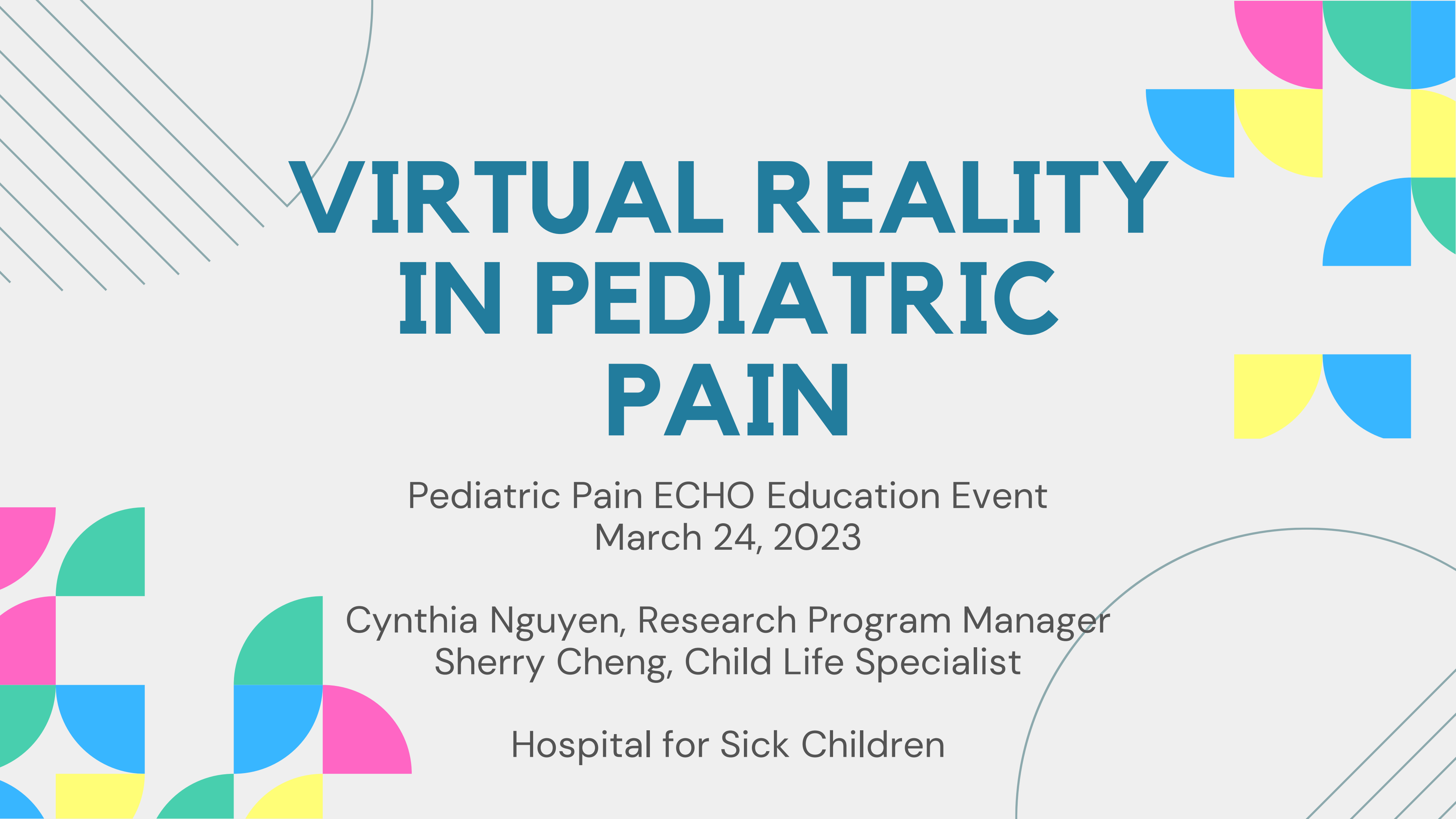




VIRTUAL REALITY IN PEDIATRIC PAIN

Pediatric Pain ECHO Education Event
March 24, 2023

Cynthia Nguyen, Research Program Manager
Sherry Cheng, Child Life Specialist

Hospital for Sick Children

PRESENTER DISCLOSURE

CYNTHIA NGUYEN

Relationship with commercial interests:
None

SHERRY CHENG

Relationship with commercial interests:
None

ECHO PROGRAM

This program has received financial support from the Ontario Ministry of Health (MOH)

SESSION OBJECTIVES

01 - DESCRIBE

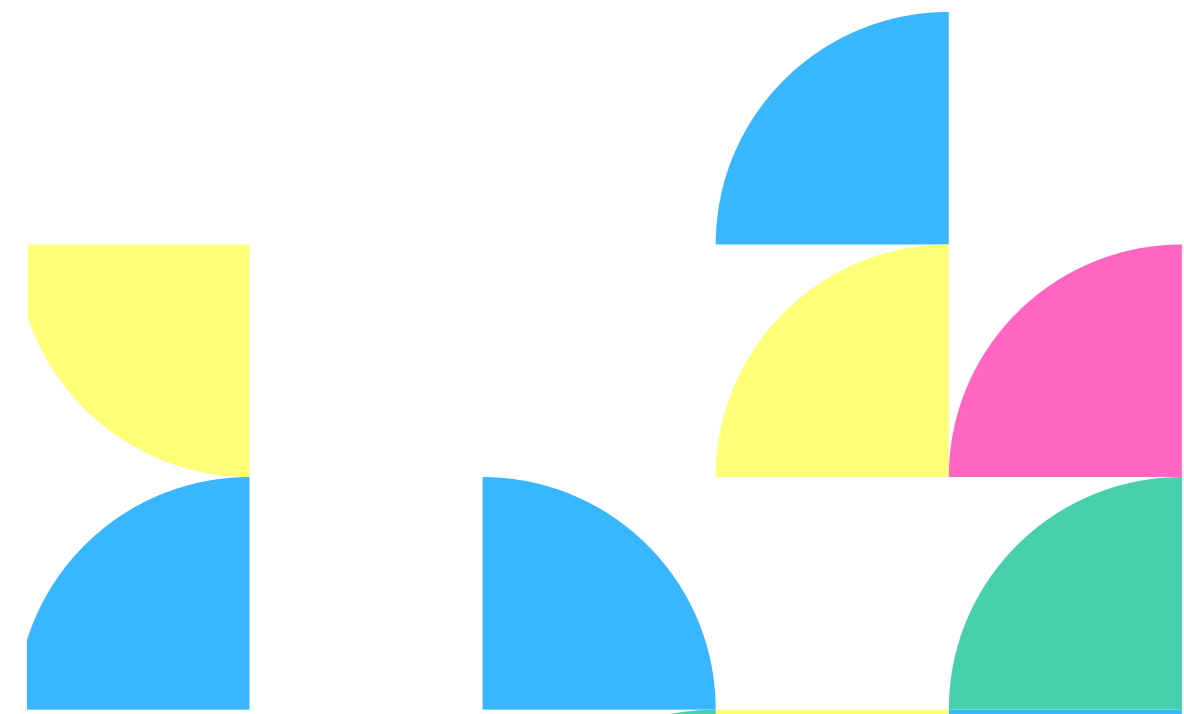
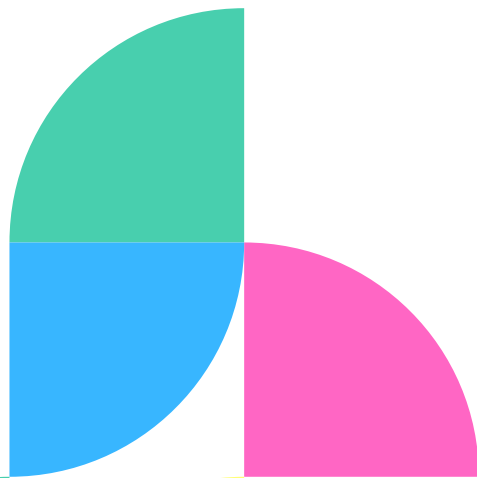
Describe virtual reality (VR) technology and its role in treating pain.

