Wii-Hab:
Using commercial videogames in rehabilitation after a pediatric trauma

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Virtual Reality in Rehabilitation

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Virtual reality in rehabilitation

- Area of practice that is growing and gaining popularity
- **Defined as computer based, interactive ,multisensory simulation environment that occurs in real time**
- Opportunity to engage in multidimensional, multisensory activities that are related to daily life
- Some examples include: motor learning, ADL learning, upper extremity function, mobility, balance, cognition and pain

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Virtual reality in rehabilitation

Equipment required

- **Computer** allowing for rapid computation of 3D movements

- **Display devices**

simple desktop computer with 2D graphic display

room-sized high resolution immersive environment

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Virtual reality in rehabilitation

Equipment

- **Hardware** to monitor kinematics or provide haptic simulations

  Any motion tracking device

  mouse, joystick

  electromagnetic tracking

  glove

  haptic feedback through vibration…

- **Software** to enable all components to work together

  Designed for specific uses, requires lots of programming and development

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Virtual reality in rehabilitation

Rationale for using/theoretical background

- VR as an adjunct for motor learning:
  - **Repetition**: linked to success
  - **Feedback:** can be augmented in VR, creation of new cell activity
  - **Motivation:** in order to tolerate high number of repetition necessary to achieve learning
- VR as a distraction, relaxation and relaxation modality

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Virtual reality in rehabilitation

Early findings

- Research consists mainly of small studies without large control groups, more about feasibility and pilot testing

- Some recurrent findings emerging
  1. Patients with disabilities appear capable of learning within VR environments
  2. Movements learned in VR environments appear to transfer to real world
  3. Learning appears increased in VR environments
  4. No occurrences of cybersickness in the available studies

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A few examples of VR with kids

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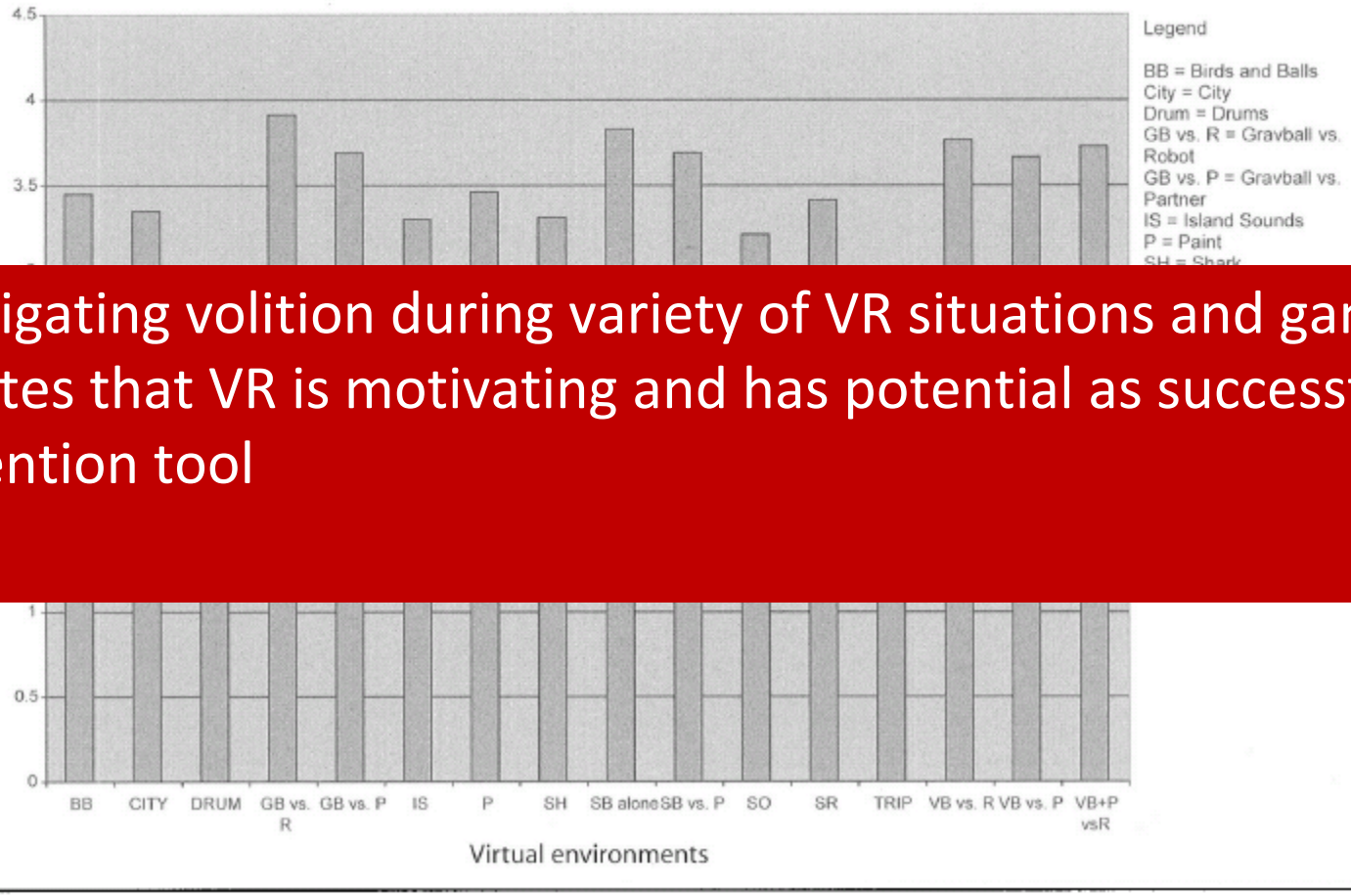
Engaging children with disability

FIGURE 3
Scores of PVQ items.



