

## EVALUATION OF THE FUNCTIONALITY OF WALKING SYSTEMS

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### ABSTRACT

Clinical evaluation is an increasingly important consideration in the research, development and application of walking systems. The main interest in clinical evaluation of walking systems is its functionality. Based on the concepts of the International Classification of Impairments, Disabilities and Handicaps (ICIDH), a model of the functionality of walking systems was developed in our rehabilitation centre. The model was used as a frame for the development of an instrument for the evaluation of the functionality of walking systems.

**KEYWORDS:** Evaluation, functionality, walking systems, FES, orthosis, ICIDH.

### INTRODUCTION

In research, development and application of walking systems, the evaluation is an important consideration. The nature of this evaluation depends very much on specificity of targets to be reached.

During research and development, evaluation has a technical nature, i.e. specific functions of system components or mechanisms are tested with measuring devices. A wide variety of equipment is available for this purpose.

During the use of walking systems, however, a different type of evaluation is necessary. The efficacy in use of a walking system is determined as the difference in functional achievement between the tested and its predecessor systems. For this type of evaluation, there is no measuring instrument available.

The functionality of the walking system is the significant criterion for all research and development efforts in this field, and the need for such an evaluation instrument exists.

Furthermore, the description of walking system performance should be standardized. This standardisation should ease international exchange of research and development results. Since the number of researches directed towards development

and improvement of walking systems is expanding, the importance of this method grows.

In "Het Roesingh" rehabilitation centre, Enschede, The Netherlands, the measuring instrument for evaluation of functionality of walking systems was developed.

## FUNCTIONALITY

As said, "functionality" plays an essential role in evaluation instrument. We define functionality as: the utilisation of general human skills [1]. This definition has consequences for the choice of elements of the evaluation instrument. The definition, itself, includes that human skills must be measured for the functionality description. Secondly and even more important, utilisation of these skills must be measured, i.e. the actual activities with the walking system in patient's daily life.

We used the International Classification of Impairments, Disabilities and handicaps (the ICIDH, [2]), as a guide for the development of the evaluation instrument. This classification is an international standard and its concepts are closely related to functionality of the assistive system.

Conform the definition in the ICIDH, impairments, disabilities and handicaps are related as displayed in the model in Fig. 1.

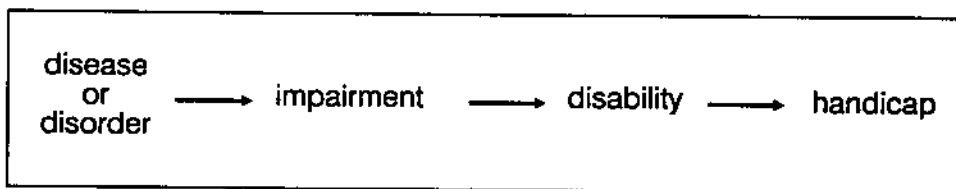


Fig. 1. Relational model of the consequences of disease.

Applied specifically to waling, the term impairment covers aspects like quadriceps function and endurance. Impairments carry over into two aspects: the disability and the handicap levels. On disability, aspects like ability to climb kerbs and change the walking speed are considered. The handicap deals with the impact of impairment and disability on the quality of daily life activity and his or her experience. Each of the three levels impairment, disability and handicap provide important aspects for the assessment of the functionality of walking systems.

## IDH-MODEL OF FUNCTIONALITY OF WALKING SYSTEMS

The purpose of the instrument is to evaluate the functionality of walking systems. In principle, instrument should correspond to all walking systems. In practice, three types of systems are used: orthotic systems, systems based on electrical stimulation and hybrid walking systems (combinations of orthotic systems and electrical stimulation). The instrument must, therefore, cover all aspects related to each of these methods.

The definition of functionality can be operationalised as: skills and daily activities. These two elements are central in an evaluation instrument. Elements that directly or indirectly influence the functionality of walking systems are: medical indication and patient functional status, design of the walking system, intensity of the corresponding training method, and social, physical and psychological aspects.

