

C-MILL PRE-TRAINING MATERIAL



1 Background information

The ability to adjust gait to the requirements of the environment is related to fall risk. Someone must be able to avoid a doorstep, puddle of water or other obstructive objects in order to walk safely in daily life. The C-Mill offers a unique therapy solution as a complete assessment and training tool, simulating everyday life challenges in an engaging, effective, comfortable and safe environment.

The basis of a C-Mill (C' stands for Cueing and Context) is a combination of an instrumented treadmill and a floor projector, allowing functional gait and balance training. By means of visual and acoustic cues, enhanced variation, motivation, parameter-adjustability and both real-time and after-session reports, therapy on the C-Mill achieves to bring the scientifically-based motor learning principles into clinical practice.

With its limited setup time and applications that can be adjusted in an ongoing session, the time spent on actual training for both patient and therapist can be greatly increased. Its training possibilities are even more extended by special balance applications and a Body Weight Support System, that cater for the additional needs in other treatment phases.

Training options

With the use of the instrumented treadmill, the walking pattern can be measured and, with the use of the visual and acoustic cues, this pattern can be influenced by adapting step length, step width, cadence and symmetry.

The C-Mill also allows for obstacle avoidance training as well as training of gait speed variation. Depending on the patient's individual capabilities, the degree of difficulty can be manually adjusted. This allows for a safe and challenging environment, in which an external focus of attention will improve the functional walking skills. Because of the repetitive, high-intensity and task-specific walking training, with direct feedback on performance, the C-Mill concept is in accordance with the latest evidence-based literature about gait training (Hollands et al., 2015, Heeren et al. 2013, Fonteyn et al. 2014, van Ooijen et al. 2015, Houdijk et al. 2012, Papegaaij et al. 2017).

Objective evaluation

Training has to be monitored over time to identify the best course of action. The C-Mill provides highly reliable, objective and valid assessment data of all treatment sessions, so a patient's performance can be measured and saved for short- and long-term insights.

Fun

Next to all these functional features, the C-Mill also delivers a variety-rich experience full of enjoyable and rewarding moments, keeping the patient immersed and motivated. And nothing beats a motivated patient with endless possibilities, provided by you.

1.1 Intended Use

The intended use of the C-Mill is to evaluate and train gait and balance of patients with balance and walking impairments.

2 C-Mill Session Workflow

The following workflow is a *practical* guideline and can be used as a memory aid to standardize a training session on the C-Mill. The corresponding practical and theoretical information should be thoroughly discussed during the User training. Make sure the participants get as many hands on experience as possible.

1

Prepare the C-Mill

- 1.1 Turn on the C-Mill and start CueFors
- 1.2 Turn on the BWS (if applicable)
- 1.3 Calibrate the force plate
- 1.4 Enter the patient info in CueFors

2a

Setup with BWS

- 2.1 Place the harness on the patient
- 2.2 Place the wheelchair under the BWS
- 2.3 Connect the patient to the BWS
- 2.4 Lift the patient

2b

Setup without BWS

- 2.1 Place the harness on the patient
- 2.2 Connect the patient to the safety portal

3

Assessment

- 3.1 Select Stand or Walk assessment
- 3.2 Select treadmill speed (Gait)
- 3.3 Start Session
- 3.4 Analyze the results

4

Training

- 4.1 Select a training
- 4.2 Select treadmill speed (Gait)
- 4.3 Start session

5a

Finish Session with BWS

- 4.1 Stop Session
- 4.2 Lower patient and disconnect from harness
- 4.3 Select results and evaluate session
- 4.4 Return to start screen of CueFors

5b

Finish Session without BWS

- 4.1 Stop Session
- 4.2 Disconnect safetycord and harness from patient
- 4.3 Select results and evaluate session
- 4.4 Return to start screen of CueFors

3 C-Mill Therapy workflow

The C-Mill Therapy workflow is a *clinical* workflow and can be used to provide therapists a guidance for a complete C-Mill session, from intake to evaluation. The different phases are schematically presented in the figure below.

Referral	Discuss the possible indications and contraindications
Intake	To determine the start level for the patient, categorized in Stand, Step and Walk .
Assessment	Measure the baseline level of the patient with balance or gait parameters to set treatment goals.
Training	Reach the treatment goals with our training protocols.
Re-Assessment	Monitor progression with a re-assessment by comparing with previous outcome parameters.
Evaluation	Reevaluate the C-Mill therapy with both the patient and referring specialist

3.1 Referral

In this therapy phase the possible indications and contra-indications are discussed.

