C-MILL& BWS TRAINING

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 motivative 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 & BWS

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

*End Training -/+ [TIME]*

# C-Mill hardware

C-MILL VR+ AND BWS
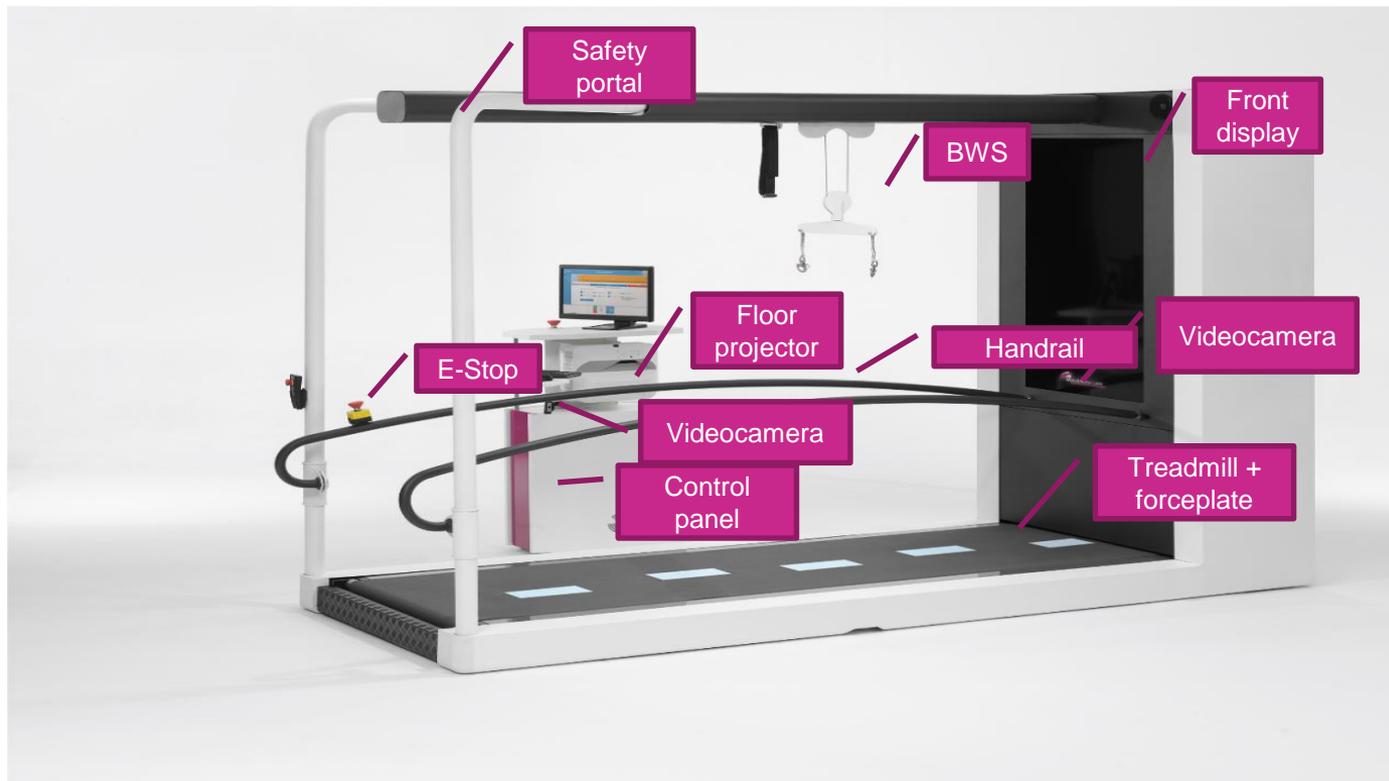
C-MILL FORCE PLATE

Force plate

Centre of Pressure (CoP)

Force plate

CoP
A.

B.

