Rehab Robotics Can help Bridge Gaps in Stroke Care

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[3] Rehabilitation Robotics Research and Design Lab (RRRD), Pennsylvania Institute of Rehabilitation Medicine

AAAS Conference, 2022

For Empowering people using robot technology

1

Agenda

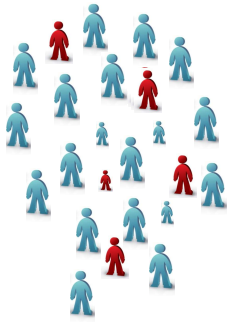
- Myths about rehab robots
- Review 2 case studies

2

Rehabilitation Robots will take therapists and clinical rehab jobs

3

- Major factors causing disabilities world-wide
  - High Blood Pressure >> Strokes
  - HIV >> Dementia, Strokes
  - Neonatal Nutrition >> Premature Births >> Cerebral Palsy, Autism, Down Syndrome etc.



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Technology Can Help Bridge This Gap

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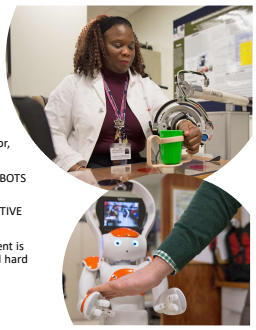
Therapist >> Robot



- Ideally the robot should take on three roles as demonstrator, observer and helper and co-act with the patient
- Helper role is often seen in hands-on effector THERAPY ROBOTS (e.g., ADLER, Theradrive)
- Demonstrator and Observer Roles are often found in ASSISTIVE ROBOTS or SERVICE ROBOTS (e.g. Nao)
- Fluid transitioning from contact to non-contact with a patient is not often done due to huge safety concerns about soft and hard impacts.

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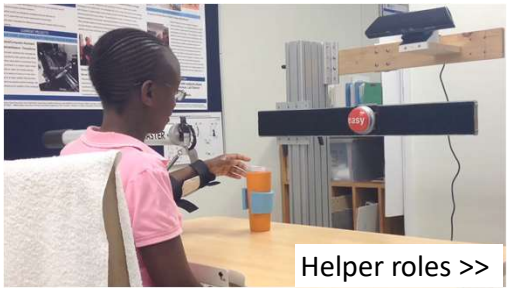

Helper roles >>

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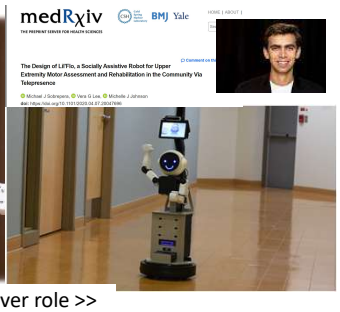

Demonstrator/Observer role >>

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Demonstrator/Observer roles >>

Baxter: Elder Exercise

Figure 2: Frames from the eight exercise games.

Naomi T. Fitter, Dylan T. Hawkes, Michelle J. Johnson, and Katherine J. Kuchenbecker, Designing Human-Robot Exercise Games for Baxter, IROS late breaking 2016

Exercising with Baxter: Design and Evaluation of Assistive Social-Physical Human-Robot Interaction

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Rehabilitation Robots are expensive and not worth the cost

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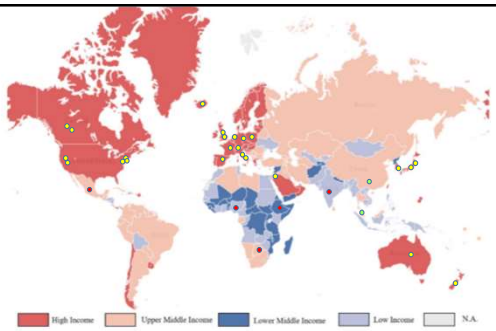
HIC
Canada
USA
Israel
Italy
France
Switzerland
Iceland
Spain
UK
Poland
Germany
Israel
Australia
Japan
South Korea



UMI
Malaysia
China

Fig. 1. Country income groupings for the fiscal year 2020. Each country is represented with a color according to its income level: red for High Income, light red for Upper Middle, blue for Lower Middle, light blue for Low Income and grey for those countries whose income level is not available (N.A: Not Available). Data are from World Bank [5].