- Investigating volition during variety of VR situations and games
- Indicates that VR is motivating and has potential as successful intervention tool

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Distracting children

- Oncology and chronic pain : some of more conclusive evidence

(Review in Parsons et al., 2009)

- Found to be efficient and beneficial analgesic component to pain distraction during variety of painful procedures

- Paired with standard pharmacological analgesics, extremely effective at reducing perception of pain

- Level of immersion needs to be high

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Orthopedic trauma

Ankle instability (Girone et al., 2001)

- Rutgers System: Individuals pilot virtual airplane or speedboat and against a resistance

- Improvements found in ankle ROM, torque production, single leg stance duration, task performance

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Children with CP

Virtual reality as a therapeutic modality for children with cerebral palsy

LAURIE SNIDER, ANNETTE MAJNEMER, & VASILIKI DARSAKLIS

McGill University, School of Physical & Occupational Therapy, Montreal, Canada

Developmental Neurorehabilitation, April 2010; 13(2): 120–128

Currently, there is a paucity of well designed studies investigating the benefits of VR therapy in the rehabilitation of children with CP. Overall, the level of evidence is poor, as most of the studies are experimental and observational studies with small sample sizes. The results of this systematic review reveal that there is conflicting evidence (Level 4) that VR therapy has positive effects on body structures and functions, a moderate level of evidence (Level 1b) that VR does not positively impact on activity and participation and a moderate level of evidence (Level 1b) that VR therapy positively impacts on personal factors such as motivation, volition and interest.

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Trauma Programs and VR

- Presently used in a longitudinal study investigating the consequences of a mild traumatic brain injury on visual perception and postural control

- Psychophysics
- VEP
- Postural control

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Trauma Programs and VR

- Presently used in a longitudinal study investigating the consequences of a mild traumatic brain injury on visual perception and postural control

- CAVE system, Tunnel paradigm

Used as a means to test postural control in complex environment that is ecologically sound and also fun for kids

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VR and clinical practice

- Most of these VR systems can be costly and are not clinically available outside research centers

- For these reasons, VR using flatscreens was explored, to simplify processes

  Preliminary reports promising and similar to more sophisticated systems (Sveistrup et al., 2004)

  Functional balance, mobility, enjoyment, independence and confidence

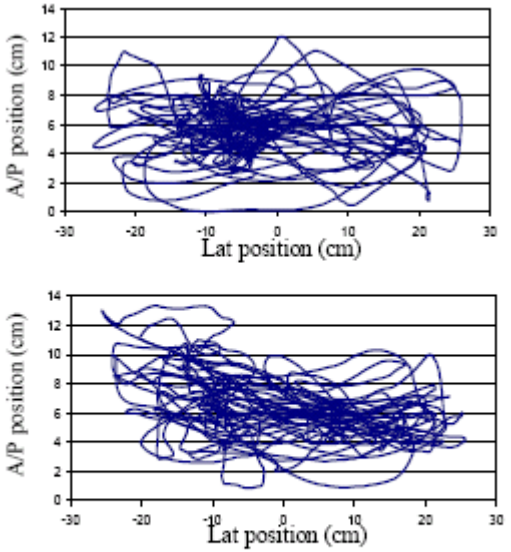

Figure 1. Center of pressure plots for the first (top) and twelfth (bottom) minute of a 25-minute session with a snowboard application (adapted from [1]).

Then came the Nintendo Wii…

And other alternatives

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The Nintendo Wii

- **Commercially available in 2006 by Nintendo**

- **Infra-red system**
  - **Detection bar responds to 3 axis movement and acceleration**
  - **wireless remotes**
    - Wiimote
    - Nunchuck
    - Wii Balance Board

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The Nintendo Wii

- Feedback to player is multi-sensory (visual, auditory, tactile)
- Nintendo was targeting a new market, making it more active therefore more attractive to non gamers (parents!)

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The Nintendo Wii

Benefited Nintendo…

Bloomberg Businessweek

Bloomberg
Friday April 23, 2010

Nintendo Shares Rise After Record Wii Sales in U.S. (Update3)

January 06, 2010, 6:35 AM EST

(Updates with closing shares in second paragraph.)