In our model the two main elements of functionality and the related aspects are incorporated in a framework, based on the concepts of the ICHD. The model is shown in Figure 2.

The first item in the IDH-model is the block "patient status", which represents the description of the patient's diseases and disorders, age, gender, weight, etc. This information is necessary for identification purposes and may be useful in descriptive studies.

Level of impairment has the block "dysfunctions or residual functions", and describes consequences of patient status and functions (physical functions, e.g. quadriceps or bladder function).

The purpose of a walking system, which is prescribed for the patient after a standard selection procedure, is to enhance residual and add new functions. In most cases a training protocol (preparation and maintenance) accompanies the walking system. The intensity, and consequently the effect of the training, is influenced by patient related factors (physical, social or psychological nature). The description of the walking system and training method, as well as measurement of patient related factors are important elements of the instrument.

The block "dysfunctions or residual functions" is not elaborated. The fact that a patient has passed the selection procedure, implies the presence of necessary preserved functions. To allow evaluation of the selection procedure, description of selection criteria is part of the measurements.

The effect of the walking system on a patient's (residual) functions is of interest for technical rather than clinical evaluation.

At disability level, skills are modeled as combinations of the (residual) functions of the patient in addition to the walking system. Standing, for example, requires stabilisation of hip, knee and ankle joints. If any of these functions is insufficient or absent, standing is not possible. Skills are gained either by enhancement or by addition of functions. In measuring functionality skills are essential. Therefore, measurement of skills is an important element of the evaluation instrument. The second block at disability level, the "activities" block, describes the functionality: the utilisation of general human skills. It describes the patient daily life activities, when using the assistive walking system.

Activities are the application of skills in daily life. The factors related to patient determine whether the walking system is used in daily life and if so, to what degree. As mentioned, these factors can be of physical, social or psychological nature. Because of this variety, patient related factors are not split into separate blocks within the levels of impairment, disability and handicap, but rather modeled as one block that covers all levels.