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Problem with current systems

Design issues:

- **Mechanical complexity**
- **Huge sizes and masses**
- **High costs**

REF: Andrea Ryolo – Thesis Presentation

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Therapy Robots

- Automate traditional therapy treatments
- Enable semi-autonomous training
- Provide consistent, repeatable, intensive training
- Provide objective measures of recovery
- Reduce Impairment
- Increase Activity

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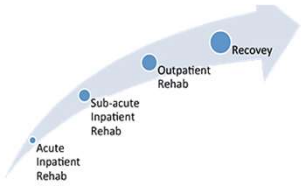
Rehab Landscape



- 75% discharge with residual impairments
- 40% go home without post-acute care

Rehab taking place in community
- At home with nursing care or a home health agency
- Nursing home
- Day-care or all-inclusive care facility (PACE)
- Assisted Living Facility

In LMICs these issues are compounded.
1) low resources
2) *limited #s of skilled clinicians*
3) limited access to *technology*

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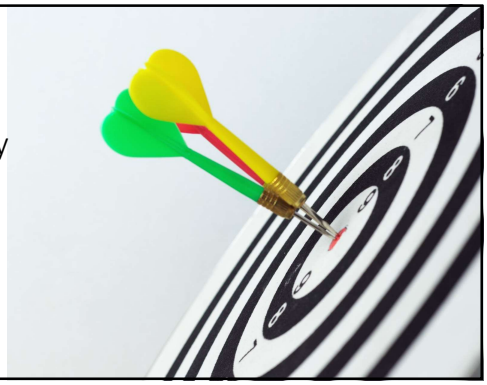
Affordability
And
Inclusivity



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Rehabilitation Robots will get in the way and will not be used or liked

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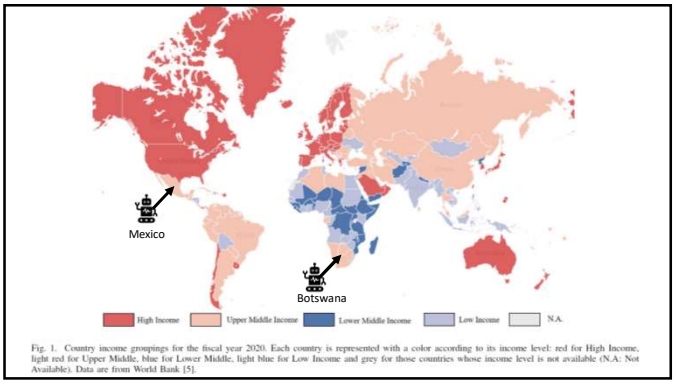

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Penn Engineering | GRASP Laboratory
General Robotics, Automation, Sensing & Perception Lab

Case #1

Robot/Technology-Assisted Stroke in Mexico and Botswana

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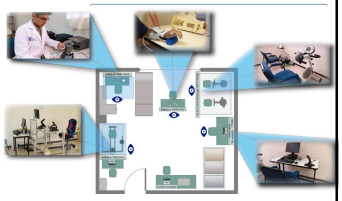
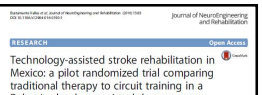
Mexican Theradrive





Journal of NeuroEngineering and Rehabilitation

RESEARCH Open Access

Technology-assisted stroke rehabilitation in Mexico: a pilot randomized trial comparing traditional therapy to circuit training in a Robot/technology-assisted therapy gym

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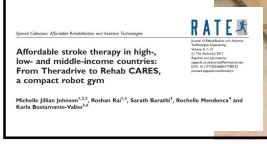
Rehab

C.A.R.E.S.