By Pavel Alpeyev

Jan. 6 (Bloomberg) -- Nintendo Co. rose the most in more than a year in Osaka trading after sales of its flagship Wii game console in the U.S. climbed by more than 40 percent to a record in December.

The stock climbed 6.9 percent to close at 24,500 yen, its biggest gain since November 2008. U.S. consumers probably bought more than 3 million Wii players last month, said Yasuhiro Minagawa, a spokesman at the Kyoto-based company. Nintendo sold 2.15 million Wii players in the country during December 2008, according to estimates by research firm NPD Group.

Nintendo ended nine months of sales declines for the Wii after hit games such as "New Super Mario Bros. Wii" and a 20 percent price cut of the motion-sensing console helped spur demand. Sales of its DS handheld player may have also risen to a record last year, the company said on its Web site.

"Nintendo's got a good lineup and we're finally seeing the benefits of the price cuts," said Eiji Maeda, senior analyst at JPMorgan Chase & Co. in Tokyo. "The new release in the 'Super Mario Brothers' franchise had a huge impact."

U.S. sales of the DS last year probably exceeded the 9.96 million unit record in 2008, Minagawa said, without giving a specific figure. The "New Super Mario" game sold close to 4 million units in the U.S. since its release on Nov. 15, the company said.

Wii sales dropped 38 percent to 1.26 million consoles in November, leading the U.S. video-game market to its eighth drop in nine months, according to NPD estimates. Sales of Microsoft Corp.'s Xbox 360 declined 2 percent to 819,500, while Sony Corp.'s PlayStation 3 sales rose 88 percent to 710,400 after a 25 percent price cut in August, the researcher said.

But was also picked up by others…

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Wii as a therapeutic tool

- Used clinically quickly
  - Rehabilitation
  - Education

- Little research on actual impact of using it for various conditions

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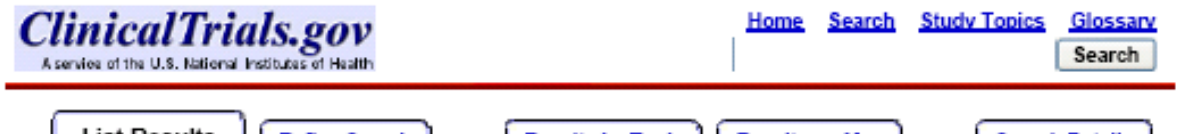
Wii as a therapeutic tool

- Clinical trials: quick search on www.clinicaltrials.gov

  Some trials reg



Effectiveness of Virtual Reality Exercises in STroke *Rehabilitation* (EVREST): Rationale, Design, and Protocol of a Pilot Randomized Clinical Trial Assessing the Wii Gaming System

G. Saposnik[1]*, M. Mamdani[1], M. Bayley[2], K.E. Thorpe[2], J. Hall[2], L.G. Cohen[3], and R. Teasell[4] on behalf of the Steering Committee and EVREST Study Group*

Comparison of Efficacy Between Traditional and Video Game Based Balance Programs

Kirk A. Brumels, PhD, ATC, Troy Blasius, Tyler Cortright, Daniel Oumedian, and Brent Solberg
Hope College, Holland, MI

Wii as a therapeutic tool

- A few observational studies
- A few case reports

Doing WiiHab: Experience With the Wii Video Game System in Acquired

Use of a Low-Cost, Commercially Available Gaming Console (Wii) for Rehabilitation of an Adolescent With Cerebral Palsy

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Judith E Deutsch, Megan Borbely, Jenny Filler, Karen Huhn, Phyllis Guarrera-Bowlby

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What do we know?

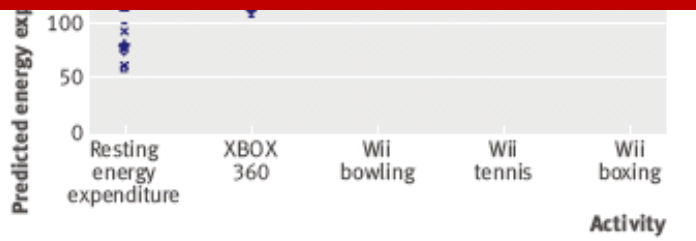
Wii as a therapeutic tool: physical activity

- Promoting physical activity: energy expenditure

Energy expenditure in adolescents playing new generation computer games

Results indicate that new generation computer games generate more energy expenditure than sedentary ones

However, games in Wii sports not high enough intensity for daily amount of exercise in older children



Participants' mean resting energy expenditure and predicted energy expenditure when playing computer games

Wii Sports bowling	11.7	700
Wii Sports tennis	12.5	750
Wii Sports boxing	12.1	730
Various activities		
Sitting playing board games	6.7	400
Bowling	13.3	800
Tennis (doubles)	22.2	1330
Boxing (punch bag)	26.8	1600
Boxing (sparring)	40.1	2410

We calculated values for the various activities using metabolic equivalents.[12]

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Wii as a therapeutic tool

Increasing energy expenditure: tips

- Older children and adults tend to expend less energy than younger children who move more during activity

  Increase of 189 kCal/hour for children vs

  148 kCal/hour for adults for same game

Need to engage whole body!