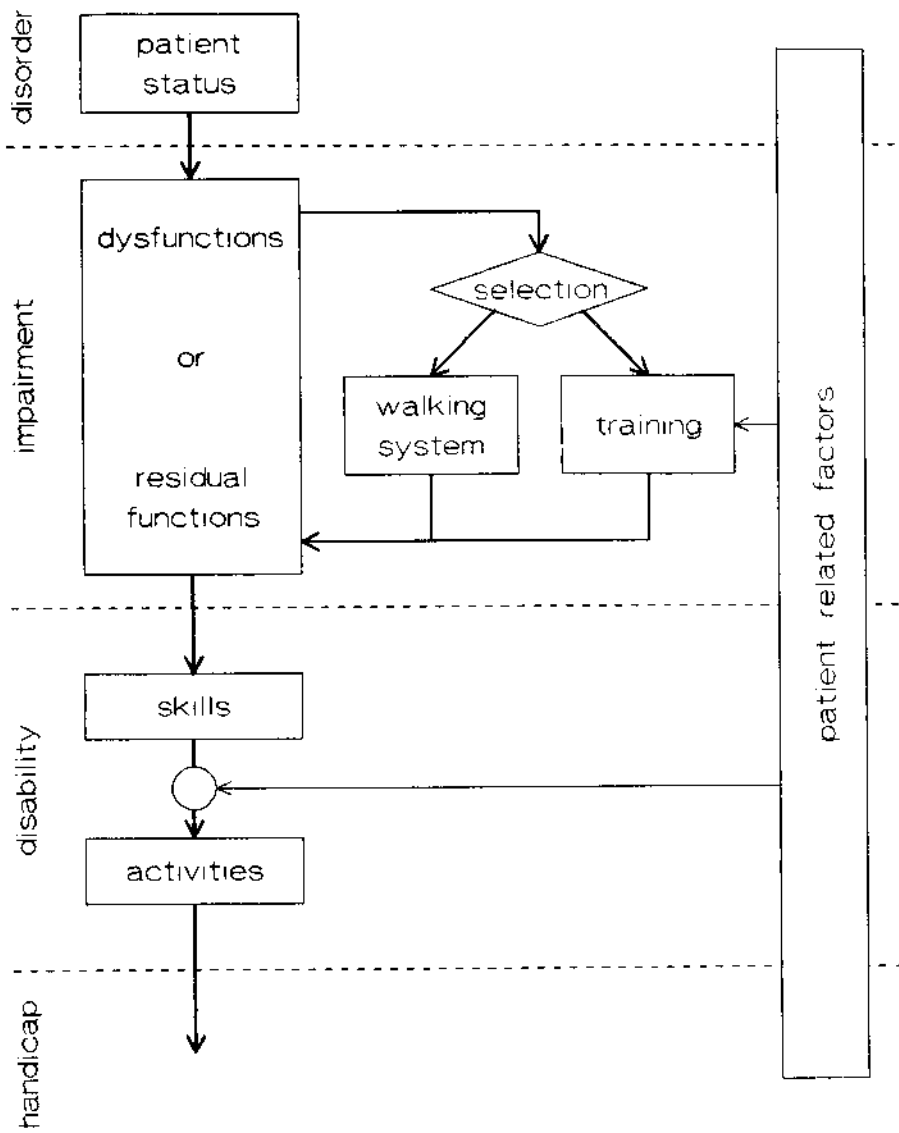


Figure 2. IDH - model of the functionality if walking system

**PATIENT STATUS**

- relevant information about disease/disorder
- name, age, gender, length and weight patient

**SELECTION**

- description of selection criteria

**WALKING SYSTEM**

- description of FES components
  - stimulator
  - electrodes
  - patient command interface
- description of orthosis
  - type
  - adjustments
  - weight
- description of additional walking aids
  - type
  - adjustments
  - weight

**TRAINING METHOD**

- description of preparatory training
  - method
  - intensity (frequency, duration, level)
- description of maintenance training
  - method
  - intensity (frequency, duration, level)

**SKILLS**

- donning/doffing: time
- standing up/sitting down from wheelchair independently: time
- standing maximum time
- walking
  - comfortable speed, 10 m: speed
  - maximum speed, 10 m: speed
  - 30 min endurance walk: distance, number of rest periods, total rest time
  - special skills
    - passing closed door: time (both directions)
    - route with obstacles: time (both directions)
    - stairs: time up/down
    - kerbs: maximum height up/down, time up/down
    - slope: maximum slope up/down, time up/down

**ACTIVITIES**

- daily use: average time
- donning/doffing: independence, time
- standing up from wheelchair: independence
- standing up after fall: independence
- standing: times per day, average time, activities while standing
- walking: average time of use, distance indoors/outdoors, activities indoors/outdoors
- special activities: (stairs, doors, kerbs, slopes): independence, average use

**PATIENT RELATED FACTORS**

- related to walking system
  - design/realisation
  - ease of use/user friendliness
  - reliability
- related to training
  - method and intensity
  - exertion
- related to skills
  - motivation for training
  - exertion
- related to activities
  - motivation with respect to utilisation of skills
  - demotivation with respect to utilisation of skills

## OVERVIEW OF THE EVALUATION INSTRUMENT

From the model description it is clear that measurement of the functionality of walking systems means measurement of many of related aspects. These aspects can be divided into two groups.

The first category consists of aspects that can be measured by objective instruments or semi-objective observation (comparable measurements have been performed before [3]). Items in this category are the patient status, descriptions of the walking system and training method, and the patient's skills.

Aspects of the second type are subjective aspects that must be collected by patient inquiries. These judgements are quantified using the Likert Scale technique [4]. In the model, these aspects are placed in the block "patient related factors". They are related to the walking system, the training, the skills and the daily activities. An overview of the measurements of the evaluation instrument is given below.

**Acknowledgement:** This project was supported by the Dutch "St.Joris" foundation.

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