02 - ILLUSTRATE

Illustrate the application of VR in acute and chronic pediatric pain through case studies.

03 - OVERVIEW

Present an overview of available evidence for VR in pediatric pain





VIRTUAL REALITY (VR)

“a simulated experience that is
intentionally presented to an
individual’s senses”

4 PILLARS OF VR

degree to which the user
can influence the virtual
world

INTERACTIVITY

PRESENCE

feeling as though you are
in a place when you are
physically in another
place

feeling that you have
one's own body in the
virtual world

EMBODIMENT

IMMERSION

feeling "caught up" or
"absorbed" in a virtual
world

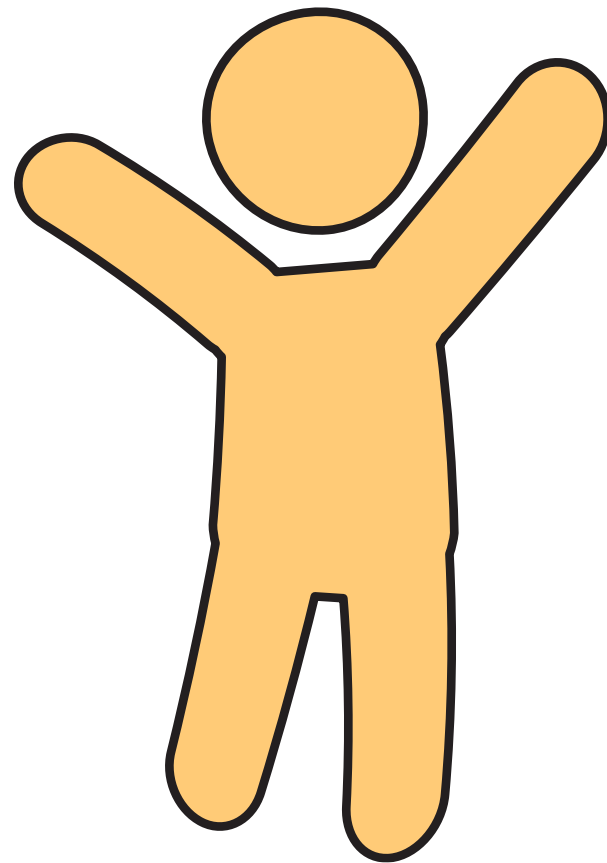
VR

CONFIGURATIONS

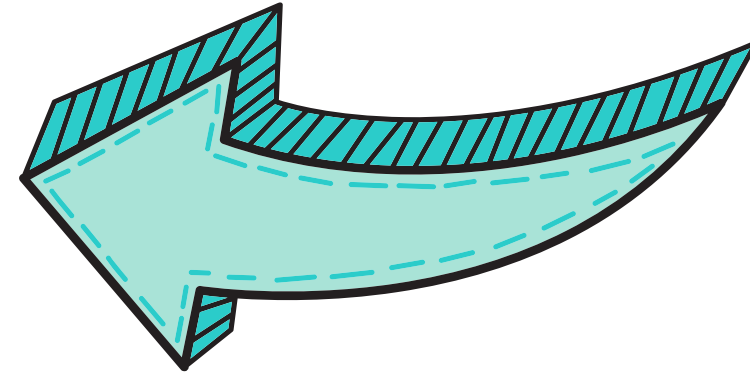
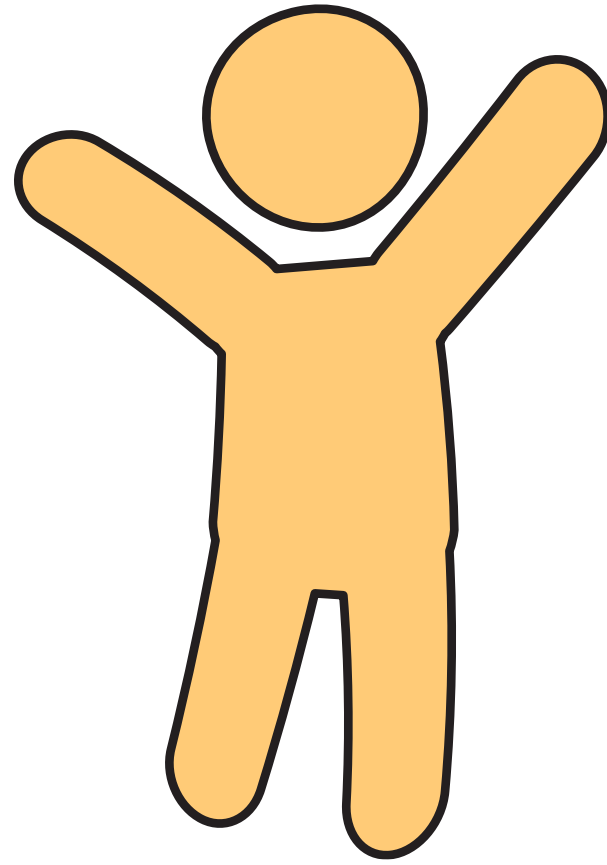
Input from

User

Head/gaze tracking
Skeletal/movement tracking
Physiology (e.g. HR tracking)
Handheld controller



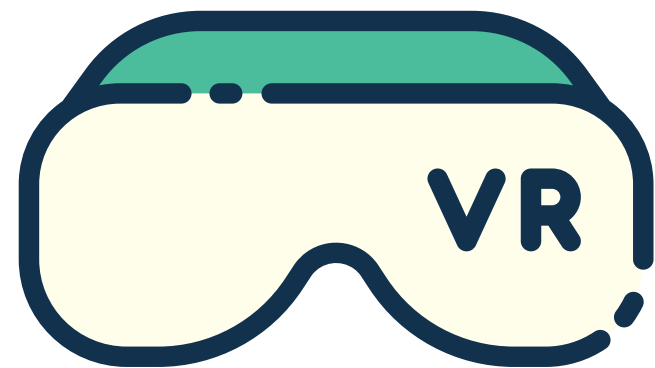
CONFIGURATIONS



Output from VR

Visual display (head mounted, flat panel)
Auditory (headphones, surround speakers)
Haptic (vibration, force feedback)