CoP
C.
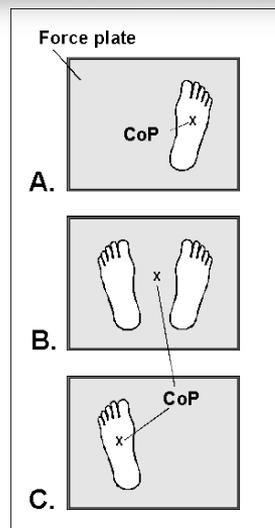
Balance measurement

Gait measurement

FO right   FO left
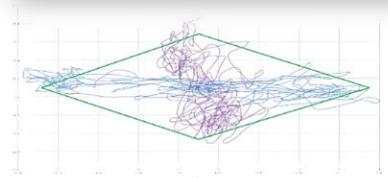
FC right   FC left
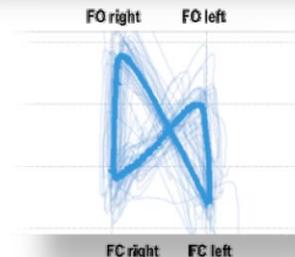
Safety C-Mill & BWS

Safety C-Mill

- Preventive measures

- Passive safety → Harness + Safety line + Support bars

- Active safety → E-stop 2x + Light Gate

Safety BWS
▪ Standalone Hardware system
▪ Passive safety → BWS harness + connection to BWS
▪ Active safety → E-stop 1x

③

Prepare C-Mill Session

C-Mill Therapy Workflow

THERAPY WORKFLOW

Referral   Indication/Contraindications?

Intake   Start level patient?

Assessment   Baseline level patient?

Training   Treatment goals?

Re-Assessment   Effect training?

Evaluation   Patient improved in performance?

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

Contraindications C-Mill with Body Weight Support
▪ 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 1.90 meter body height
▪ Open skin lesion or bandage in the area of harness contact.
▪ < FAC 1; i.e. cannot walk, or needs help from 2 or more persons
▪ Pregnancy

Risk factors C-Mill with Body Weight Support
▪ Severe reduced bone density
▪ Spinal instability or unstable fractures
▪ Severe vascular disorders or cardiac abnormalities that affect the ability to exercise safely

FAC: functional ambulation categories

0   1   2   3   4   5

REFERRAL

| 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

0   1   2   3   4   5
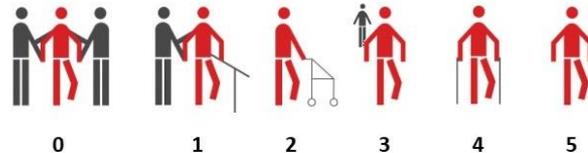
INTAKE
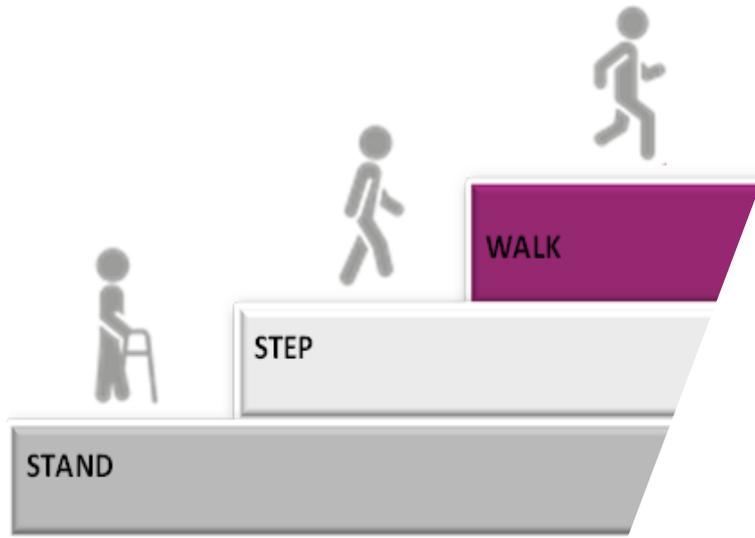
	Indication	Training goals
Stand	FAC level ≥ 1 (with BWS) FAC level 2	- Dynamic balance - Weight shifting
Step	FAC level ≥ 1 (with BWS) FAC level ≥ 2	- Stepping balance - One leg stance
Walk	FAC level ≥ 1 (with BWS) FAC level ≥ 3	- Gait - Gait adaptability

