support network
- Addiction support
Virtual Support for Addiction

- 31% less relapses
- 50% reduced severity of relapse
- 71% reduced readmissions
- 20% more likely to complete treatment

Ref: Chess Health
Virtual Care

Cardiac rehab with wearable

- 6-8 week program
- Patient prompted on their smart watch to exercise for up to **30 minutes**
- There is a cool-down period after which patient symptoms are assessed.
Link-HF Study
• N= 100 Vets
• 3 months
• Patch: HR, RR, HRV, Acceleration, Temp
• Alert 11 days before admission
• ROC AUC 0.88
Loneliness

Associations between sensory loss and social networks, participation, support, and loneliness

Analysis of the Canadian Longitudinal Study on Aging

Paul Mick MD MPH  Maksim Parfonov MD  Walter Wittich PhD
Natalie Phillips PhD  M. Kathleen Pichora-Fuller MSc PhD

Table 6. Adjusted odds ratios of loneliness among participants with sensory loss compared with participants without sensory loss: Loneliness was defined as reporting feeling lonely “some of the time,” “occasionally,” or “all of the time” (vs “rarely or never”).

<table>
<thead>
<tr>
<th>SENSORY LOSS</th>
<th>ODDS RATIO (95% CI)</th>
<th>P VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hearing</td>
<td>1.17 (1.04 to 1.32)</td>
<td>.009</td>
</tr>
<tr>
<td>Vision</td>
<td>1.24 (1.09 to 1.42)</td>
<td>.001</td>
</tr>
<tr>
<td>Dual</td>
<td>1.29 (1.02 to 1.64)</td>
<td>.035</td>
</tr>
</tbody>
</table>
Inter-Generational Programs with VR

VR to Facilitate Interpersonal Relationships

- Social Isolation
- Sense of Purpose
Summary

• Therapeutic XR – exciting new use cases
• Clinical Validation
• Virtual Care Programs