VR IS A MEDIUM TO DELIVER A TREATMENT FOR PAIN



Pain Targets

COGNITIVE

- Distraction
- CBT skills

EMOTIONAL

- Fear/Anxiety
- Depression

SOCIAL

- Empathic interactions

PHYSIOLOGICAL

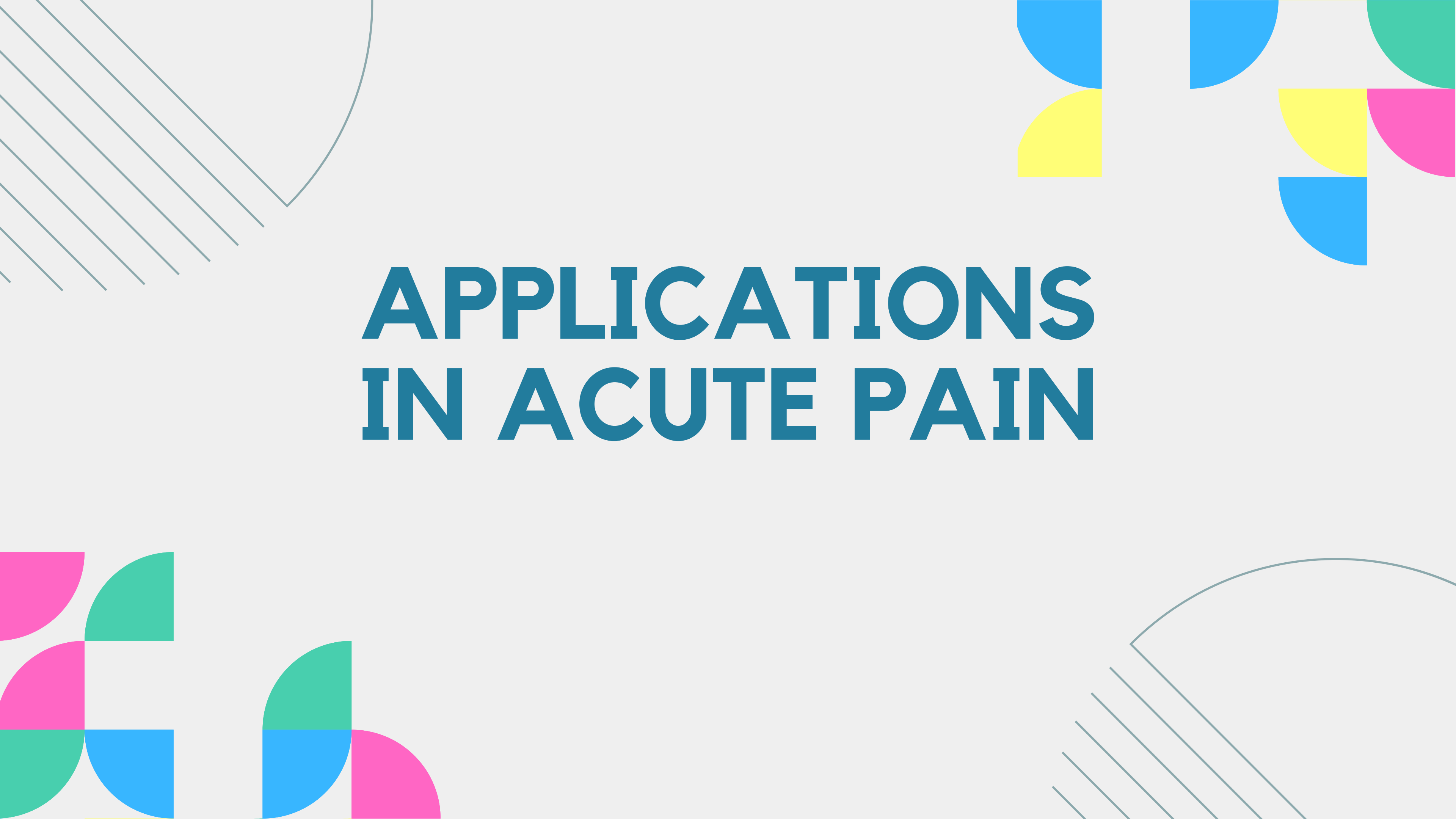
- Brain activity and plasticity

BEHAVIORAL

- Pain behavior
- Kinematic patterns



OUTCOMES

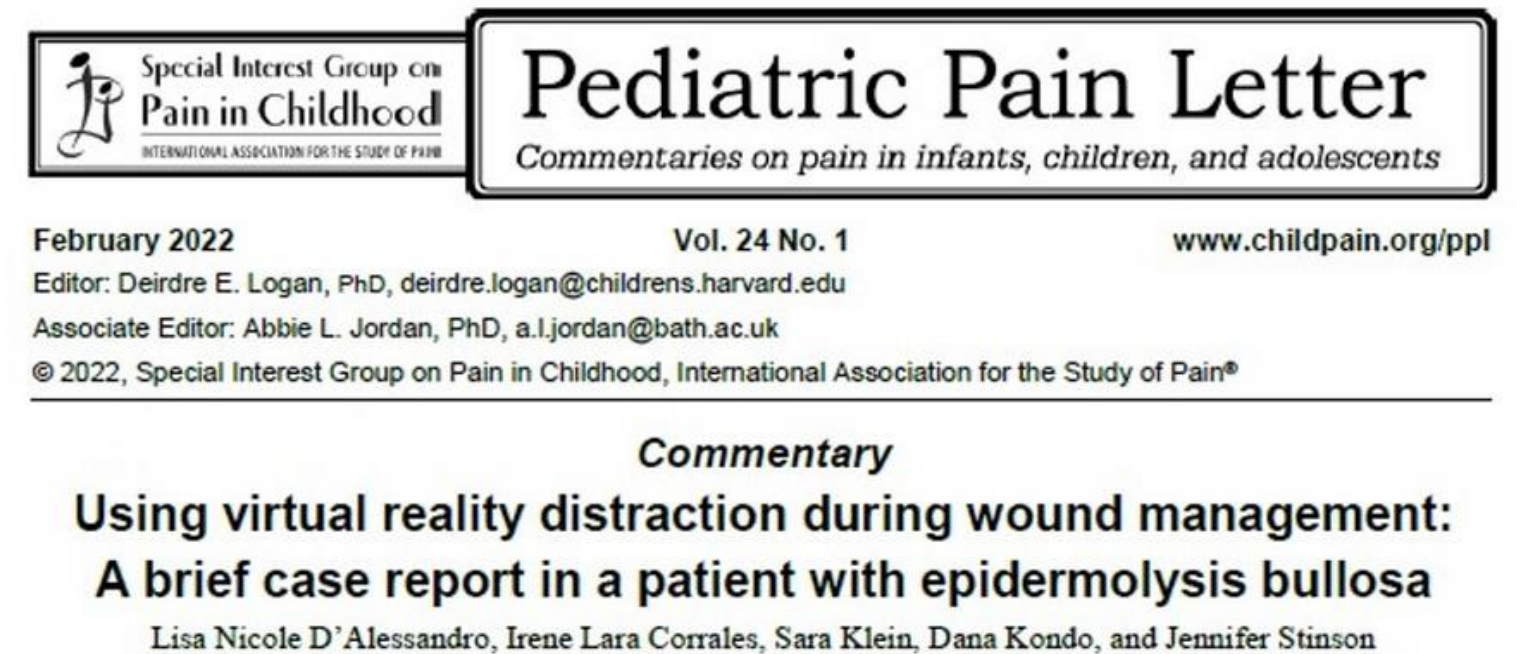


APPLICATIONS IN ACUTE PAIN

CASE STUDY: Acute Procedural Pain

8-yo male with epidermolysis bullosa

- Condition requires daily dressing changes
- Acute pain experience at time of dressing change
- Anxiety and extreme distress with dressing changes
- Reluctance to comply to treatment and affecting ADLs (i.e. bathing)



CASE STUDY: Acute Procedural Pain



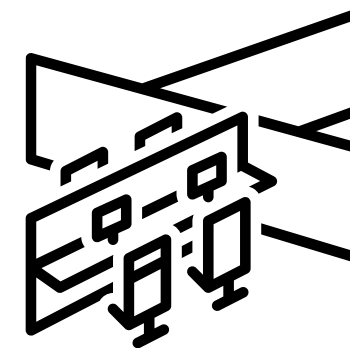
VR PROGRAM IN CHILD LIFE THERAPY



1-year program review



325 patient users



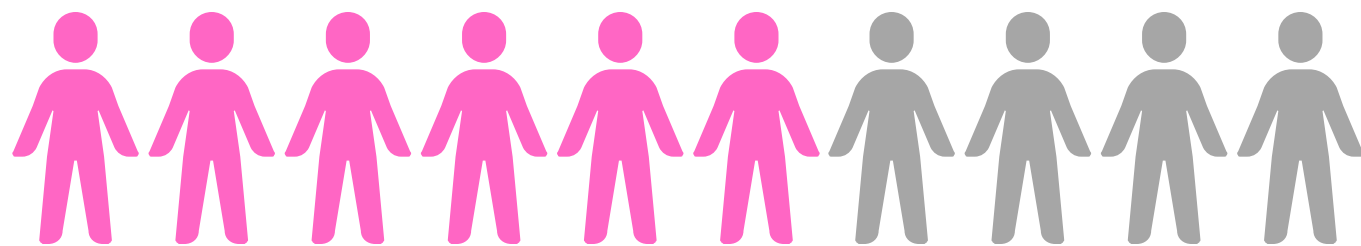
16 departments

RESULTS

97% enjoyed VR

97% would recommend to another patient

69% felt it reduced their pain/anxiety



"Takes away from pain because you concentrate elsewhere, because it's completely out of sight... great distraction"
-12yoM



