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DEVELOPING HUMAN FUNCTIONING AND REHABILITATION RESEARCH PART I: ACADEMIC TRAINING PROGRAMS

Gerold Stucki, MD, MS[1,2,3]

From the [1]Department of Physical Medicine and Rehabilitation, Ludwig-Maximilian University, Munich, [2]ICF Research Branch of the WHO CC FIC (DIMDI), Institute for Health and Rehabilitation Sciences, Ludwig-Maximilian University, Munich, Germany and [3]Swiss Paraplegic Research, Nottwil, Switzerland

Key to building research capacity is the development of a qualified workforce. This requires the establishment of academic training programs and the creation of attractive research career opportunities. The adoption of the International Classification of Functioning, Disability and Health as unifying conceptual model for rehabilitation, the emergence of distinct scientific fields of human functioning and rehabilitation research, and the change to Bachelor and Master degrees in Europe provide opportunities to initiate academic training programs in human functioning and rehabilitation research. Applied training includes certificate programs in rehabilitation effectiveness and Masters and Doctoral programs in rehabilitation with specializations, e.g. in rehabilitation studies, management, education and rehabilitation counseling. Scientifically-oriented training includes Masters of Science and PhD programs in human functioning sciences and integrative rehabilitation sciences. There is also potential for collaborative Masters and Doctoral programs with the rehabilitation professions, movement sciences, psychology and the behavioral and social sciences. When initiating the process to develop these programs, one may learn from and co-operate with established programs in public health.

Key words: education, rehabilitation, human functioning sciences.

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Correspondence address: Gerold Stucki, Department of Physical Medicine and Rehabilitation, University Hospital Munich, Marchioninistrasse 15, DE-81377 Munich, Germany. E-mail: gerold.stucki@med.uni-muenchen.de

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INTRODUCTION

There is an urgent need to increase research capacity in rehabilitation in order to address the challenges summarized in the WHO resolution on disability, including rehabilitation, management and prevention (1–3). As is the case for any scientific area, the key to building research capacity is the development of a qualified workforce and the creation of attractive research career opportunities (4, 5). The integration and translation of knowledge generated by the biomedical, behavioral and social sciences into tangible benefits for people experiencing disability requires human functioning and rehabilitation researchers who are educated and trained in research from the comprehensive perspective based on an integrative model of human functioning (1, 5, 6). There are a number of reasons why it is timely to initiate respective new academic training programs.

The first reason is the approval of the International Classification of Functioning, Disability and Health (ICF) in 2001 (1). The ICF is the basis for the conceptualization of rehabilitation (7–9) and, hence, the development of coherent research training curricula in human functioning and rehabilitation.

The second reason is the emergence of distinct scientific fields for human functioning and rehabilitation research (10, 11). Distinct scientific fields for human functioning and rehabilitation research are the cornerstone of focused research training programs (1, 7, 12, 13). It is not possible adequately to train researchers in all potentially relevant domains of human functioning and rehabilitation research (3, 5). Only if we strike the right balance between the training of core aspects relevant to all human functioning and rehabilitation research and the focused and rigorous training in distinct scientific fields and research domains (10, 11), will trainees develop both a common identity as human functioning and rehabilitation researchers and become competitive researchers in distinct scientific fields and research domains.

The third reason is the implementation of the designated Bologna Process in Europe. The transition of current academic programs from diploma degrees to Bachelors and Masters degrees has already brought, and will bring, profound changes in academic training programs in many European countries. For research training in human functioning and rehabilitation, the Bologna Process provides exciting new opportunities. Scientific and applied training programs in human functioning and rehabilitation at the Masters and Doctoral level may become attractive not only to rehabilitation professionals but also to scientists with a Bachelors degree in a wide range of related disciplines, including psychology, sociology or movement science.

To be successful, graduate and postgraduate training programs in human functioning and rehabilitation must be tailored to the needs of students with a background in varying disciplines and alternative career perspectives. Ultimately, they will only be successful if there is, or will be, relevant demand for researchers trained in human functioning and rehabilitation.

The aim of this paper is to outline a framework for the development of academic programs in human functioning and rehabilitation. The specific aims are: (*i*) to summarize current training in human functioning and rehabilitation research; (*ii*)

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to outline general considerations relevant to the development of new training programs; and (*iii*) to describe envisioned training programs in human functioning and rehabilitation research.