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Wii as a therapeutic tool: Balance

Balance training traditional vs videogames (Brumels, 2008)

Comparison of Efficacy Between Traditional and Video Game Based Balance Programs

Kirk A. Brumels, PhD, ATC, Troy Blasius, Tyler Cortright, Daniel Oumedian, and Brent Solberg
Hope College, Holland, MI

Found that use of video game based programs increase patient enjoyment and engagement, decrease perception of difficulty, but they also improve selected balance performance measurements

Wii as a therapeutic tool: Balance

- Adolescent with CP (Deutsch, 2008)

Use of a Low-Cost, Commercially Available Gaming Console (Wii) for Rehabilitation of an Adolescent With Cerebral Palsy

Judith E Deutsch, Megan Borbely, Jenny Filler, Karen Huhn, Phyllis Guarrera-Bowlby

Table 3.
Preintervention and Postintervention Measurements on the Posture Scale Analyzer (PSA)

PSA Measures	Preintervention		Postintervention	
	Eyes Open	Eyes Closed	Eyes Open	Eyes Closed
Percentage of body weight	96	89	97	98

Improvements in postural control, visual-perceptual processing, and functional mobility were measured after training

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Wii as a therapeutic tool: TBI

Doing WiiHab: Experience With the Wii Video Game System in Acquired Brain Injury Rehabilitation: 0034

Goldberg, Gary; Rubinsky, Hillel; Irvin, Erin; Linneman, Emily; Knapke, Jennifer; Ryan, Manijeh

- Tested 8 adults with ABI in in-patient rehabilitation
- 1 hour/week, group session

No clinical measures presented

Reports of improved eye-hand coordination,

Increased social participation

Decreased helplesness

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Not much out there but…
There will be more

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www.wii-hab.com

Wii-hab to Wii Fit

facebook

Wii-hab

Name:
Wii-hab to Wii Fit

Status:
So those of you that use the Wii for home...

Fans:
111

Promote Your Page Too

- HOME
- NEWS AROUND THE WORLD
- WII-HAB TO WII FIT EXERCISES
- VIDEOS AND REVIEWS
- MEDIA ROOM

What is Wii-hab?

Wiihabilitation was introduced to the nation in early 2008 as an adjunct to physical and occupational therapy programs, using Nintendo's new motion-sensitive gaming platform, the Wii™. This revolutionary tool quickly became favorable within the rehab industry and a nationwide media storm covered the implementation of Wii-hab programs across the country. Since that time, a few key modifications have been made to improve the motion-sensitive gaming hardware including Wii Fit™ with the pressure sensitive balance board and Wii Motion Plus™, an attachable device to enhance the sensitivity of our body's motions.

Wii-hab is the medical application of interactive video gaming devices to augment therapies of physical, cognitive, behavioral, and otherwise, under the guidance of a trained and licensed healthcare professional.

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Using the Wii in pediatric trauma rehabilitation

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MCH Trauma Programs

- Neurotrauma Program
- Trauma Program
- Burn Trauma Program
- Concussion & Return to Sports Program
- Injury Prevention Program

Where would VR be useful?

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Trauma Wii initiatives

Exploring the Wii as an alternative for aerobic activities in the mild traumatic brain injury/return to sports clinic

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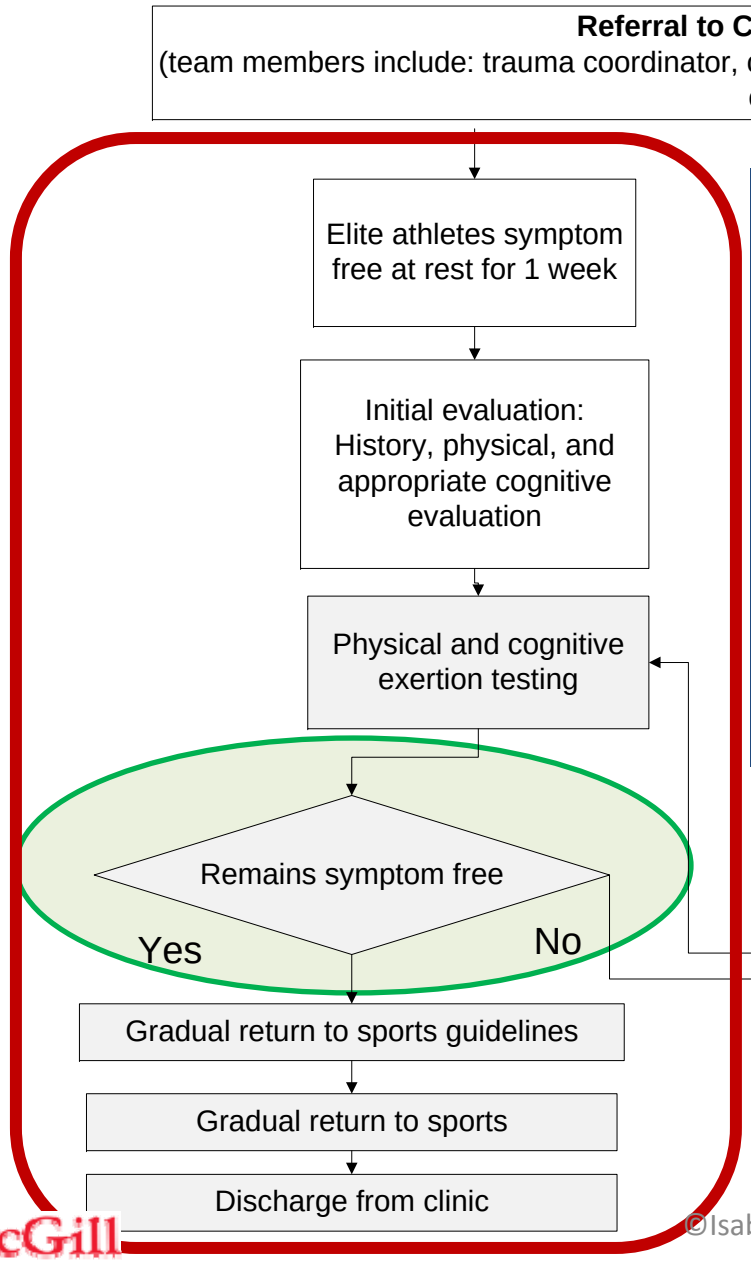
MTBI Clinic Stream 1: Exertion Test