Indications
The C-Mill can be used for elderly with increased fall risk and patients with neurological, cardiovascular or orthopedic conditions affecting balance and gait.

Patients with following contraindications are excluded from C-Mill usage.

Contraindications C-Mill
<ul style="list-style-type: none"> ▪ 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**

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

* To ensure reliable force plate data

** FAC (Functional Ambulation Categories). See the FAC level explanation in paragraph 3.2 Intake.

3.2 Intake

	Start level	Training goals
Stand	FAC level \geq 1 (with BWS) FAC level 2	- Dynamic balance - Weight shifting
Step	FAC level \geq 1 (with BWS) FAC level \geq 2	- Stepping balance - One leg stance
Walk	FAC level \geq 1 (with BWS) FAC level \geq 3	- Gait - Gait adaptability

The intake phase serves to determine the start level for the patient, categorized in Stand, Step and Walk.

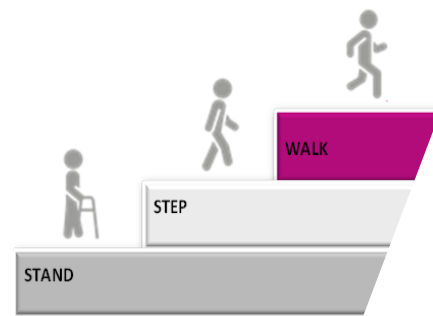
Categories

The three categories for the assessments and training with their corresponding therapy goals are:

Stand: Improve postural control while standing and shifting weight

Step: Improve stepping balance, stepping ability and one-leg stance

Walk: Improve gait functionality and adaptability



Start level

The figure below provides the Functional Ambulation Categories (FAC) scores to determine the start level for **Stand**, **Step** and **Walk**

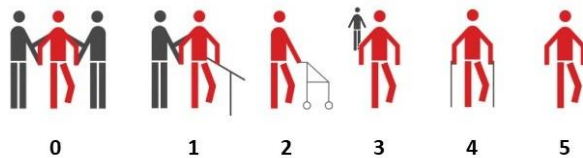


Figure 1: FAC: Functional Ambulation Categories

- FAC 0: Patient cannot walk, or needs help from 2 or more persons
- FAC 1: Patients needs firm continuous support from 1 person who helps carrying weight and with balance
- FAC 2: Patient can walk with continuous or intermittent support of one person to help with balance and coordination.
- FAC 3: Patient can walk but requires verbal supervision/stand-by help from one person without physical contact
- FAC 4: Patient can walk independently on level ground, but requires help on stairs, slopes or uneven surfaces
- FAC 5: Patient can walk independently anywhere

A distinction is made between with or without Body Weight Support (BWS).

3.3 Assessment

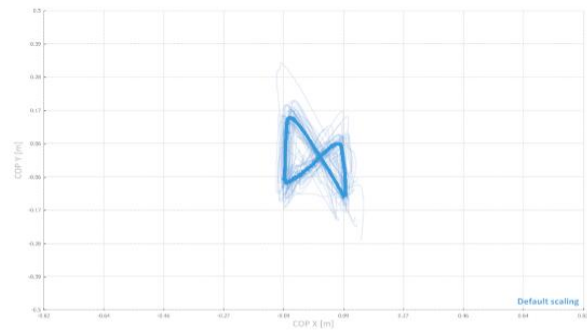
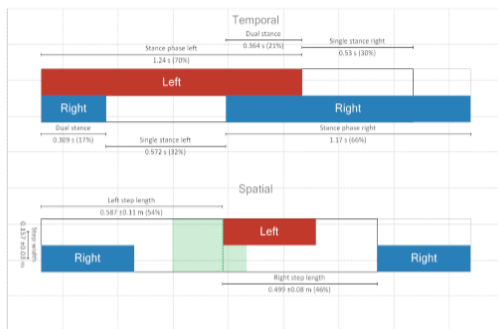
The assessments serve to measure the baseline level of the patient to set treatment goals

Assessments			
Category	Assessment goals	Assessment	Outcome measures
STAND	Static postural control	Postural stability	CoP velocity in cm/s
	Dynamic weight shifting in 4 directions	Limits of stability	CoP displacement in cm
WALK	Walking adaptability	C-Gait	C-Gait score
	Steady state gait	Walk assessment	Step length/Step width Stance duration / Step symmetry
Recording video is applicable during all sessions			

Outcomes

Address the different outcome parameters of each assessment.