CURRENT TRAINING IN HUMAN FUNCTIONING AND REHABILITATION RESEARCH

In most countries, current training in rehabilitation research takes largely place in the context of the professional rehabilitation sciences (3). However, research is generally only a small part of the professionally oriented training in these disciplines. Accordingly, research productivity of academic clinical departments across the rehabilitation professions has been limited (3).

The situation may change with new training and funding opportunities in some countries. For example in the USA, the Netherlands and Scandinavia the rehabilitation professions, including physiotherapy and occupational therapy, now offer Masters and Doctoral programs in their disciplines. Some faculties of medicine and health sciences also offer applied programs for rehabilitation. An example is the postgraduate diploma in rehabilitation of the Rehabilitation Teaching and Research Unit, University of Otago, New Zealand. It offers training in best practice in rehabilitation. It is attractive to a wide range of health professionals including physicians (14). Given the breadth of topics, it has been questioned whether similar, more science-oriented programs, in rehabilitation science (15) are suited to provide the necessary training to succeed as a scientist in the highly competitive international research environment (3). Accordingly, it has been suggested to focus researcher training on distinct scientific fields of study (1, 3, 10).

CONSIDERATIONS FOR THE DEVELOPMENT OF NEW TRAINING PROGRAMS IN HUMAN FUNCTIONING AND REHABILITATION

The development of needs-based and student-oriented research training programs is facilitated by the organization of programs according to considerations discussed in the following sections.

Curricula and careers in distinct scientific fields for human functioning and rehabilitation research

Research training programs are generally organized around distinct scientific fields of study (1, 10). In 2 accompanying papers we have developed a structure for organizing human functioning and rehabilitation research in 5 distinct scientific fields (10) and have provided conceptual descriptions and domains for research in these fields (11). The distinct scientific fields provide the conceptual framework for the development of coherent research curricula. Research training programs may thus be organized accordingly. Table I summarizes current and envisioned future qualifications and careers in the 5 scientific fields of human functioning and rehabilitation research.

Programs in human functioning and rehabilitation vs collaborative programs with related scientific disciplines

Research training programs may be dedicated entirely to one or a combination of the 5 distinct scientific fields of human functioning and rehabilitation research. Alternatively, training may be organized in collaboration with a related scientific discipline. Related scientific disciplines that may be considered for collaborative programs with the 5 distinct scientific fields are shown in Table I.

The first option holds great promise for the human functioning sciences and integrative rehabilitation sciences that take the comprehensive perspective. The main reason is the potential of these emerging fields (1, 16). Also, they are currently not a major focus of any of the related scientific disciplines.

Collaborative programs are the preferred option for the professional rehabilitation sciences that are rooted in their professional disciplines. Collaborative programs are also preferable for the biomedical rehabilitation sciences and engineering. This field is arguably too heterogeneous to allow for the development of a comprehensive and coherent training program dedicated solely to biomedical rehabilitation sciences and engineering.

Participants in a collaborative program may study under the primary auspice of a supervisor (Masters thesis) or promoter (Doctoral degree) who is either qualified in the relevant rehabilitation field or the related discipline. It seems advisable to engage a co-supervisor or co-promoter of the respective partner field (Table II).

Scientific vs applied programs

Similar to public health (17, 18, p. 59), there is a need to provide rigorous scientific training for human functioning and rehabilitation scientists pursing a career as principal investigators as well as applied training for professionals who intend to become leaders in their discipline. Professionals with applied research training can link rehabilitation practice with research and vice versa.

When designing training programs one needs to be aware of the quite different competencies required for a scientific vs an applied orientation. This is reflected by the 2 types of Masters programs according to the Bologna process in Europe. According to this process each Masters program is required to designate its program either as science-oriented or application-oriented.

Applied programs provide students with the competency to translate knowledge into practice, to participate in research and to study practice-relevant questions. The process of studying practice relevant questions is often called “development” or “performance improvement” rather then “research”.

