IMPROVE HUMAN PERFORMANCE

C-MILL TRAINING
WHY?

Click here to open the video on YouTube
DAILY LIFE OUTSIDE WALKING & C-MILL

- Step over obstacles
- Avoid obstacles
- Speed up / slow down
THE C-MILL

- Effective functional gait therapy
  (Heeren et al. 2013)
- Incorporate motor learning principles
  (Papegaaij et al. 2017)
- Fun and motivational therapy in a safe environment
  (Houdijk et al. 2012)
- Objective balance and gait assessment results
  (Roerdink et al. 2014)
- Monitor progression over time
PROGRAM C-MILL TRAINING

1. Hardware C-Mill
2. Safety C-Mill
3. Prepare C-Mill session
4. C-Mill Therapy Workflow
5. Assessment & Training
6. Patient Session
7. Manual control & Make your own protocol
8. Advanced Items
C-Mill hardware
C-MILL VR

- Front display
- Safetysportal
- Control panel
- Floor projector
- Video
- E-Stop
- Video
- Handrail
- Treadmill + forceplate
C-MILL FORCE PLATE

Centre of Pressure (CoP)

Balance measurement

Gait measurement
Safety C-Mill
## Safety C-Mill

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventive measures</td>
<td></td>
</tr>
<tr>
<td>Passive safety</td>
<td>Harness + Safety line + Support bars</td>
</tr>
<tr>
<td>Active safety</td>
<td>E-stop 2x + E-stop safety portal + Light gate*</td>
</tr>
</tbody>
</table>
Prepare C-Mill Session
C-Mill Therapy Workflow
THERAPY WORKFLOW

- Referral
- Intake
- Assessment
- Training
- Re-Assessment
- Evaluation

Indication/Contraindications?
Start level patient?
Baseline level patient?
Treatment goals?
Effect training?
Patient improved in performance?
## Contraindications C-Mill

- A severe cognitive, visual or hearing impairment where the patient is not able to follow the instructions of the operator.
- More than 135 kg total bodyweight or less than 25 kg
- More than 2.00 meter body height
- Open skin lesion or bandage in the area of harness contact.
- < FAC 2

## Risk factors C-Mill

- Severe reduced bone density
- Spinal instability or unstable fractures.
- Severe vascular disorders or cardiac abnormalities that affect the ability to exercise safely
- Running < FAC 5

### FAC: functional ambulation categories

<table>
<thead>
<tr>
<th>FAC</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Walking with normal gait</td>
</tr>
<tr>
<td>1</td>
<td>Walking with a cane</td>
</tr>
<tr>
<td>2</td>
<td>Walking with a walker</td>
</tr>
<tr>
<td>3</td>
<td>Walking with a cane or walker</td>
</tr>
<tr>
<td>4</td>
<td>Walking with partial support</td>
</tr>
<tr>
<td>5</td>
<td>Walking with full support</td>
</tr>
</tbody>
</table>

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**Referral**

- Referral
- Intake
- Assessment
- Training
- Re-Assessment
- Evaluation

**Motek**

- Motek
- DIH brand

**IMPROVE HUMAN PERFORMANCE**
**Indication** | **Training goals**
--- | ---
Stand FAC level 2 | - Dynamic balance  
- Weight shifting
Step FAC level ≥ 2 | - Stepping balance  
- One leg stance
Walk FAC level ≥ 3 | - Gait  
- Gait adaptability

**FAC: functional ambulation categories**

![FAC categories](image)
<table>
<thead>
<tr>
<th>Goal</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static balance</td>
<td>Postural control</td>
</tr>
<tr>
<td>Dynamic balance</td>
<td>Limits of Stability</td>
</tr>
</tbody>
</table>
## WALK

<table>
<thead>
<tr>
<th>Goal</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk pattern</td>
<td>Gait Assessment</td>
</tr>
<tr>
<td>Gait Adaptability</td>
<td>C-Gait</td>
</tr>
</tbody>
</table>
IMPROVE HUMAN PERFORMANCE

Virtual Reality

Augmented Reality
MOTOR LEARNING PRINCIPLES

- Training intensity
- Variable practice
- External focus of attention
- Implicit learning
- Task-specific
- Feedback
RE-ASSESSMENT

Assessment → Training

T0

Training → Assessment

T1
Assessments & Training
THERAPY WORKFLOW

Indication/Contraindications?