FAC: functional ambulation categories

0   1   2   3   4   5
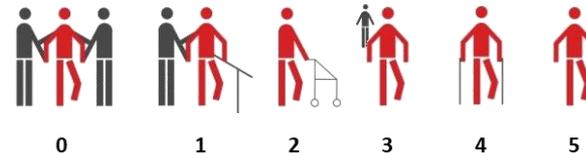
STAND	
Goal	**Assessment**
Static balance	Postural control
Dynamic balance	Limits of Stability

ASSESSMENT

WALK	
Goal	**Assessment**
Walk pattern	Gait Assessment
Gait Adaptability	C-Gait

?

TRAINING

Virtual Reality

Augmented Reality

MOTOR LEARNING PRINCIPLES

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

RE-ASSESSMENT

T0
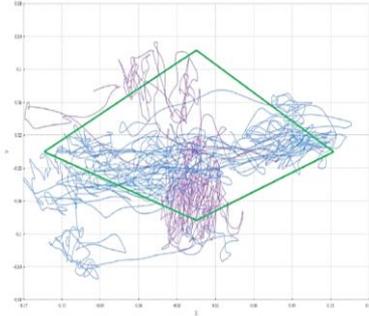
T1
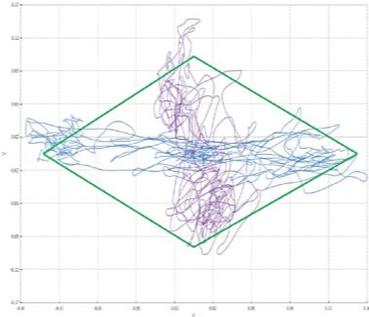
Assessment   Training
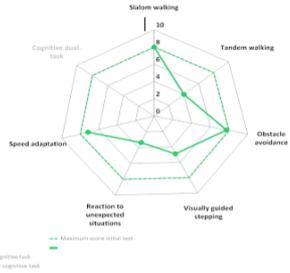
Train cross pass

EVALUATION

C-Gait

Avg. speed: 2.3 km/h
Duration: 33 sec
Distance: 21.5 m
Steps: 38
Step frequency: 33.2 steps/min

	Left	Right
Step length [m]	0.617	0.516
% stride length	54.5	45.5
Step time [s]	1.3	1.21
% stride duration	69.9	64.9
Stride length [m]	1.13	
Step width [m]	0.17	

Obstacle avoiding
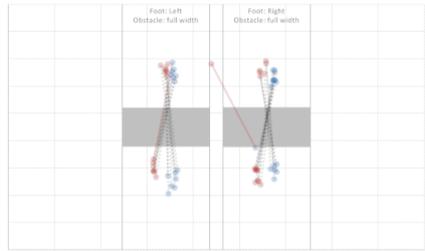
Left foot full width
14/14

Right foot full width
15/16

Butterfly

Spatial temporal

⑤
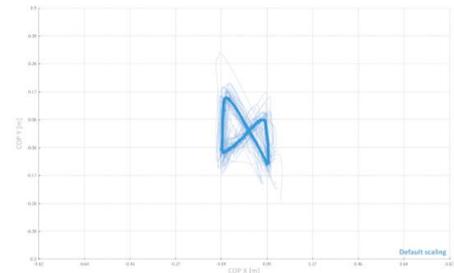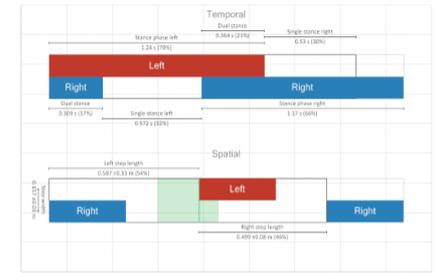
Assessments & Training