Instead, science-oriented programs provide the basis for developing independent research capacity. According to the Swedish Department for Research Cooperation (19), research capacity is defined as the “…..ability to independently identify and define researchable problem areas; plan and implement research tasks; participate in and utilize international research; evaluate, select and adapt research findings; publish, disseminate and apply research findings; offer attractive

Table I. *Current and envisioned qualifications and careers in human functioning and rehabilitation.*

Field	Biosciences in rehabilitation	Biomedical rehabilitation sciences	Professional rehabilitation sciences	Integrative rehabilitation sciences	Human functioning sciences
Related disciplines and fields	Molecular biology Molecular medicine Neurobiology Physiology Pathophysiology	Applied and exercise physiology Movement science Nutrition and pharmacology Rehabilitation engineering Sports science	Clinical psychology PRM Neuro-psychology Nursing Occupational therapy Physiotherapy Rehabilitation counseling Social work Speech therapy	Economics Education Environmental engineering Health services research Health management Psychology	Architecture and design Anthropology and cultural geography Behavioral sciences Biostatistics, decision science and epidemiology Health policy, political science and economics History Sociology and social psychology
Typical current qualification of rehabilitation researchers	Diploma or MS/PhD in a related field	Diploma or MS/PhD in a related field	Diploma or MS/PhD in a related field Certificate in clinical effectiveness or similar qualifications Master in medical science (or another professional science e.g. nursing science, physiotherapy science, occupational therapy science)	Diploma or MS/PhD in a related field Master in a rehabilitation profession Master of public health (with a prior professional qualification)	Diploma or MS/PhD in a related field Master of public health (with a prior professional qualification)
Envisioned qualification	–	MS/PhD in biomedical rehabilitation sciences	Certificate in medical rehabilitation Master in rehabilitation (possible specialization in management; counseling; medical education) Doctor in Rehabilitation and Health	MS/PhD in integrative rehabilitation sciences	MS/PhD in human functioning sciences
Envisioned collaborative qualification	–	MS/PhD in movement sciences (or sports science; or another related field) and rehabilitation sciences	MS/PhD in physiotherapy (or occupational therapy; nursing; or another professional science) and rehabilitation sciences	MS/PhD in psychology (or another related field) and rehabilitation sciences	MS/PhD in sociology (or another related field) and human functioning sciences
Required prior qualification	–	BC in a related field	BC in a professional discipline	BC in a related field or in a (rehabilitation, health) profession	BC in a related field
Career perspectives	–	Research Teaching (BC/MS in a related discipline or a rehabilitation profession) Health education and promotion for people with health conditions Industry (rehabilitation technology)	Clinician-researcher Clinician-teacher Clinician-manager Rehabilitation counselor Case manager (insurance, integrated care networks, hospitals) Project scientist	Research Insurance (indemnity, injury, sickness) Ministries of health, labor, social affairs, education	Research Insurance (indemnity, injury, sickness) Ministries of health, labor, social affairs, education
Current academic perspectives	Chairs in bioscience	Chairs in human movement sciences (or a related field) Chair in rehabilitation engineering	Chair in PRM Chair in a professional science (e.g. physiotherapy, occupational therapy, nursing, psychology)	Chair in rehabilitation sciences (US; Germany)	Chair in health sciences Chair in public health

Table I *contd.*

Field	Biosciences in rehabilitation	Biomedical rehabilitation sciences	Professional rehabilitation sciences	Integrative rehabilitation sciences	Human functioning sciences
Envisioned academic perspectives	-	Chair in biomedical rehabilitation sciences Chair in movement (or another related field) and rehabilitation sciences	Chair in occupational therapy (or another professional science) and rehabilitation sciences	Chair in rehabilitation sciences (and human functioning sciences) Chair in psychology (or another related field) and (integrative) rehabilitation sciences	Chair in human functioning sciences Chair in human functioning and (integrative) rehabilitation sciences Chair in sociology (or another related field) and human functioning sciences
Faculty/ department affiliation	Biology	Biology Medicine Health sciences Human sciences Movement sciences	Medicine Health sciences	Medicine Health sciences Psychology Public health	Medicine Health sciences Public health Social or human sciences

PRM: physical and rehabilitation medicine; MS: Master of Science; PhD: Doctor of Philosophy; BC: Bachelor.

research environments; (and) the capacity to reproduce its own capacity" (20). Ultimately, scientists should therefore be able to develop research capacity in their fields. Accordingly, strongly science-oriented programs may consider accepting into a Masters program only those students who also qualify for a PhD program. Similar to some programs in public health, rigorously science-oriented programs may accept only PhD students (17).

Education and training

In this paper we use the terms "education" and "training" interchangeably, as is common in the health professions (18, p. 20). Conceptually, however, education and training differ. Education may be viewed as transmitting broad knowledge relevant to the field and developing critical thinking abilities which are widely viewed as essential to the creation and evaluation of new knowledge. Didactically, education involves, for example, lectures and seminars.

