Technology-based measurement of arm-hand skill performance in daily life conditions

Why is this instrument innovative and important, and opening up new horizons?

The instrument developed is novel and both *technologically and clinically innovative*. Until now, no instruments are available to objectively assess actual arm-hand performance, i.e. measuring at a level that is most important for the patients, representing their (in)ability to perform activities of daily living. This research project is innovative because (sensor)technology has been used in a newly developed instrument which will be capable of objectively measuring both the *amount of use* and the *quality of performance* of *specific activities*. Thereby the instrument can be used to answer relevant clinical questions regarding arm-hand skill performance of the activities patients want to improve on, i.e. questions which cannot be answered yet using the currently available measurement instruments.

The instrument developed is also innovative because it is applicable in different patient populations, thereby transcending diagnosis boundaries. Regarding arm-hand training, most treatment approaches target a specific patient population, and almost all arm-hand assessment instruments are currently applied in only one particular pathology [2]. This has led to a myriad of patient-specific assessment tools. However, patients with different disorders with similar clinical characteristics may benefit from similar treatments, and assessment instruments may be suitable for more than one patient population. To enable a comparison of treatments within one patient population, and to gain more insight in the possibilities of common therapies for different patient populations with similar clinical characteristics, consensus should be reached regarding the choice and use of outcome measures that can be used across pathologies. The instrument developed in the present research may be used in different patient populations.

How can the instrument be beneficial for patients receiving rehabilitation?

When the instrument is available to be used in clinical practice, benefits for the patients will be achieved in two ways, i.e. 1) direct benefit through the use of the instrument in the clinic in direct support of patient-related diagnosis, treatment selection, prognosis and (therapy) evaluation; and 2) indirect benefit in facilitating the development of new therapies and improvement of current treatments, by using the newly developed instrument as an evaluation tool.

Direct benefit for patients through the use of the instrument in clinical practice

First of all, with this instrument, an earlier and better detection of arm-hand related problems in daily life is possible. Arm-hand use in daily life is very important for the patient, because this has a major influence on the dependency of the patient and his/her quality of life. Being able to measure problems patients experience is important for rehabilitation specialists to improve their current goal-directed task-oriented training regimes. If it is possible to detect, at an early stage of rehabilitation, which problems the patient experiences regarding the use of his arms and hands while executing activities of daily living, the patient-centred therapy can be adapted in such way that the specific problems can be addressed. For instance, with this instrument it may be possible to detect which specific activities are difficult for the patient to perform and it may be possible to define, based on the quality of performance, what the underlying problem for these difficulties is. This underlying problem can then be targeted during therapy.

Secondly, with this instrument it is possible to assess improvements of arm-hand use of the patient in a domain that is most important for him, i.e. at ICF activity level. For the patient as well as for the rehabilitation team, this gives insight in the possibilities the patient has regarding the performance of activities of daily living. For the patient, this may be beneficial because it can increase the self-efficacy of the patient, i.e. the degree of confidence possessed by persons in their ability to perform specific acts successfully [3]. It is known that a low-self-efficacy, which is the case in many stroke patients, is correlated with improved disability.

Thirdly, recent trends in rehabilitation include module-based therapy and home-based therapy. By assessing actual arm-hand skill performance in patients' daily life, the instrument will be pre-eminently suitable to determine which therapy module is necessary at which point in time. With this instrument it is possible to measure which are the main problems patients experience regarding their arm-hand use at home (e.g. using the affected arm-hand while eating with knife and fork), and consequently, a specific therapy module can be offered to the patient to improve arm-hand performance with the aim to reduce the problem (i.e. provide therapy to improve the use of the affected arm-hand during the activity eating with knife and fork). For the patient this is beneficial because by choosing the best therapy approach, treatment will be most efficient. In addition, the possibility to determine therapy modules beneficial for the patient might be valuable for health insurance companies, since the instrument can be used to substantiate the need for specific therapy-modules during the rehabilitation treatment.

Fourthly, the instrument can be used to gauge/document the course of recovery of arm-hand skill performance. A library can be created containing templates of signals representing arm-hand skill performance of numerous patients. These templates

should be arranged based on the patient's diagnosis and severity of arm-hand impairment. For every patient, multiple templates should be created in time, i.e. movement patterns of performance at the beginning of rehabilitation and after therapy. By using this library it is possible to compare movement patterns of a specific patient in time and to compare his/her movement patterns with the templates of other patients in the library, and thereby infer on the status of the patient's arm-hand performance. Using this library, it may also become possible to predict the course of recovery of patients. This is very valuable for patients, since their main question for the rehabilitation physicians at the start of rehabilitation is: "Doctor, what will I be able to do with my arm and hand once rehabilitation treatment is finished?"

Indirect benefit in facilitating the development of new therapies and improvement of current treatments

Indirectly, patients may benefit from the instrument developed because this instrument may provide information necessary to optimize current therapy and develop new treatments. With the instrument developed, therapies and treatments can be evaluated as to their efficacy in the domain which is most important for the patients, i.e. on the performance of activities of daily living. Most rehabilitation therapies and treatments focus on this domain. Moreover, this research project opens new horizons regarding more fundamental research. It is very important to be able understand the learning mechanisms behind rehabilitation, and design therapies that make use of this knowledge. Patients may each have different training preferences regarding which arm-hand activities they wish to train on [4, 5]. However, as rehabilitation time is too short to address a comprehensive set of activities, patients are trained on a selected (and very limited) number of arm-hand activities. Inter-task transfer, i.e. transfer of trained activity performance towards untrained activities, is important in order to be able to perform a wide range of activities after rehabilitation. An instrument capable of identifying activities in daily life is needed to investigate this inter-task transfer phenomenon. The instrument is very useful to a) measure which activities patients can perform at home and new/other activities are learned after therapy, b) determine the quality of performance, c) determine the task (dis-)similarity between different activities. The latter is assumed to be related to inter-task transfer of learning.

To attain the implementation of the instrument developed in clinical practice, more research is necessary to further optimize the instrument regarding its applicability in daily life and the applicability in different patient populations. Furthermore, the instrument should be further optimized regarding its design, usability and user friendliness (for both the patient and the rehabilitation specialist). To be able to perform this research, funding is required.

References

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