THERAPY WORKFLOW
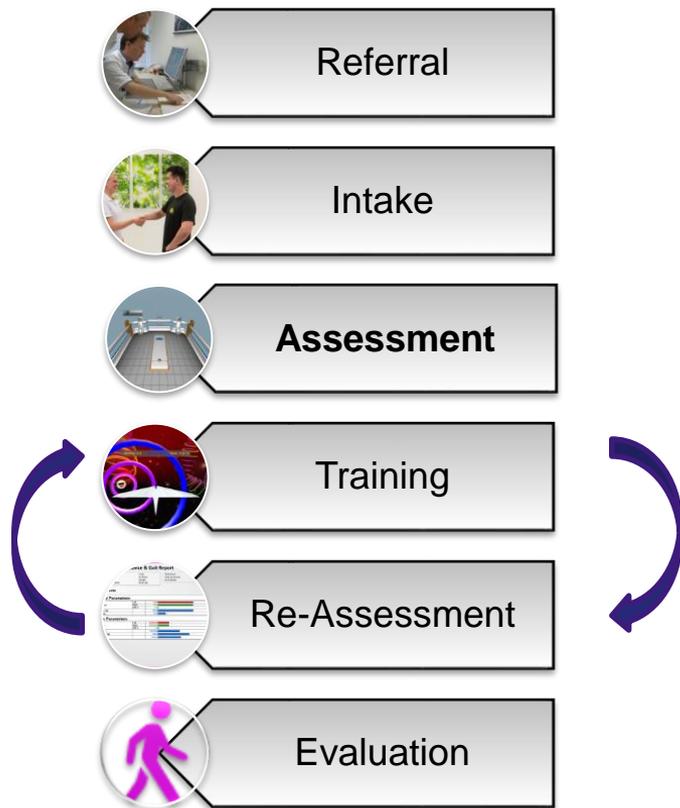
Referral — Indication/Contraindications?

Intake — Start level patient?

Assessment — Baseline level patient?

Training — Treatment goals?

Re-Assessment — Effect training?

Evaluation — Patient improved in performance?
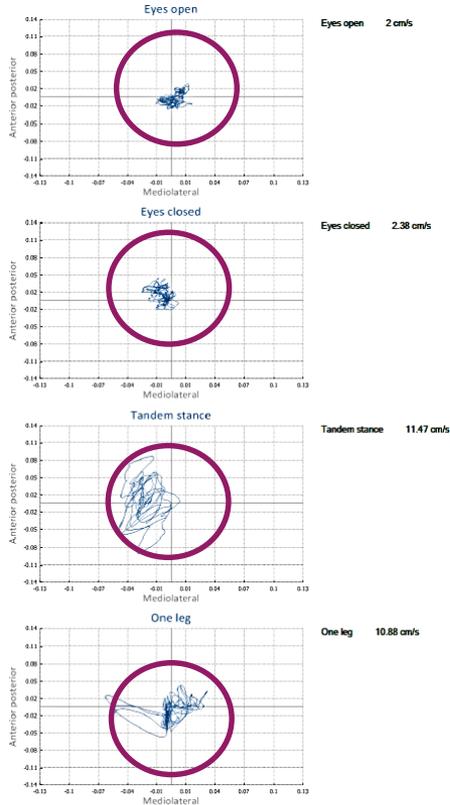
POSTURAL CONTROL

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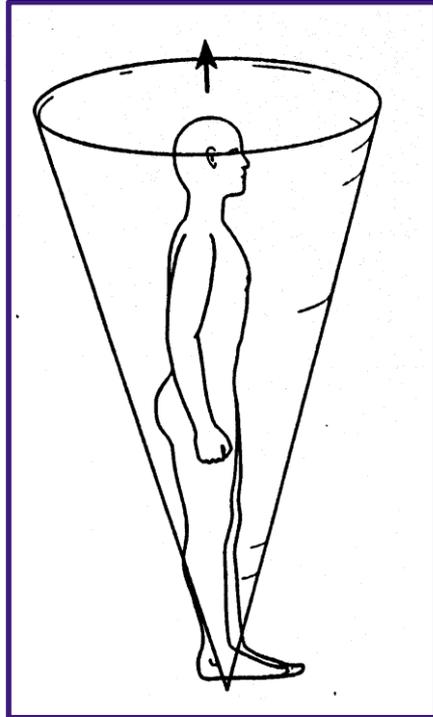
- **GOAL**: measures the dynamic stability without moving the BOS
- **OUTCOME**: Medio-lateral and Anterior-posterior CoP displacement in cm
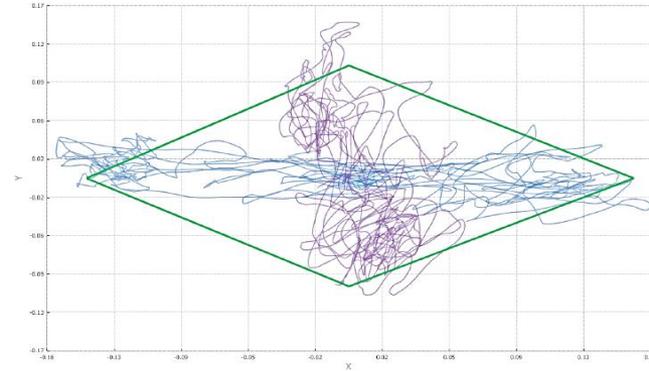
- **Higher** CoP displacement = **Better** stability