"It's pretty cool, it's like if I'm hurt it helps me get away from it"
-10yoM

VR HARDWARE



VR SOFTWARE



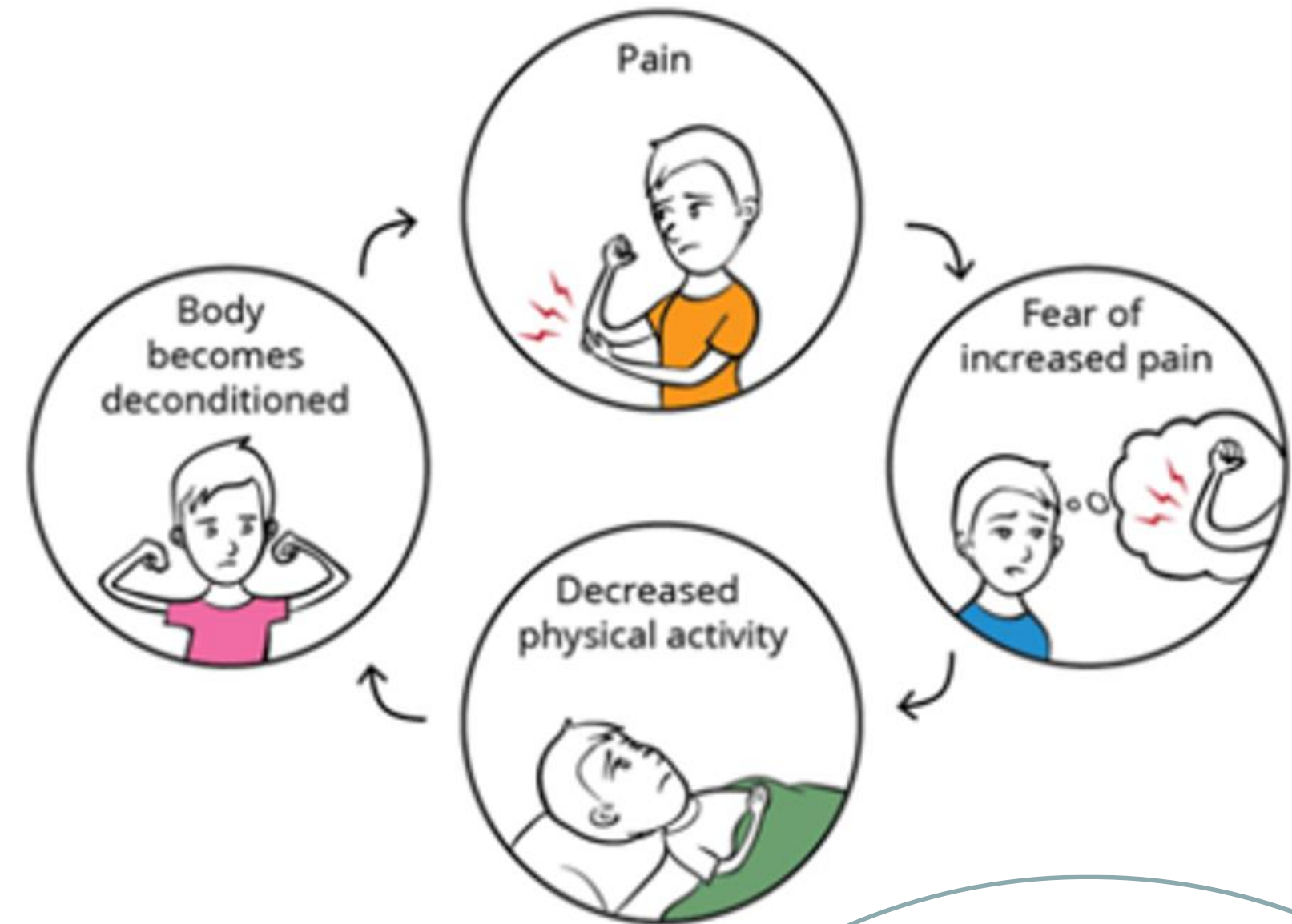
The background features decorative geometric patterns in the corners. The top-left corner has a series of parallel diagonal lines. The top-right corner contains a cluster of overlapping semi-circles in blue, yellow, green, and pink. The bottom-left corner also features overlapping semi-circles in pink, green, and blue. The bottom-right corner has a large, faint semi-circle outline with several parallel diagonal lines inside it.

APPLICATIONS IN CHRONIC PAIN

CASE STUDY: Chronic Pain

9-yo female in skiing accident

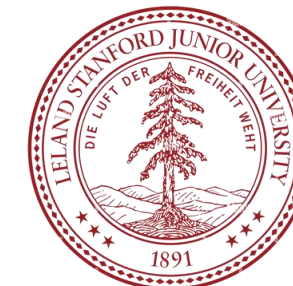
- Skiing accident 9 mo ago and sustained a tib/fib fracture
- Fracture healed, but pain persisted beyond the usual time frame
- Used crutches to mobilize
- Fear of pain and fear of movement