WHO: Active children involved in > 8 hours/wk sport participation

WHY: Some deny symptoms, prevent early return to activities

Insure that no symptoms are present during exertion test

WHEN: After one week symptom free

WHAT: Standardized evaluations, physical and cognitive exertion tests

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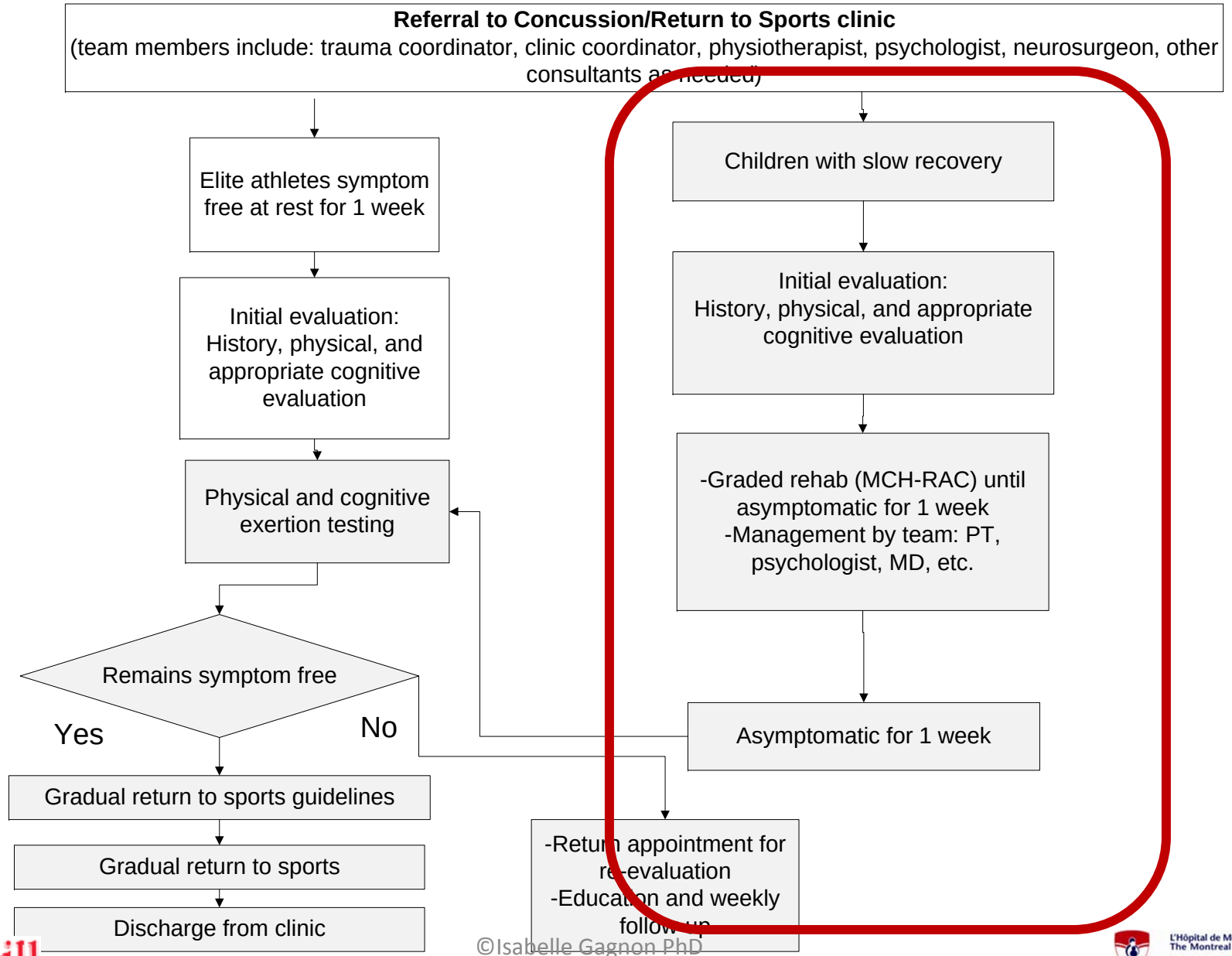
MTBI Clinic Stream 2: Active Rehab