Instead, training may more narrowly be defined as providing the skills that are necessary for certain research activities (18, p. 21). Training always involves practice and experience. Training is an essential aspect of both applied and science-oriented programs. Training is generally an important part of Masters degrees through the supervised conduct of the Masters thesis project. In the case of a scientific degree this is, for example, a systematic review and/or a data analysis project. Masters programs may also require a practical rotation, which, in the case of a scientific orientation, generally involves experience with data collection. Major training activities, including internships and on-the-job-training, are pursued during doctoral programs. From public health we can learn that fieldwork is essential for the training of students and to stimulate meaningful research (14).

Academic degrees in human functioning and rehabilitation

Bachelors degree. Human functioning and rehabilitation are essential topics for any undergraduate training of physicians and health professionals. The provision of attractive courses is an important opportunity to motivate qualified students to enroll in a Masters program in human functioning and rehabilitation or a collaborative program with a related discipline upon completion of their undergraduate studies.

It does not seem advisable to develop dedicated undergraduate programs in human functioning and rehabilitation. The main reason is that both the scientific or applied study of human functioning and rehabilitation requires an in-depth understand-

Legend to Table II

[1]Or another scientific discipline related to biomedical rehabilitation sciences and engineering; [2]or another scientific discipline related to professional rehabilitation sciences; [3]or another scientific discipline related to integrative rehabilitation sciences; [4]or another scientific discipline related to human functioning sciences [5]topics described in accompanying papers (11, 12); [6]topics listed in table III; [7]depending on the choosen specialisation for the applied Master in Rehabilitation.

Masters program: x = required module; y = recommended module; z = optional module; n = not applicable.

Doctoral program: u = required module; v = recommended module; w = optional module; n= not applicable.

I = basic training; II = advanced training.

HFS: human functioning sciences; IRS: integrative rehabilitation sciences; BMRS: biomedical rehabilitation sciences; PRS: professional rehabilitation sciences; HF&R: human functioning and rehabilitation; BC: Bachelor; MS: Master of Science; PhD: Doctor of Philosophy; CIR: certificate in rehabilitation effectiveness; PT: physiotherapy.

Table II. *Training programs in human functioning and rehabilitation.*

Degree	CIR	Applied Masters/Dr	MS/PhD		Collaborative MS/PhD			
Modules and courses		Rehabilitation	HFS	IRS	Movement Science[1] and IRS	PT[2] and IRS	Psychology[3] and IRS	Sociology[4] and HFS
Scientific methods								
General methods and principles								
Principles of public health	x	x u	x u	x u	x u	x u	x u	x u
Research design I	x	x u	x u	x u	x u	x u	x u	x u
Research design II	n	n u	y u	y u	y u	y u	y u	y u
Quantitative methods I	x	x u	x u	x u	x u	x u	x u	x u
Quantitative methods II	n	n u	y u	y u	y u	y u	y u	y u
Research skills[6]								
Research skills I	x	x u	x u	x u	x u	x u	x u	x u
Research skills II	n	n u	x u	x u	x u	x u	x u	x u
Research skills III	n	n u	x u	x u	x u	x u	x u	x u
Specific scientific methods								
Measurement of functioning	n	z w	x u	z v	z w	z v	z u	z u
Modeling of complex functioning data	n	n w	y u	z w	n w	n w	n v	n u
Longitudinal modeling of functioning	n	n w	y u	z v	n u	n v	n w	n v
Economic evaluation of programs and interventions	n	n w	z w	x u	n u	n u	n u	n w
Qualitative research methods	n	n w	y u	z w	n w	n w	n v	n u
Theory and model development	n	n w	y u	z u	n w	n w	n w	z u
Rehabilitation technology assessment	n	n u	z w	x u	n u	n u	n u	n w
Functioning impact assessment	n	z w	x u	z v	z w	z v	z u	z u
Rehabilitation technology transfer/ implementation	n	n u	z w	x u	n u	n u	n u	n w
Distinct scientific fields in HF&R								
Human functioning sciences[5]								
Human Functioning Sciences I	n	x u	x u	x u	y u	y u	y u	y u
Human Functioning Sciences II	n	z w	x u	z v	n w	n w	z u	z u
Integrative rehabilitation sciences[5]								
Integrative Rehabilitation Sciences I	x	x u	x u	x u	y u	y u	y u	y u
Integrative Rehabilitation Sciences II	n	z w	z v	x u	n w	n v	z v	z w
Professional rehabilitation sciences[5]								
Clinical and service effectiveness I	x	x u	z w	x u	z v	y u	z v	z w
Clinical and service effectiveness II	n	n u	n w	n u	n v	n v	n w	n w
Biomedical rehabilitation sciences								
Principles of Biomedical Rehabilitation Sciences and Engineering	n	x u	y u	x u	y u	y u	y u	y u
Biosciences and rehabilitation								
Principles of Biosciences and Rehabilitation	n	x u	z v	x u	y u	y u	n v	n v
Applied topics in HF&R								
Condition group or condition perspective	n	x u	z u	x u	z u	z u	z u	z u
Body function and activity perspective (capacity)	n	z w	z w	y v	z u	z u	n v	n w
Participation perspective (performance)	n	x u	y u	x u	n w	n v	z u	z u
Personal factor perspective	n	z v	x u	z u	n w	n w	z u	z u
Environmental factor perspective	n	z v	x u	z v	z w	z v	z v	z u
Service provision perspective	n	x u	z v	x u	n w	n v	n v	n v
Payer perspective	n	x u	z v	x u	n w	n w	n w	n v
Policy and law perspective	n	n w	x u	z v	n w	n w	n w	z u
Knowledge transfer	n	n v	x u	x u	z u	z u	z u	z u
Specializations in rehabilitation								
Rehabilitation management	n	x[7] w	z w	z w	z w	z w	z w	z w
Rehabilitation counseling	n	x[7] w	z w	z w	z w	z w	z w	z w
Rehabilitation education	n	x[7] w	z w	z w	z w	z w	z w	z w
Rehabilitation studies	n	x[7] w	n n	n n	n n	n n	n n	n n