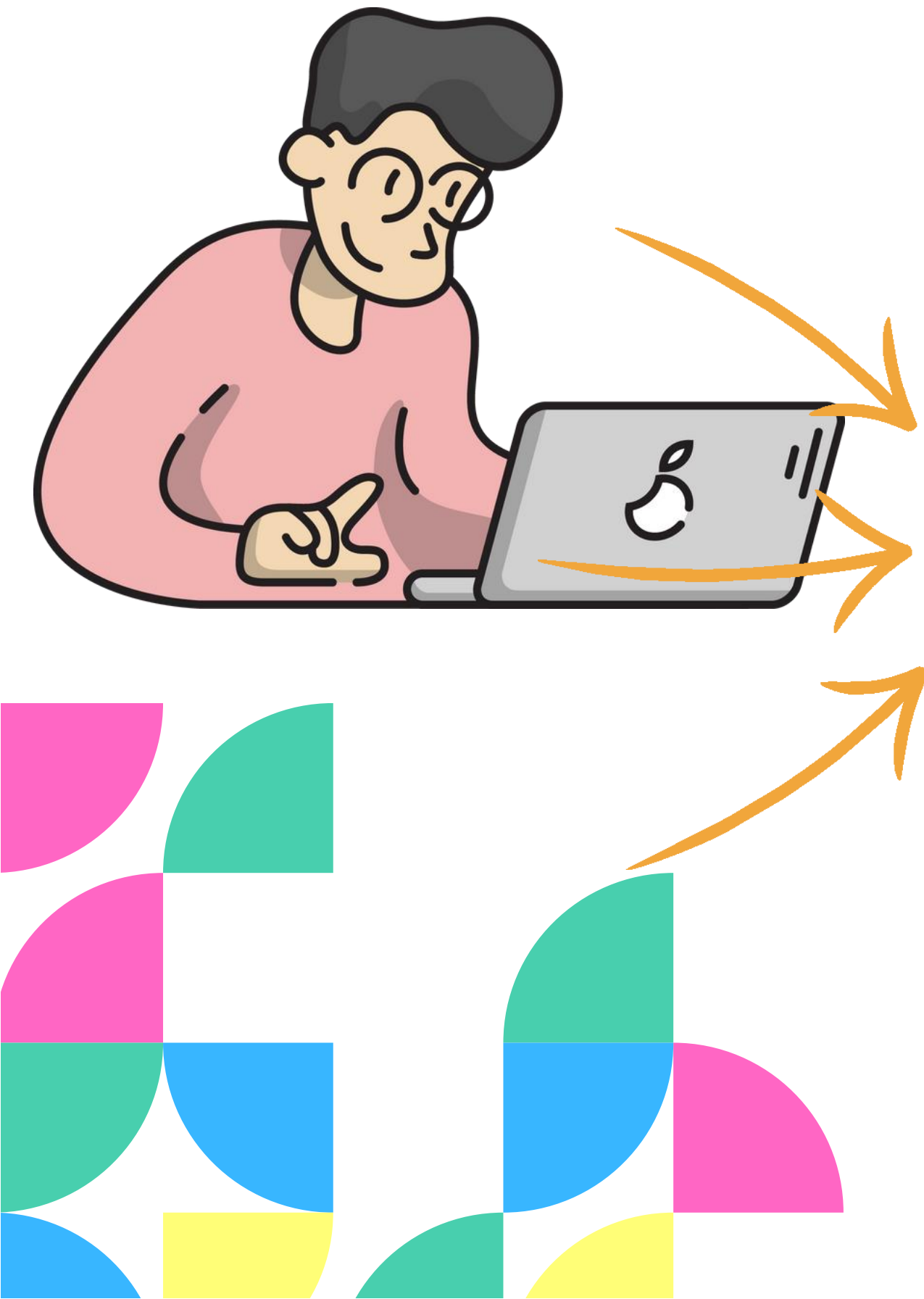
CASE STUDY: Chronic Pain



FRUITY FEET GAME (PATIENT VIEW)



FRUITY FEET GAME (PT VIEW)





Fruity Feet

Stomp, kick, punch, and chomp as much fruit as you can. It's time to make some tasty juice!

App Variant: Regular Hungry Mode

Intensity: Relaxed Normal Intense

Left/Right Focus: ☒ Left  Right

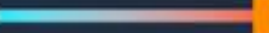
Advanced Settings ▾

Fruit Size: Small  Large

Extremity Focus: Feet Only  Arms Only

Foot Mirroring: None Mirror Left Mirror Right

Hand Mirroring: None Mirror Left Mirror Right

Foot Exaggeration: 1 0.25x  2x

Hand Exaggeration: 1 0.25x  2x

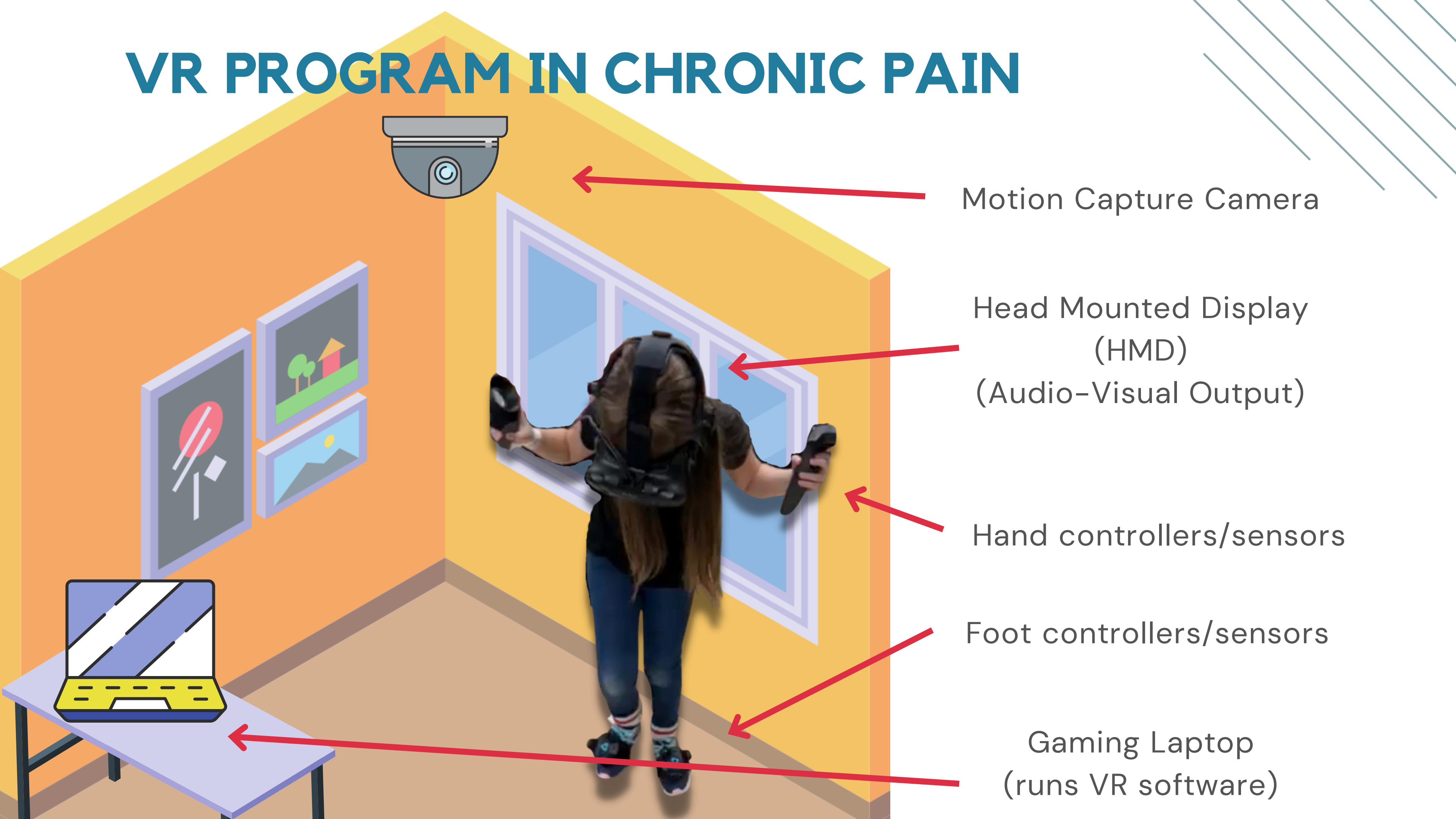
VR PROGRAM IN CHRONIC PAIN

In-hospital Pain Rehabilitation Virtual Reality (PR-VR)



- Implementation Winter 2020
- Dedicated VR room in Rehabilitation Dept.
- Fixed hardware set-up
- Fruity Feet software
- Outpatients with chronic pain attending in-person physiotherapy treatment
- Evaluation through Quality Improvement

VR PROGRAM IN CHRONIC PAIN



Motion Capture Camera

Head Mounted Display
(HMD)
(Audio-Visual Output)

Hand controllers/sensors

Foot controllers/sensors

Gaming Laptop
(runs VR software)