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MTBI Clinic Stream 2: Active Rehabilitation

- Eligible if symptomatic or have impairments after 4 weeks
- May have more severe injury than anticipated
- Pre-morbid characteristics placing them at higher risk of functional complications (medical conditions (ex. migraines); previous TBI; familial stressors; personality; behavioral problems or learning problems; psychiatric disorders (depression, anxiety)

Decrease persisting symptoms, **early rehabilitation** initiated (physical and cognitive)

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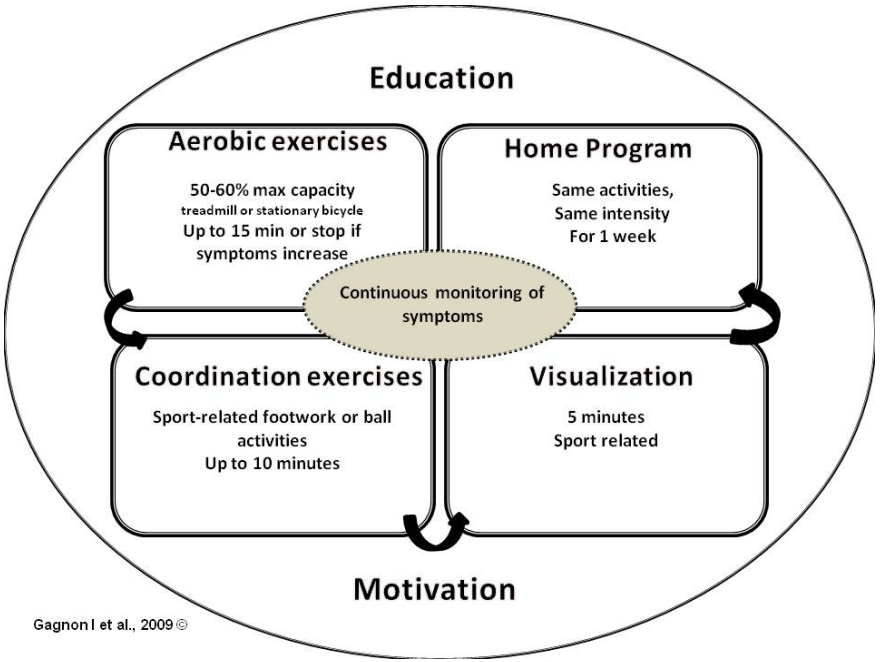
MTBI Clinic Stream 2: Active Rehabilitation

- Clinical program with interesting anecdotal evidence based on following principles
  - Exercise has a cerebral effect
  - May contribute to neural repair and vascular auto-regulation
  - Contributes to improve mood and energy level



Gagnon, Galli, Friedman, Grilli, Iverson., Brain Injury, 2009

Wii as alternative for aerobic activities

Development of a protocol for aerobic activities: 2 phase process

1. Structured literature review re:
    - use of VR for aerobic activities
    - Use of Wii and other commercial videogames in rehabilitation (if possible with children)

2. Experimentation process

    Testing of various games to determine suitability
    - Using polar heart rate monitor and chest strap
    - Ability to practice game and sustain HR > 50-60% of max capacity (for use in the clinic)

Wii as alternative for aerobic activities

• Wii sports (boxing) considered not suitable, unless for younger children who practice it with whole body

•Wii FIT considered unlikely to generate enough METS

•Wii FIT plus better choice

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Wii FIT plus

- Recommended exercises (60 to 70% max HR)
  - Running
    - Aerobics - Basic Run, 2-P- Run, Free Run
    - n Plus
    - dv
    - s
  - Complementary exercise (go to 60% max HR)
    - Hula Hoop

Potential problems	Recommendations

• Running on the spot
  • Movement unnatural
  • Excessive plantarflexion
  • ↑ fatigue
	• Use the Wii active thigh band with *Wiimote*
	• Use of stationnary bicycle and treadmill possible
	• Need running shoes
	• Encourage arm movements

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Gold's Gym cardio workout

- Recommended exercises (60 to 70% max HR)
  - Cardio Kick Boxing
    - Shape Boxing
  - Jump rope
    - Exercise – Jump Rope
- complementary exercises (50 to 60% max HR)
  - Running
  - Punching Bag