ing of at least one component of human functioning and/or an understanding of the interactions between components. This may be the knowledge of pathologies and/or body functions and structures, as is the case for physicians and physiotherapists. Alternatively, it may be the knowledge of personal factors, as is the case for psychologists or an understanding of the environment and its interaction with functioning, as is the case for some sociologists. From public health we can learn that dedicated undergraduate degrees, if attempted, had only a short half-life (21). Currently most public health programs require a Bachelors degree as access requirement.

With the implementation of the Bologna process also for the training of physicians, e.g. in Switzerland, rehabilitation may become an interesting topic for undergraduate students who decide not to pursue clinical medicine at the graduate level. According to the Bologna process, all undergraduate degrees must provide a professional qualification. Since an undergraduate degree does not qualify one to practice medicine, there must be alternatives for students not continuing in clinical medicine. In the third year, these students may therefore be given the option to specialize in an area leading to a professional qualification. Rehabilitation may be an interesting option, e.g. by providing a professional qualification in rehabilitation management or rehabilitation counseling, as outlined in a following section. Other options for these students could include specializations in biomedicine, public health or medical education (providing the qualification to teach at schools for health professionals).

Masters degree. Masters level degrees are the preferred entry level for science-oriented Masters programs in the human functioning sciences and integrative rehabilitation sciences. The practicability and attractiveness of science-oriented and application-oriented collaborative programs at the Masters level is less clear, and the gain in breadth needs to be weighed carefully against a potential loss of depth and focus with respect to the training in the related scientific discipline and the rehabilitation field.

With the implementation of the Bologna process in Europe there are an increasing number of professional Masters programs, e.g. in physiotherapy and occupational therapy. They may be interested in developing a collaborative program with rehabilitation sciences, since rehabilitation is generally a core topic of these programs. Similarly, Masters programs in movement and sports sciences train a large number of students and may also be interested in a collaborative Masters program as an attractive niche for students with an interest in rehabilitation. An alternative to collaborative Masters programs for these fields is a specialization in rehabilitation within their own programs.

Doctoral degree

Doctoral students ideally have a prior Masters qualification in human functioning and rehabilitation research. If not, students should take the courses as required for a Masters degree in human functioning and rehabilitation as well as suitable advanced courses (Table I).

Schools of public health often distinguish between a research-oriented PhD curriculum and an applied DPH (Doctor of Public Health) for advanced training in public health leadership (18, p. 59, 17, p. 8). Science-oriented curricula dedicated to human functioning sciences and/or integrative rehabilitation sciences may accordingly lead to a PhD (18, p. 59, 17, p. 8). Instead, application-oriented curricula within the realms of the professional sciences could accordingly lead to a doctoral degree in rehabilitation or "rehabilitation and health", possibly abbreviated as DRH (Doctor in Rehabilitation and Health).