- Step length
- Stride length
- Step width
- Distance

Spatial parameters (distance)
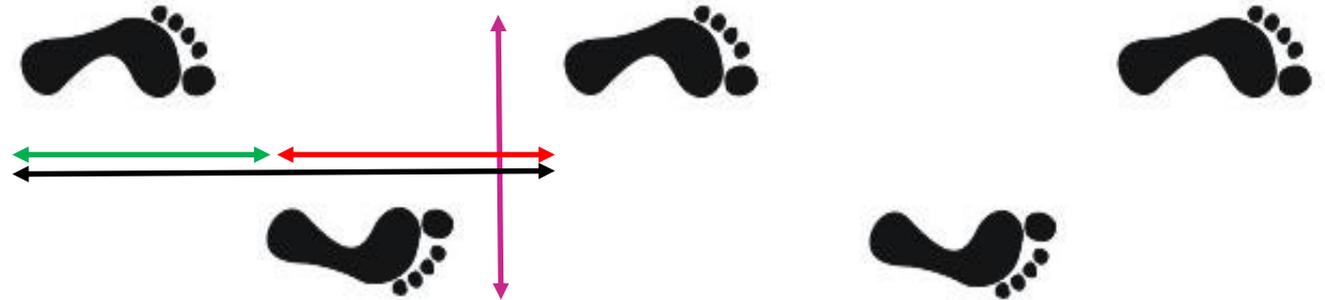
Left step length (m)

Right step length (m)

Step width (m)

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

GAIT ANALYSIS

- Total stance time
- Unipedal stance time
- Bipedal stance time
- Cadence

Temporal parameters (time)
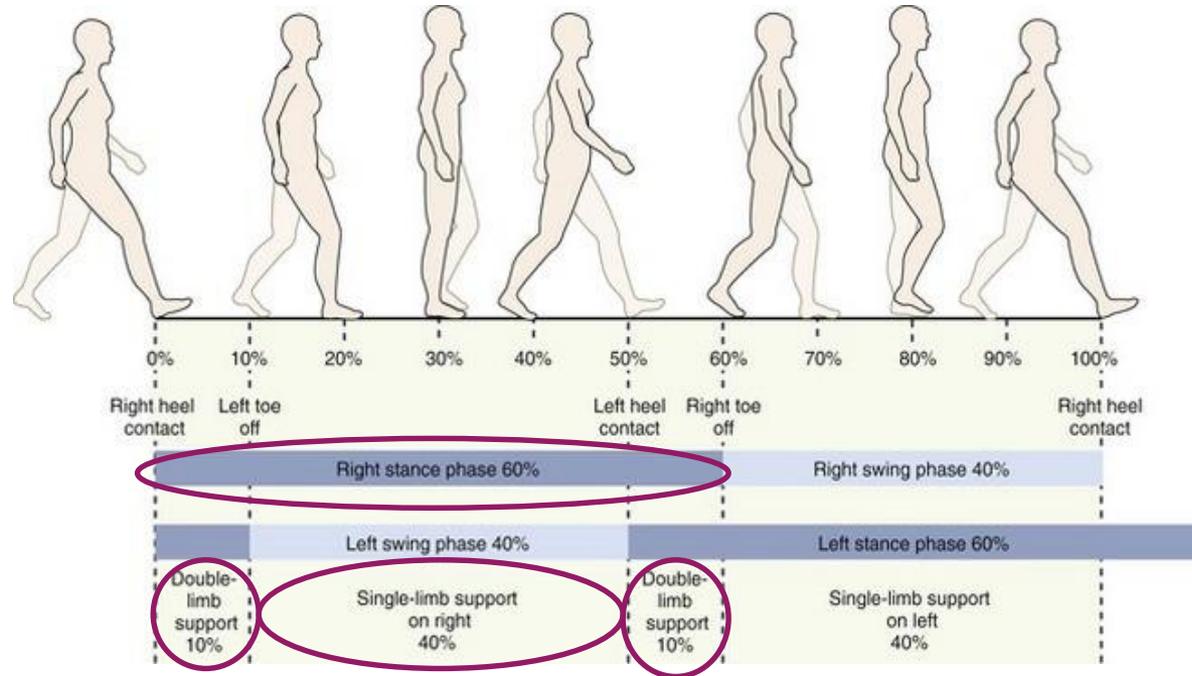
BUTTERFLY (COP GAITOGRAM)