IN-HOSPITAL VR QUALITY IMPROVEMENT



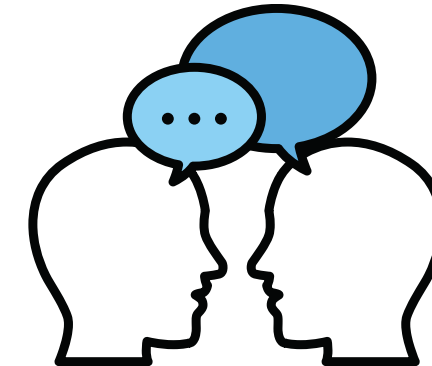
Patient Survey

- Pain Intensity
- Safety
- Immersion
- Satisfaction



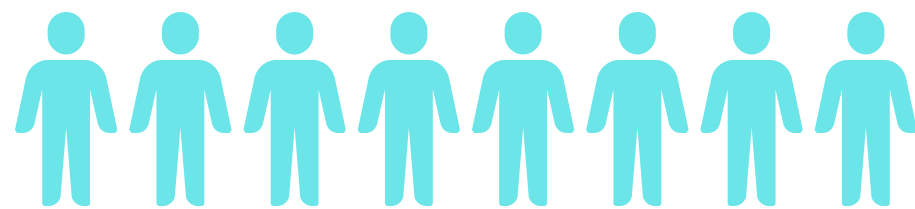
Physio Survey

- Satisfaction
- Feasibility
- Safety

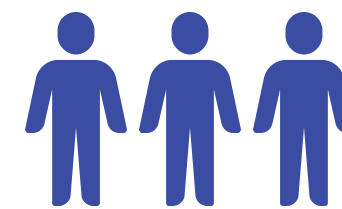


Patient Interviews

- Satisfaction



8 patients



3 Physiotherapists

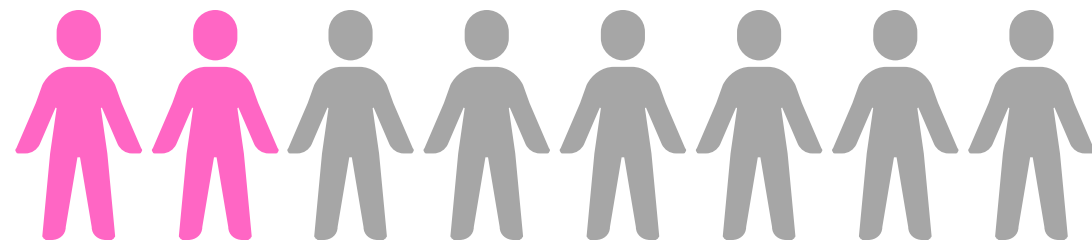


15 VR sessions

IN-HOSPITAL VR QUALITY IMPROVEMENT

- 88% PT responses rated the negative impact on clinical workflow as **'not at all'** (n=8)
- 75% of patients 'very much' **want to use VR** again

Number of participants with mild motion sickness



"...hands felt like my hands" and "the weirdest thing about VR is that you **lose track of where you are.**"



"exercise can be a negative thing for a lot of kids with chronic pain...but having this **incentive in a game that's immersive...I got very immersed** in it because I wanted to do my best and smash all of the fruit."

VR PROGRAM IN CHRONIC PAIN

At-Home Pain Rehabilitation Virtual Reality (PR-VR)

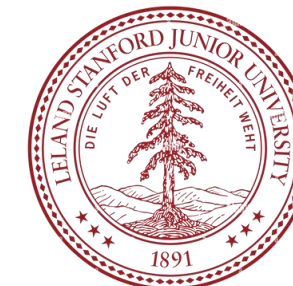


- In response to COVID-19 pandemic with shift to virtual care physiotherapy
- Re-development of software to be compatible with portable hardware
- Outpatients with chronic pain attending virtual physiotherapy treatment
- Evaluation through a Research study