Collaborative programs may choose a scientific orientation and hence offer a PhD degree. Examples would be collaborative programs in human functioning sciences and sociology or behavioral sciences; programs in integrative rehabilitation sciences and psychology; and programs in biomedical rehabilitation sciences and engineering and movement or sports sciences.

Collaborative programs with the professional sciences with an applied orientation may instead offer an applied doctoral degree. An example would be a doctoral degree in "Rehabilitation and Physiotherapy Science", possibly abbreviated as DRPS.

Program organization

Curricula. Table II shows modules and courses for the tracks described in the following sections. Suggestions for required, recommended and optional modules and courses for Masters and doctoral degrees are denoted according to the table's glossary.

The first set of modules refers to scientific methods. The modules on general scientific methods and principles as well as skills are relevant to any scientific training. They contain some of the core components of public health training (17): quantitative methods (biostatistics); research design (epidemiology); health services administration; community-based participatory research; and ethics. Selected contents of the modules, general scientific methods and skills are shown in Table III. The module-specific scientific methods (in Table II) show examples of courses specifically relevant to human functioning sciences and integrative rehabilitation sciences including, for example, qualitative research methods. They are not further specified.

The modules under the heading "distinct scientific fields of human functioning and rehabilitation" refer to the 5 distinct scientific fields of human functioning and rehabilitation research (10, 11). The domains of these fields that define the content of the modules have been described in detail in an accompanying paper (11). These modules also address additional core domains with respect to public health, including policy and law, genomics and social and behavioral sciences. Policy and law is part of the module on human functioning sciences. Genomics is part of the module on biosciences and rehabilitation. Social and behavioral sciences are part of the modules on human functioning sciences and integrative rehabilitation sciences.

The next heading "applied topics" provides examples of modules focusing on topics in relation to the 4 types of health conditions (developmental disorders, diseases, injury and ag-

Table III. *Description of contents of the modules for general scientific methods and research skills.*

Scientific methods	
General scientific methods and principles	
Quantitative methods I	Descriptive and bivariate statistics; Reliability statistics; Statistical graphics Probability statistics (Bayes theorem); Sample size calculation
Quantitative methods II	Multivariate statistics; Survival statistics Probabilistic modeling (Markov)
Research design I	Experimental and non-experimental study designs; Qualitative studies; Bias, confounding, chance; Outcome assessment (truth, discrimination, practicability)
Research design II	Complex experimental and non-experimental study designs Quasi-experimental study designs Community-based participatory research Comprehensive intervention research
Principles of public health	Population perspective; Ecological model; Ethics; Genomics and health; Behavior and health; Environment and health; Health prevention and promotion Health services administration; Health economics
Skills	
Research skills I	Statistical software programs; Protocol development; Publication writing; How to read the literature; Qualitative systematic review; Data collection (survey; telephone; face-to-face)
Reseach skills II	Informatics; Statistical programming and documentation; Successful grant writing; Principles of writing ethics protocol; Research organization (how to build and run a study center; how to build and maintain a cohort); Quantitative systematic review (meta- and mega-analysis)
Research skills III	Cultural competence (how to address people with different cultural backgrounds) Communication (the art and technique of informing, influencing, and motivating individual, institutional, and public audiences about health issues); Presentation; Dissemination

ing) or selected health conditions (e.g. stroke); the components of human functioning (body function and activity; participation); the personal or environmental factor perspective; service provision, payer, policy and law; and knowledge transfer.

The last heading refers to examples of specializations for a Masters from the perspective of the professional sciences.

Since the specification of programs, e.g. according to the Bologna process, depends on a number of issues and cannot be generalized, no attempt is made to assign credits according to the European Credit Transfer System (ECTS) to each module or to provide a time schedule. However, the provision of modules and courses in blocks of 1, 2 or 3 weeks is advantageous for a program with international students and when planning collaborative programs and cross-registration with other programs.

Program provision. Considering the necessary resources and limited teaching capacity of faculties and programs, one may consider collaboration with other programs, schools or faculties in the provision of common modules and courses, particularly with respect to general scientific methods and skills. The courses summarized in these modules are now common to many programs in public health or the health sciences.

Collaborative programs with other faculties, departments and schools of the related disciplines are also advantageous, because they increase the number of students exposed to programs in human functioning and rehabilitation. This can attract students into human functioning and rehabilitation research and foster interdisciplinary collaboration.