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Wii Active

- Recommended exercises (60 to 70% max HR)
  - Running
    - Cardio - Run and Walk, Run, Walk and Run, Kick ups, Run, knees and kick ups, Track random
  - Jump
    - Lower limbs exercises - Jump Squats, Side to side jumps
    - Sports – Shooting, Inline Skating
- Complementary exercises (50 to 60% max HR)
  - Box
  - Cardio dance

Wii Active more workouts

- Recommended exercises (60 to 70% max HR)
  - Course
    - Cardio – Sprint, Follow the leader, Island outrun
    - Fitness activities – Obstacle course
  - Jumps
    - Cardio – Stride jumps, Skipping
    - Lower body exercises – Forward-backward ankle hops
    - Fitness activities – Water skiing
  - Step
    - Fitness activities – Step aerobic

Wii Active more workouts

- Recommended exercises (60 to 70% max HR)
  - Others
    - Fitness activities – Paddle surfing
  - Pre-Set Workouts
    - Cardioresp training program
- Complementary exercises (50 to 60% max HR)
  - Box

What's next?

- Pilot testing with children in the clinic to begin in the summer of 2010
- Measures of statisfaction, enjoyment, as well as monitoring of effort perception and HR
- Compare with children who are seen now consecutively in the clinic

Trauma Wii initiatives: balance

Exploring the impact of a physiotherapy intervention on the risk of re-injury and recovery in children and adolescents with acute ankle sprains: a randomized controlled trial

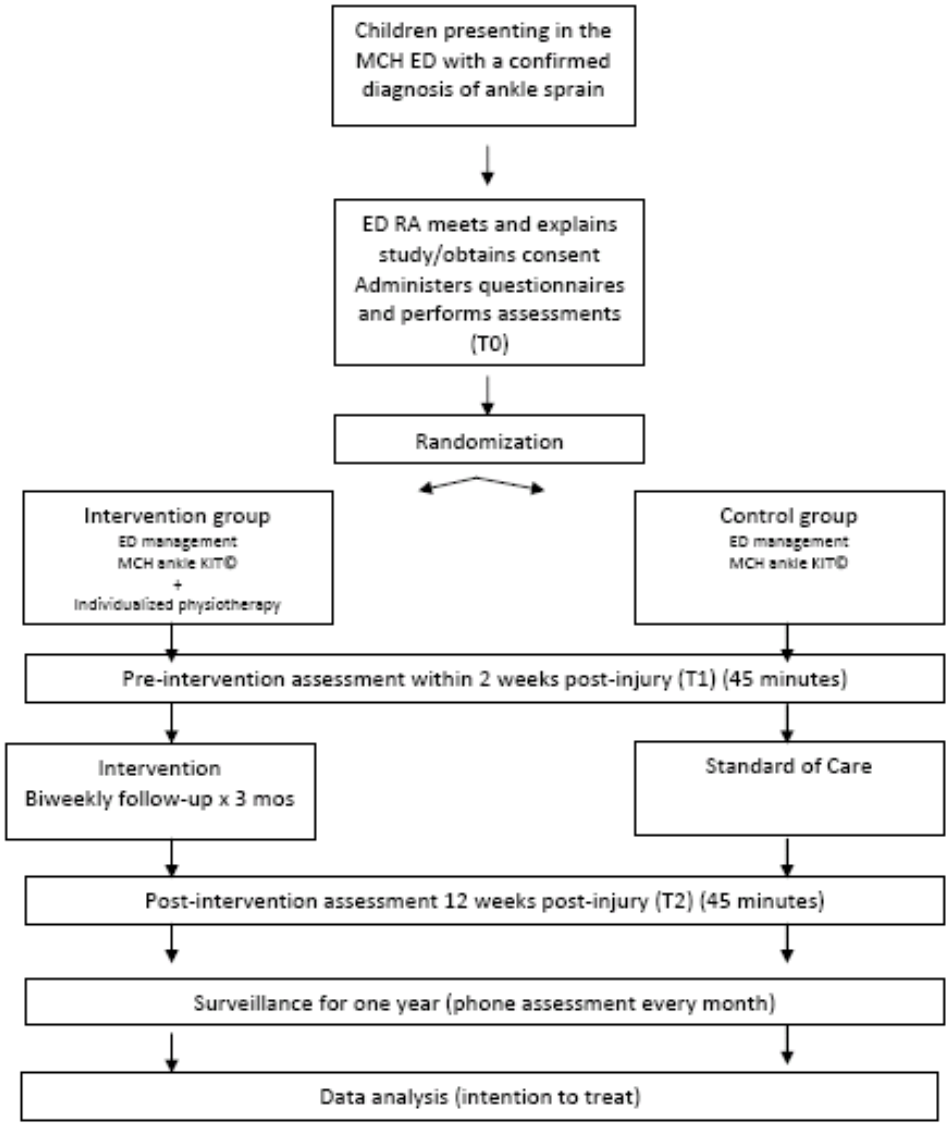
Ankle sprain rehabilitation

Objectives

1) determine the impact of providing individualized PT intervention in addition to standard care on *risk of re-injury in the first year* following an initial ankle sprain in children and adolescents presenting to a pediatric ED,