Gym



Special Collection: Affordable Rehabilitation and Assistive Technologies

RATE

Affordable stroke therapy in high-, low- and middle-income countries: From Theradrive to Rehab CARES, a compact robot gym

Michelle Jillian Johnson[1,2,3], Roshan Rai[1,2], Sarath Barathi[1], Rochelle Mendonca[4] and Karla Bustamante-Valles[1,2]

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Haptic Theradrive (TD-3)

Position 1 Position 2

Michelle Jillian Johnson, Roshan Rai, Sarath Barathi, Rochelle Mendonca,andKarla Bustamante-Valles: Affordable stroke therapy in high-, low- and middle-income countries: From Theradrive to Rehab CARES, a compact robot gym. Journal of Rehabilitation and Assistive Technologies Engineering. sagepub.co.uk/journalsPermissions.nav, 4: 1-12, May 2017 Notes: DOI: 10.1177/2055668317708732.

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2017 International Conference on Rehabilitation Robotics (ICORR)
QEII Centre, London, UK, July 17-20, 2017.

Using Upper Limb Kinematics to Assess Cognitive Deficits in People Living with Both HIV and Stroke *

Kevin D. Bai[1,2], Roshan Rai, M.S.[2], Michelle J. Johnson, Ph.D., *Member, IEEE* [1,3]

Case Study #2

HIV/Stroke: Towards Robot-Assessment of Motor and Cognitive Impairments

CFAR Center for AIDS Research

University of Pennsylvania Children's Hospital of Philadelphia The Wistar Institute

NIH NAM T32 Training Grant

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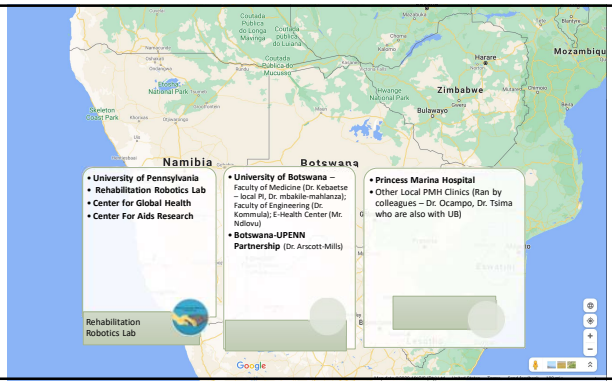

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HIV, stroke, and rehabilitation in Botswana

4th
highest HIV prevalence in the world

2
Occupational therapists in the main referral hospital

1/3*
Stroke survivors have HIV

*unpublished data

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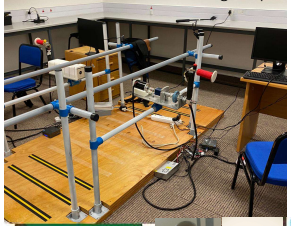
Haptic Theradrive
BOTSWANA
Sir Ketimule Masiere Teaching Hospital



Mahalapye District Hospital

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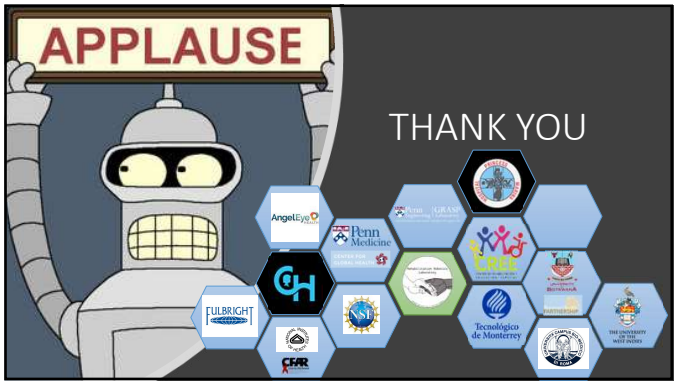

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Financial Disclosures

1. Patents filed on PANDA gym, Theradrive, Rehab CARES robot system
2. Equity in a spin-off company of UPENN called Recupero Robotics, LLC.

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