Collaboration with schools and programs of public health. Most attractive partners for programs of human functioning and rehabilitation are programs and schools in public health. There are a number of similarities between public health and human functioning and rehabilitation. Similar to public health, human functioning and rehabilitation research may take the population perspective. Also, the integrative model of human functioning mirrors the ecological model used in public health.

Human functioning and rehabilitation can thus learn from public health with respect to its population focus and the ecological model. Conversely, public health, which is currently virtually exclusively focusing on preventive and curative health strategies, may benefit from considering the rehabilitation strategy (8).

As outlined in the section on curricula, all components of public health training are potentially relevant for training programs in human functioning and rehabilitation. Therefore, collaborative programs of human functioning sciences and integrative rehabilitation sciences with public health programs are conceivable. An alternative to collaborative programs are specializations in human functioning sciences and integrative rehabilitation sciences in current programs of schools of public health. According to the Bologna process, such specializations would be specified in the diploma supplement.

More specifically, human functioning sciences are an attractive specialization for Masters and PhD programs in epidemiology, complementing established and other new specializations, including, e.g. environmental epidemiology and genetic epidemiology. Similarly, the applied rehabilitation sciences are a very important and attractive specialization for

Masters in Public Health (MPH) and Doctoral programs in public health (DPH), complementing specializations in healthcare management and administration, public management and community or international health.

Program provider. Currently, there are no schools of human functioning and rehabilitation similar to schools of public health. Keeping with the example of public health, many programs in public health are not provided by schools of public health, but by other schools and faculties. They include medical schools, schools for health sciences and schools for health professionals. Thus, it seems advisable to initiate the development of academic programs in human functioning and rehabilitation within existing schools and faculties, as shown in Table I. This includes schools and faculties of medicine, health sciences or public health. To stimulate the process of developing academic programs, national, regional or international schools of human functioning and rehabilitation could make a difference. Since human functioning and rehabilitation involves so many disciplines, a network approach involving related disciplines seems attractive.

RESEARCH TRAINING IN THE PROFESSIONAL REHABILITATION SCIENCES

Recognizing the need systematically to reflect and evaluate clinical practice, clinicians are increasingly interested in a qualification in professional scientific methods (10). Clinicians of all medical specialties and health professions rely on the knowledge generated by the basic and applied sciences for their practice, service provision, training and professional politics. Therefore, they need to be able to evaluate the knowledge generated and to translate and integrate it into their daily practice. Towards these goals, clinicians can now apply methods developed in outcomes research and clinical trials for the continuous monitoring and improvement of care and service provision. Also, many clinicians are involved in clinical trials and in the development of practice guidelines. Others are involved in the development of clinical training curricula for students and clinicians in specialization.

Most clinicians, especially physicians, do not have the possibility of, or sufficient interest in, taking 1 or 2 years out of their clinical work to obtain a Masters degree in professional clinical sciences. However, many clinicians across professions and disciplines may be able to commit themselves to a certificate program of 6–9 weeks duration. To meet the needs of these participants, programs generally need to be provided in blocks of maximum 2 weeks, spread over 2 years and include a reasonable amount of e-learning (distance learning) and self-learning credits.

Professionals who have completed a certificate program may decide to go on to obtain a Masters and/or PhD in rehabilitation sciences, or to embark in an applied Masters and/or doctoral program in rehabilitation.

Certificate programs in professional rehabilitation sciences

Certificate programs in professional sciences in the medical field are sometimes called "clinical effectiveness", "clinical sciences", "evaluative clinical sciences" "best practice" or "evidence-based medicine". A typical example is the "research training in clinical effectiveness: replacing 'in my experience…' with rigorous clinical investigation" at the Harvard School of Public Health (22). Most programs do not differentiate by medical specialty. They are thus an attractive option for physicians in physical and rehabilitation medicine (PRM).

Since these programs focus on the curative health strategy (8), they may not fully address the needs of physicians in the areas of PRM, community and family medicine, and geriatrics, or medical specialists of other areas involved in rehabilitation such as neurologists active in neuro-rehabilitation. Also, some programs may not enroll health professionals. Thus, certificate programs specialized in rehabilitation may gain attention from a relevant number of physicians and rehabilitation professionals.