2) document *recovery and return to activities* following ankle sprains in children receiving both types of intervention 12 weeks post-injury

RCT planned to start late 2010



Balance training

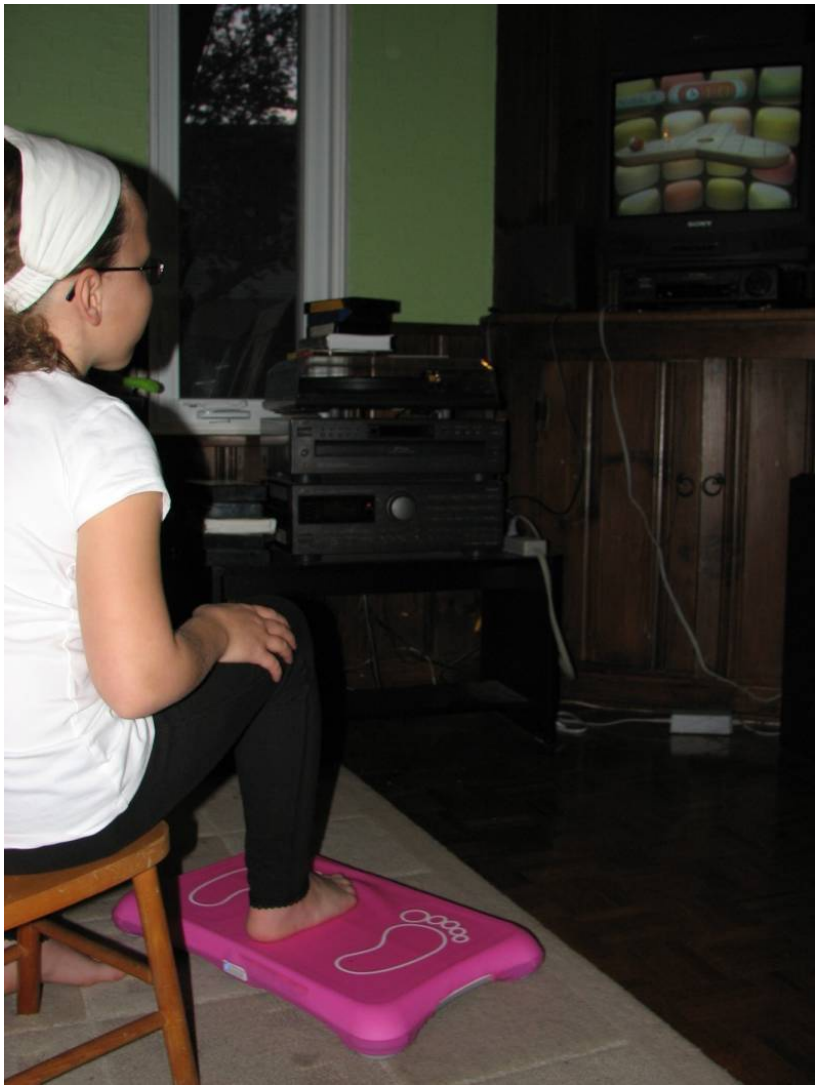
- **Physiotherapy intervention to include**
  - mobilization,
  - strengthening,
  - balance and proprioception training and,
  - if the child is involved in sports, activity specific exercises, such as those described in

Potential for use of VR

Ankle sprain intervention

- **Strengthening example**

Sitting strengthening exercise



Ankle sprain intervention

- **Balance and proprioception training examples**

- On 2 feet
- On 1 foot

Ankle sprain intervention

- Awaiting funding for clinical trial (collaboration with University of Calgary, Drs C. Emery and D. Johnson)
- Developing the physiotherapy intervention and deciding on Wii content
- Advantage: once exercises are taught, could be used as a home program

Other potential uses in trauma

- Motivation and cognitive training for severe TBI
- Distraction for painful procedures
- Strengthening and balance training after fractures
- Remains to be explored…

Some limitations

- Not specific to rehabilitation
- Not adapted to all clienteles
  - Range of motion/need grasping abilities/reaction speed
- Progression may be too rapid
- Games may be too difficult (e.g. dance dance revolution)
- Undesirable movement patterns

Reports of injuries

- Muscular pain
  - Following a sudden and intense increase in physical activity level
- *Wii-*
- *Wiit*
  - S
- *Wii-*
  - F
- Pne
- Inte

Recommendations

- Evaluate physical condition of patient
- Reasonable level of training
- Adequate monitoring
- Supervision
- Safe environment

Conclusion

- Different therapies & modalities come and go
- Theoretical background remains the same
- Choosing any therapeutic tool relies on sound reasoning that supports the client's desired outcome
- It requires the expertise of a skilled therapist to monitor, modify and evaluate

Conclusion

- Wii is interesting, potential low cost alternative to standard VR systems
- Potential uses remain to be developed
- Research is scarce and remains to be undertaken

- Remember why you want to use it
- Follow logic intervention
- Supervise children

Questions