Top view COP traject
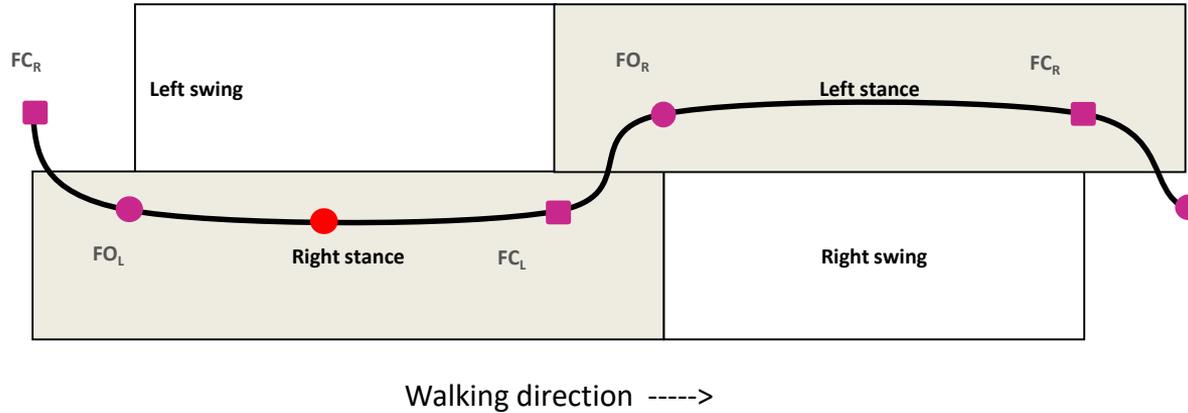
Walking direction ----->

FO left: Foot Off left
FO right: Foot Off right
FC left: Foot Contact left
FC right: Foot Contact left