Johnson & Johnson



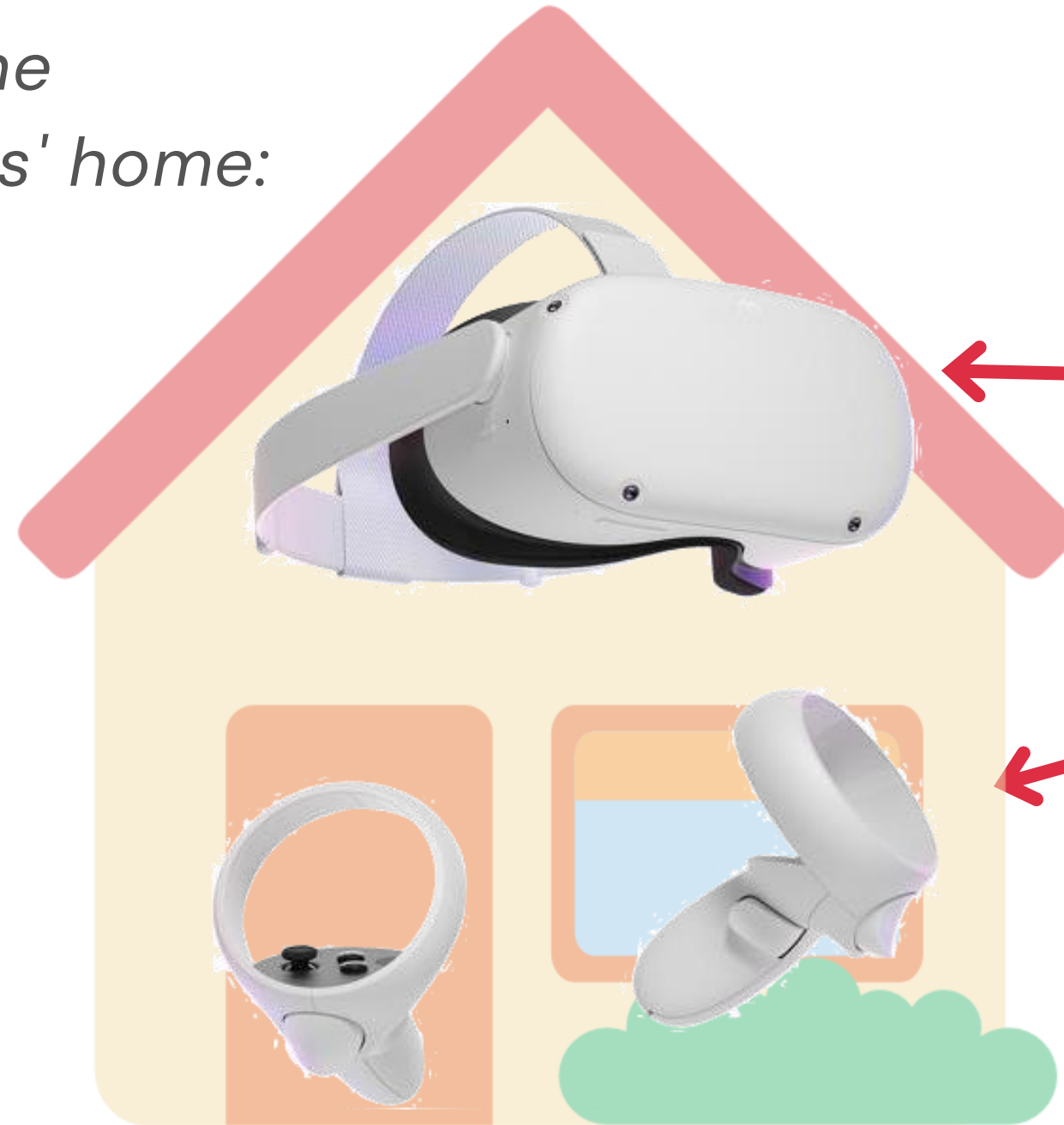
PSI
FOUNDATION



invincikids

VR PROGRAM IN CHRONIC PAIN

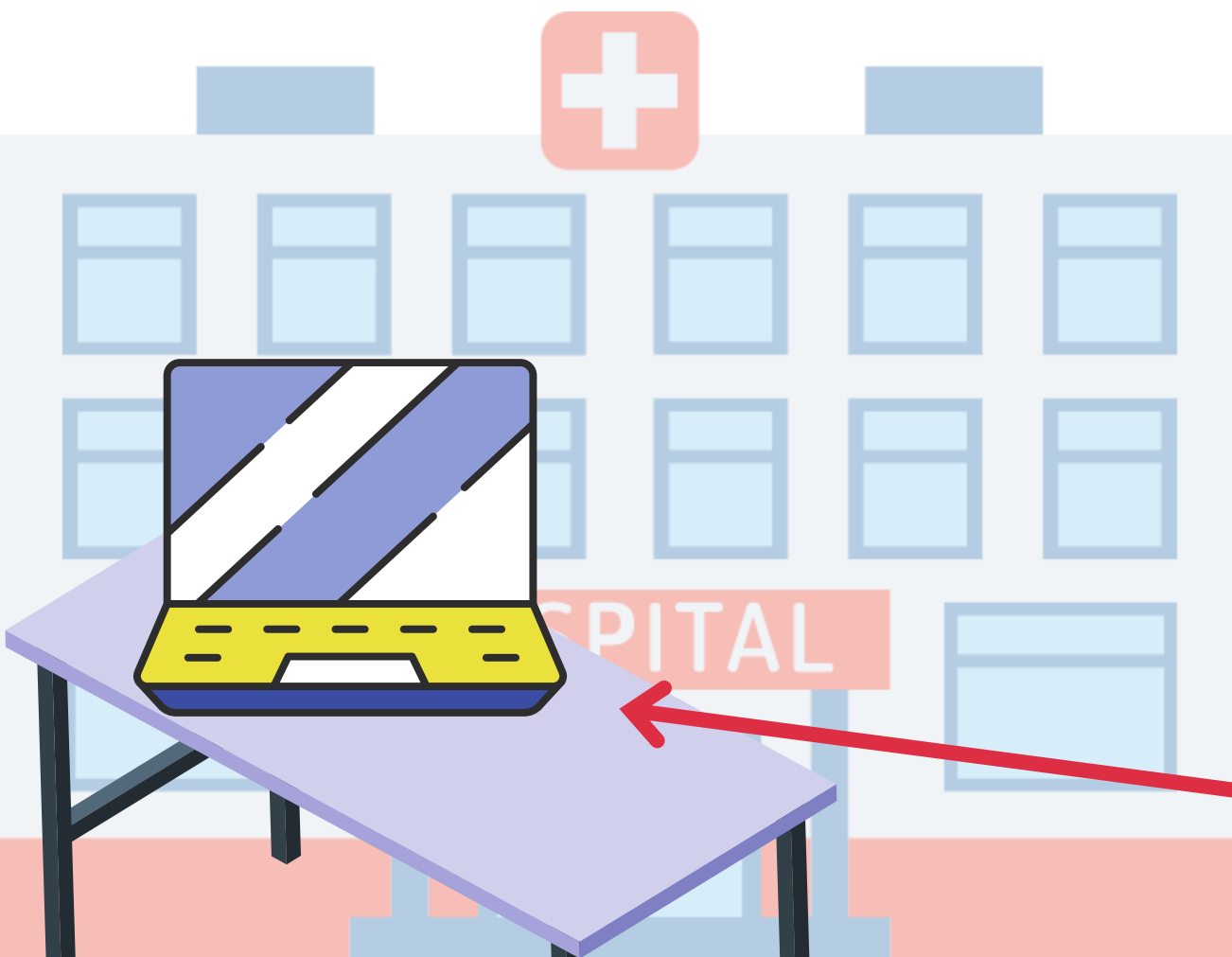
*At the
participants' home:*



All-in-one Head
Mounted Display
(audio-visual output +
software)

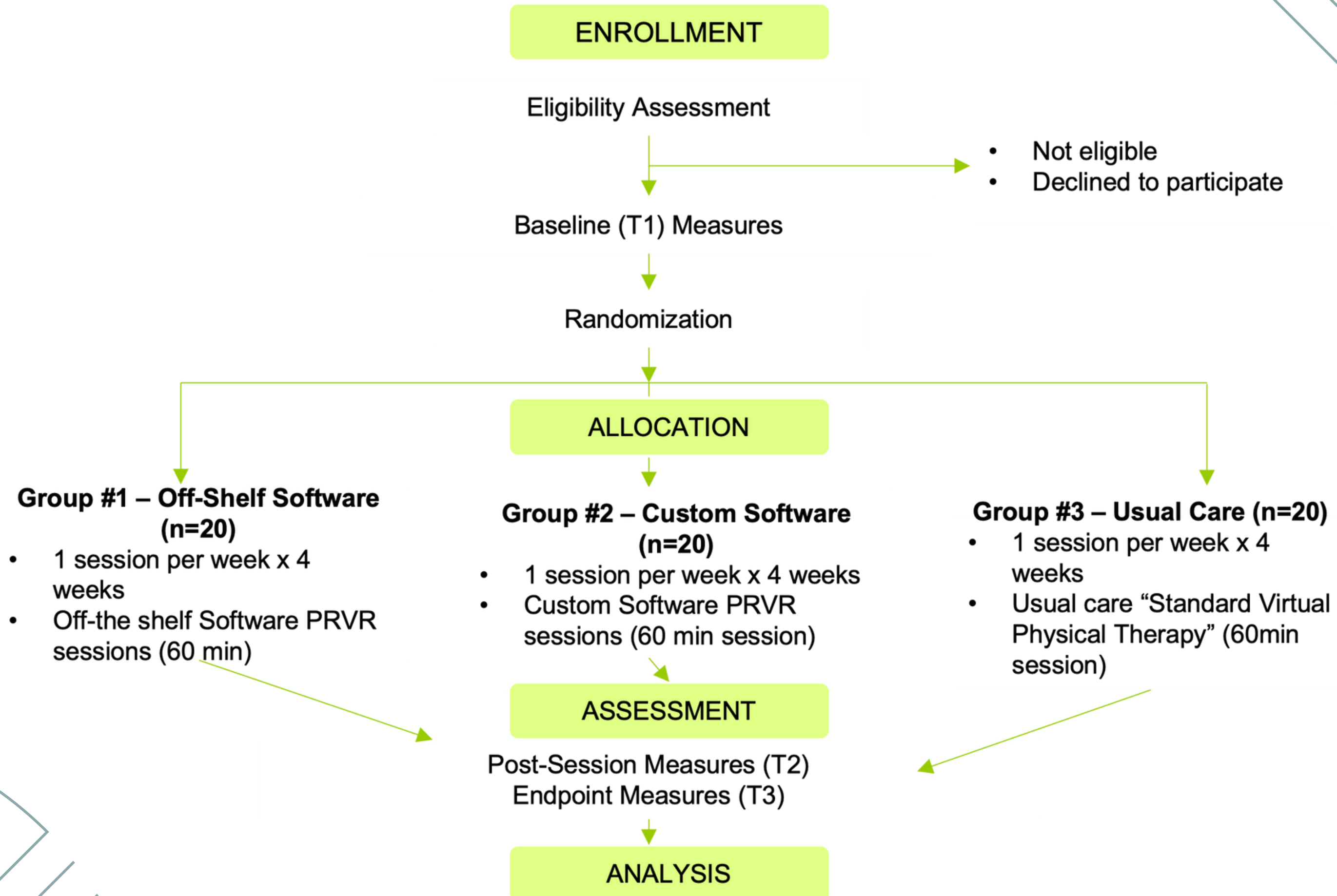
Hand Controllers

At the hospital:



Gaming laptop
(runs backend VR software)

PILOT RCT: AT-HOME PRVR



WHAT ABOUT THE EVIDENCE?



**Cochrane
Library**

Trusted evidence.
Informed decisions.
Better health.

Cochrane Database of Systematic Reviews

[Intervention Review]

Virtual reality distraction for acute pain in children

Veronica Lambert¹, Patrick Boylan², Lorraine Boran², Paula Hicks³, Richard Kirubakaran⁴, Declan Devane⁵, Anne Matthews¹