Spatial temporal Butterfly



Examples of outcome parameters: spatial temporal parameters and the butterfly.

3.4 Training

In this phase the patient needs to work on his/her specific treatment goals. These can be addressed in (custom) C-Mill protocols or by using manual control.

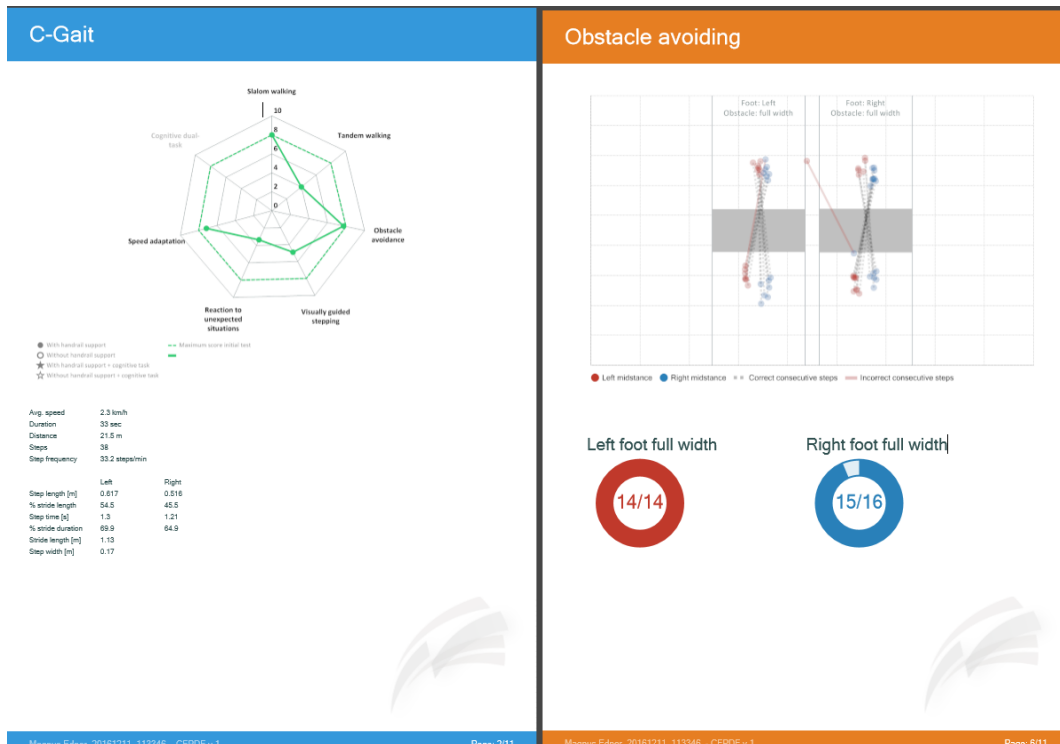
During the training you will receive the C-Mill Therapy Quick sheets' to determine the appropriate training application(s) for your patient to meet your therapy goals.

3.5 Re-assessment

This phase serves to monitor progression with another (the same) assessment to be able to compare the results with the previous assessment outcomes. The example below compares the results of the Limits of Stability Assessment.

3.6 Evaluation

Re-evaluate the therapy with both patient and referring specialist. The figure below shows the report of the C-Gait assessment or the Obstacle avoidance training.



Example of a C-Gait assessment report (left) or an obstacle avoidance training report (right)

4 References

Fonteyn, E.M.R. et al., 2014. Gait adaptability training improves obstacle avoidance and dynamic stability in patients with cerebellar degeneration. *Gait & Posture*, 40(1), pp.247–251.

Heeren, A. et al., 2013. Step by step: A proof of concept study of C-Mill gait adaptability training in the chronic phase after stroke. *Journal of Rehabilitation Medicine*, 45(7), pp.616–622.

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Papegaaij, S. et al. 2017. Virtual and augmented reality based balance and gait training.