BUTTERFLY (COP GAITOGRAM)
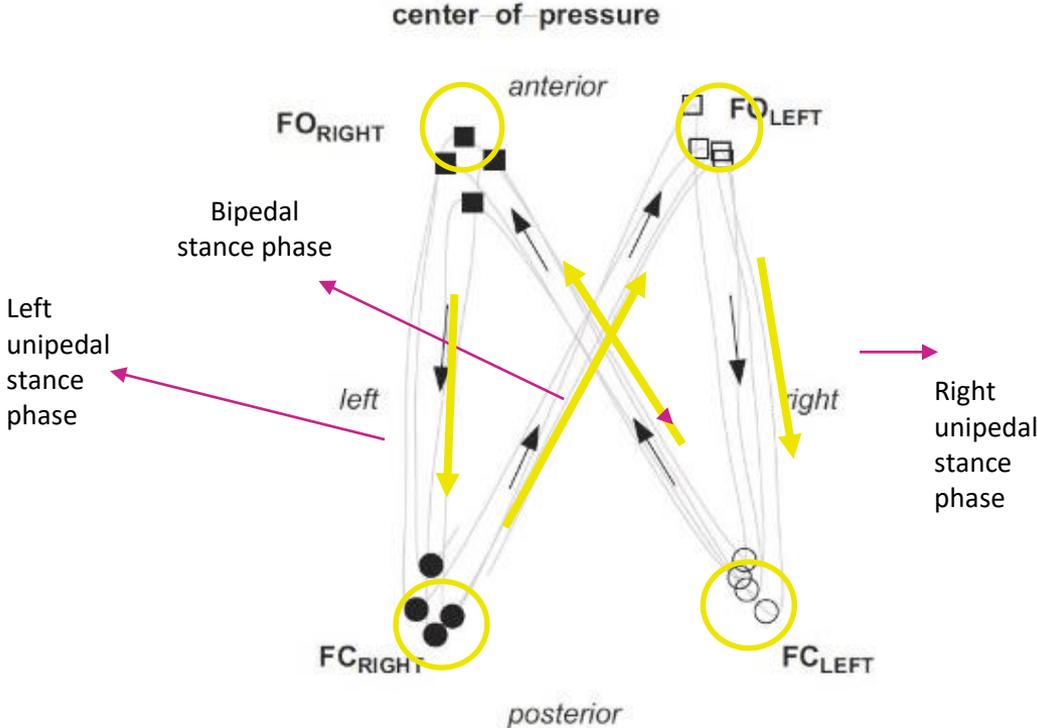
center-of-pressure

anterior

FO$_{RIGHT}$

FO$_{LEFT}$

Bipedal stance phase

Left unipedal stance phase

left

right

Right unipedal stance phase

FC$_{RIGHT}$

FC$_{LEFT}$

posterior

FO left: Foot Off left
FO right: Foot Off right
FC left: Foot contact left
FC right: Foot contact left

C-GAIT (GAIT ADAPTATION OUTCOME)
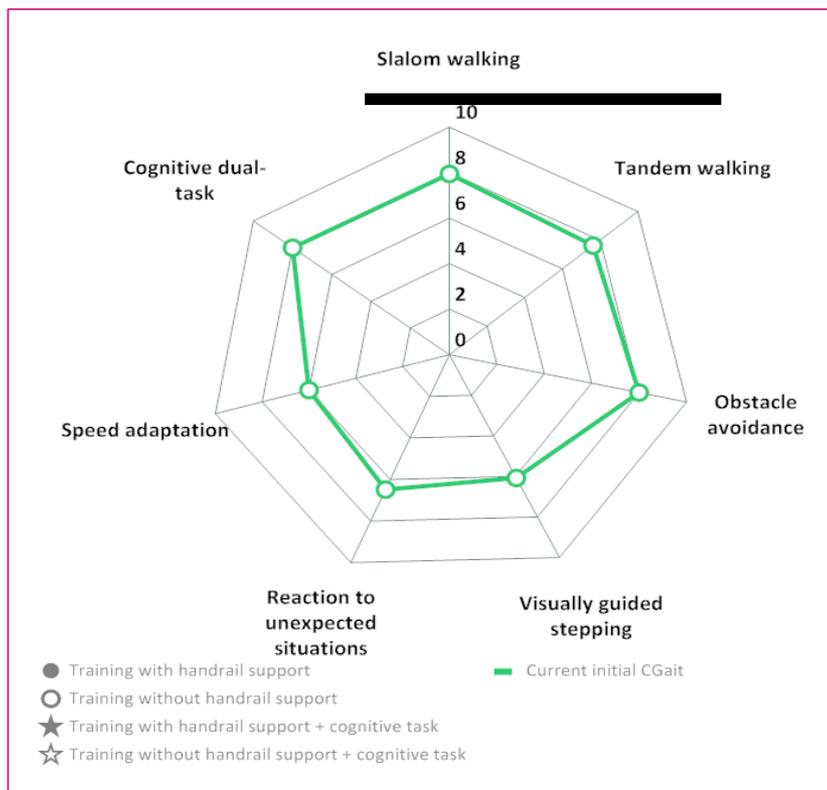
| C-Gait assessment		
Familiarization on the treadmill	±3 min	Determine comfortable walking speed
Gait adaptability assessment Low difficulty level	±10 min	1.5 min: visually guided stepping 2 min: obstacle avoidance 1.5 min: slalom walking 2 min: speed adaptations 1.5 min: tandem walking 1.5 min: reaction to unexpected situations
Assessment of cognitive dual task	±1 min	Walking while performing an auditory Stroop task
Gait adaptability assessment High difficulty level	±10 min	1.5 min: visually guided stepping 2 min: obstacle avoidance 1.5 min: slalom walking 2 min: speed adaptations 1.5 min: tandem walking 1.5 min: reaction to unexpected situations