Start level patient?

Baseline level patient?

Treatment goals?

Effect training?

Patient improved in performance?
POSTURAL CONTROL

• **GOAL**: measures static postural control in 4 different postures.
  - Eyes open
  - Eyes closed
  - Tandem stance
  - One-leg stance

• **OUTCOME**: Center of Pressure (CoP) velocity in cm/s
  - Low CoP velocity = Better postural control
LIMIT OF STABILITY

- **GOAL**: measures the dynamic stability without moving the BOS
- **OUTCOME**: Medio-lateral and Anterior-posterior CoP displacement in cm

• Higher CoP displacement = **Better** stability
GAIT ANALYSIS

- Step length
- Stride length
- Step width
- Distance

**Spatial parameters (distance)**

- Left step length (m)
- Step width (m)
- Right step length (m)

Stride length (m) = right step length + left step length
GAIT ANALYSIS

- Total stance time
- Unipedal stance time
- Bipedal stance time
- Cadence
BUTTERFLY (COP GAITOGRAM)

Top view COP trajectory

Walking direction ----->

FO left: Foot Off left
FO right: Foot Off right
FC left: Foot Contact left
FC right: Foot Contact left
BUTTERFLY (COP GAITOGRAM)

- Right unipedal stance phase
- Bipedal stance phase
- Left unipedal stance phase
- Right unipedal stance phase

- $FO_{RIGHT}$: Foot Off right
- $FO_{LEFT}$: Foot Off left
- $FC_{RIGHT}$: Foot contact right
- $FC_{LEFT}$: Foot contact left
C-GAIT (GAIT ADAPTATION OUTCOME)

<table>
<thead>
<tr>
<th>C-Gait assessment</th>
<th>Duration</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Familiarization on the treadmill</td>
<td>±3 min</td>
<td>Determine comfortable walking speed</td>
</tr>
<tr>
<td>Gait adaptability assessment Low difficulty</td>
<td>±10 min</td>
<td>1.5 min: visually guided stepping</td>
</tr>
<tr>
<td>level</td>
<td></td>
<td>2 min: obstacle avoidance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5 min: slalom walking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 min: speed adaptations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5 min: tandem walking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5 min: reaction to unexpected situations</td>
</tr>
<tr>
<td>Assessment of cognitive dual task</td>
<td>±1 min</td>
<td>Walking while performing an auditory Stroop task</td>
</tr>
<tr>
<td>Gait adaptability assessment High difficulty</td>
<td>±10 min</td>
<td>1.5 min: visually guided stepping</td>
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- Training with handrail support
- Training without handrail support
- Training with handrail support + cognitive task
- Training without handrail support + cognitive task

Gait assessment: Slalom walking, Tandem walking, Cognitive dual-task, Speed adaptation, Obstacle avoidance.
THERAPY WORKFLOW

Referral

Intake

Assessment

Training

Re-Assessment

Evaluation

Indication/Contraindications?

Start level patient?

Baseline level patient?

Treatment goals?

Effect training?

Patient improved in performance?
<table>
<thead>
<tr>
<th>Category</th>
<th>Training (Floor)</th>
<th>Treatment goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>WALK</td>
<td></td>
<td>Walking symmetry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increase stance time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increase step length</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improve gait stability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Change step width</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improve gait adaptability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improve walking accelerations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Train double task (with Steps, Nature Island, Symmetry or Italian Alps)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category</th>
<th>Training (Front)</th>
<th>Treatment Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEP</td>
<td></td>
<td>Improve weight distribution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improve weight shifting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improve single leg stance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improve stepping sideways</td>
</tr>
<tr>
<td>WALK</td>
<td></td>
<td>Improve walking duration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improve gait stability</td>
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Manual control & Make your own protocol
Patient Session
Advanced Items
CONFIGURATION MENU

- Admin account
- Belt projection
- Create new users
TROUBLESHOOT C-MILL

- Cue Display
- Update CueFors
- Logfiles
- Support/ Clinical Applications contact
Virtual/Augmented reality is a powerful tool for rehabilitation: optimizing therapy outcome by following the motor learning principles.