17

**RANDOMIZED
CONTROLLED TRIALS**

>1000

PARTICIPANTS

Age 4 – 18 years

**LOW
LEVEL**

EVIDENCE

Due to study diversity and high risk of bias

**HIGH
LEVEL**

EVIDENCE

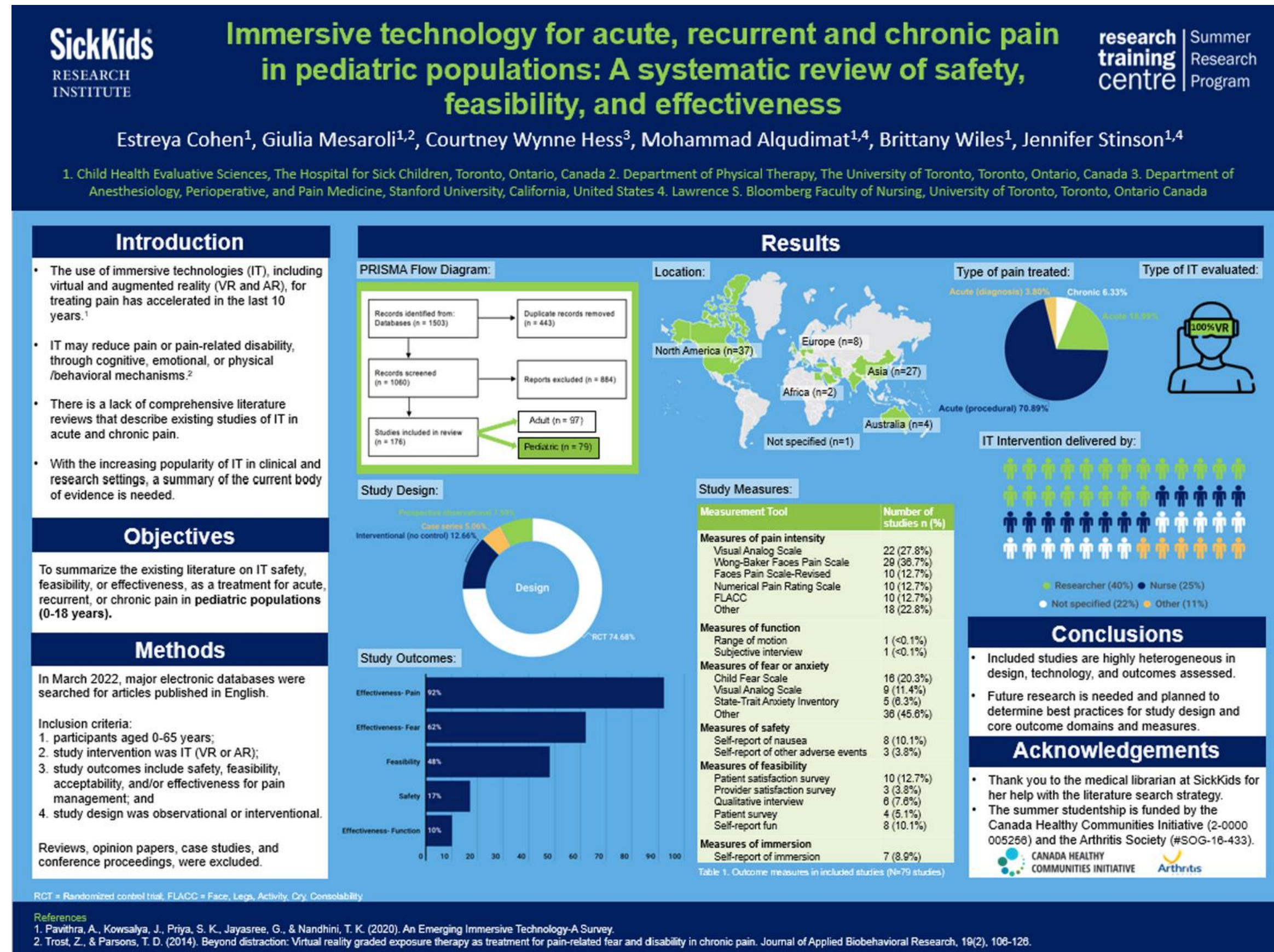
- Control intervention (no distraction, other distraction)
- Pain measured during vs post procedure
- Different types of acute pain (blood draw, dressing changes)
- Diverse pain measures (observational, self-report, parent report)

WHAT ABOUT THE EVIDENCE?

SYSTEMATIC REVIEW

PI: Dr. Stinson

Objective: to summarize the existing literature on Immersive Technology (VR and AR) safety, feasibility, or effectiveness, as a treatment for acute or chronic pain in pediatric populations.



INVINCIKIDS

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Open-exchange worldwide platform

Our international collective - **Invincikids Consortium** - convenes the expertise of its founders, specialists, and medical providers, to distribute research, resources, training guides, and advice to refine and iterate our patient care delivery.



Building a global collective

Fueled by research grants and private and corporate philanthropy, the software and customized hardware developed by physicians, child life specialists, and physical therapists soon spread across the U.S. and internationally. The founding team of doctors helped to initiate clinical immersive technology programs in over 20 hospitals and counting!

With a growing community of hospitals utilizing the software and hardware suite, Invincikids was established in 2019 to accelerate worldwide adoption of clinical immersive technology experiences for pediatric patients.

www.invincikids.org

SPECIAL CONSIDERATIONS IN PEDIATRICS

Who Can Use VR?

- Age of the child (ideally > 6 years) / Size of their head
- Type of pain/painful procedure
- Movement

Contraindications

- History/Risk of seizures
- Pain type and setting
- Infection prevention and control

Side effects

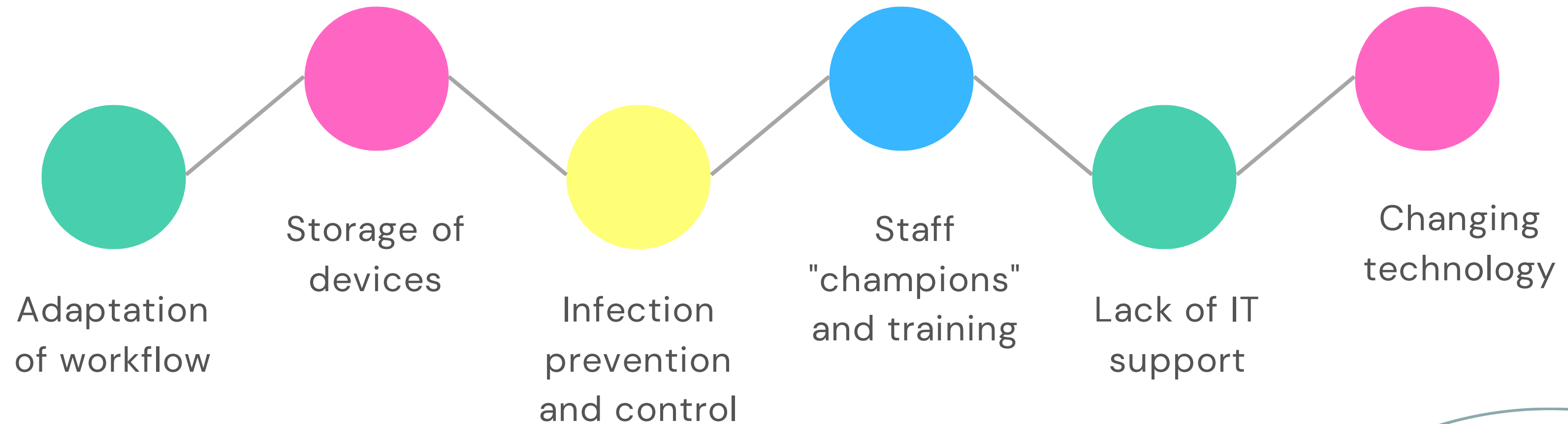
- Headaches
- Nausea
- Dizziness
- Fatigue

Relative contraindications

- Receiving sedating medications
- Developmental age
- Patient position (supine, sitting, upright)



CHALLENGES IN IMPLEMENTING VR PROGRAM



CHALLENGES IN IMPLEMENTING VR PROGRAM

Lack of IT
support

Changing
technology

Thank you ❤️

After seven years, the Within app will be sunsetting soon. We created Within to support the emerging artform of VR storytelling. We're so grateful to the creators who shared their art here, and to the millions of viewers who explored this new medium with us. You can continue watching these stories at our YouTube channel, WithinVR. Our journey continues with Supernatural, an exercise and meditation app for Meta Quest VR. -Chris Milk & Aaron Koblin, Co-Founders

OK

Go to
YouTube

Go to
Supernatural

CHALLENGES IN IMPLEMENTING VR PROGRAM

Infection
prevention
and control





THANK YOU

Any Questions?



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