THERAPY WORKFLOW
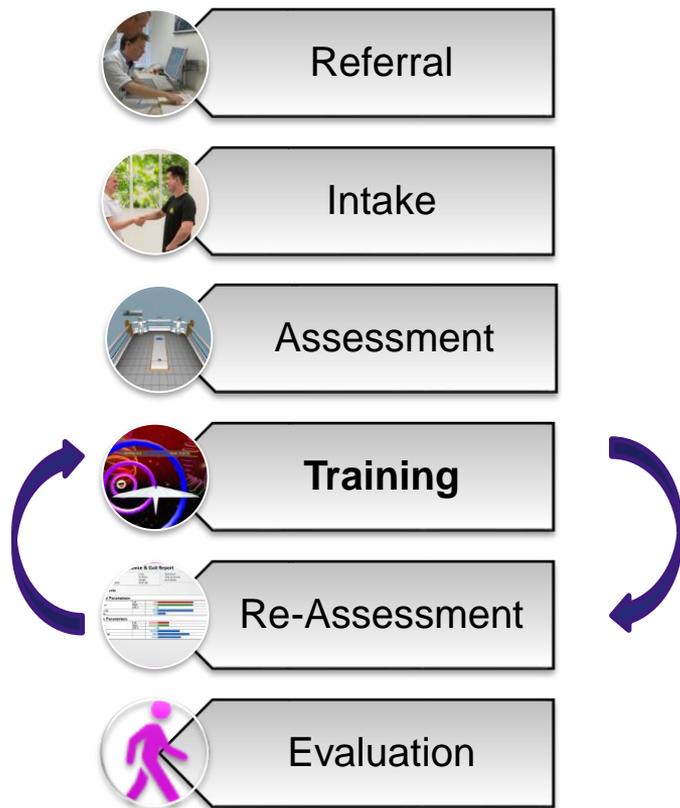
Workflow Step	Question
Referral	Indication/Contraindications?
Intake	Start level patient?
Assessment	Baseline level patient?
Training	Treatment goals?
Re-Assessment	Effect training?
Evaluation	Patient improved in performance?

TRAINING

Category	Treatment goals	Training (Floor)								
		Stepping stones	Auditive cueing	Obstacle avoidance	Random Stones	Speed adaptation	Re-active obstacles	Tandem	Slalom	Tracks (also applicable to Monster Game)
WALK	Walking symmetry	*	*							
	Increase stance time	*	*	*						
	Increase step length	*		*	*					
	Improve gait stability			*				*	*	*
	Change step width	*			*			*	*	*
	Improve gait adaptability			*	*		*			*
	Improve walking accelerations					*				
	Train double task (with Stroop[1], Nature Island[2], Symmetry[3] or Italian Alps[4])	* [1,2,3]	* [1,2,3]	* [2,4]	* [1,2]	* [1,2]	* [1,2,3]	* [1,2,3]	* [1]	* [1,2]

Category	Treatment Goals	Training(Front)							
		Symmetry	Arkanoid	Catch	Soccer	Traffic Jam	Nature Island	The Italian Alps	Walk Symmetry
STAND	Improve weight distribution	*							
	Improve weight shifting		*	*	*	*			
STEP	Improve single leg stance				*				
	Improve stepping sideways		*	*	*				
WALK	Improve walking duration						*	*	
	Improve gait stability		*	*	*			*	
	Improve step length						*		*
	Improve walking symmetry						*		*
	Improve gait adaptability							*	

⑥

Manual control & Make your own protocol

7

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.**