Certificate programs focusing on scientific methods in rehabilitation may be called "rehabilitation effectiveness" or "best practice in rehabilitation". For practical reasons, program developers may consider collaborating with a program in clinical effectiveness, enrolling both physicians and health professionals and simply adding a module in rehabilitation sciences to an existing program in clinical effectiveness. The core modules of any program in clinical effectiveness (22) typically include training in the principles of public health with a focus on health services research, quantitative methods (often referred to as statistics); research design (often referred to as epidemiology); research skills including the learning of a statistical software, how to perform a qualitative systematic review and how to write a research protocol and a scientific publication; and professional sciences (sometimes called clinical effectiveness, clinical science, clinical studies or clinical epidemiology) addressing practical questions including medical decision-making (decision analysis; economic evaluation), outcome assessment, clinical trial and quality management and guideline development. The modules relevant for programs in rehabilitation effectiveness are denoted in the overview shown in Table II.

Applied Masters and Doctoral programs in rehabilitation

Applied Masters programs generally require prior professional experience and prepare participants for a career in their professional field. In some countries, such as Switzerland, these Masters programs are called Masters of Advanced Studies (MAS). MAS are free with regard to the naming of the MAS degree. Typical examples are Masters of Business Administration (MBA), Masters of Executive Management (MEM) or Masters in Public Health (MPH).

Similar to any other field, careers in rehabilitation include management (and administration) and education. Career paths specific to rehabilitation are rehabilitation studies and rehabili-

tation counseling. Relevant modules for these Masters degrees are shown in Table II.

Since applied Masters programs should qualify participants in response to specific needs of communities and the society, they must be designed accordingly. Depending on the region, e.g. European Union (EU), USA or Asia, the country or the local setting needs and according training may differ considerably. Applied Masters programs therefore need to be designed and redesigned dynamically in response to the rapidly changing and highly heterogeneous environment of rehabilitation and related services. Also, a key element of applied Masters programs is practical experience in the field. The relevant modules for the different applied Masters programs are denoted in Table II.

Master in rehabilitation studies. A Master in Rehabilitation with a specialization in *rehabilitation studies* (alternative names for this specialization are "rehabilitation effectiveness", "rehabilitation research" or "evaluative rehabilitation sciences") can be designed as an extension of a certificate program in rehabilitation effectiveness. We favor the use of the term "studies" to differentiate the applied Master degree in rehabilitation studies from a science-oriented Master of Science degree.

The program is an attractive option for physician-researchers and rehabilitation professionals (e.g. physiotherapy, occupational therapy, psychology) pursuing a career as clinician-researchers or who want to become competent partners for industry-sponsored clinical trials, participants in larger research projects or project scientists working in a team lead by a principal investigator. An example not specific for rehabilitation is the Dartmouth program in "evaluative clinical sciences" (18, p. 59).

A Master degree in rehabilitation studies also provides the foundation for professionals pursuing a career in industry, ranging from developers of rehabilitation technology to nutrition and pharmaceutical companies. In addition to basic training in general scientific methods, the curriculum includes extensive training in the professional sciences at an advanced level. The areas relevant to the professional rehabilitation sciences have been specified in an accompanying paper (11).

Master in rehabilitation management. A Master in Rehabilitation with a specialization in *management* (alternative names for the specialization are "administration" or "administration and management") (Table II, column 3) is an attractive option for rehabilitation professionals pursuing a career as managers of rehabilitation, health and community services, or for professionals pursuing a career in industry. According to the program's focus, topics include organizational development and management, personnel development and management, quality management, and cultural competence and communication.

Master in rehabilitation education. A Master in Rehabilitation with a specialization in *education* is intended to train participants who want to become teachers at schools of health sciences, e.g. undergraduates in the rehabilitation professions (Bachelors degree) or who want to become teachers and organizers in the context of rehabilitation intervention programs in the health or other sectors or in communities. The typical participant has a background in a rehabilitation profession. With the implementation of the Bologna process for medical studies in Europe, students with a Bachelors degree but not pursuing a Masters degree towards a full Medical degree may be interested in becoming teachers at schools for rehabilitation and health professions. In addition to topics such as didactics pertinent to education, the future "educators" learn both how to educate individuals experiencing disability and how to educate health professionals.

Master in rehabilitation counseling. A Master in Rehabilitation with a specialization in *rehabilitation counseling* is an attractive option for rehabilitation professionals who want to become case-managers for rehabilitation and health services, communities, payers or governments. Since the focus of the training is on the individual, training requires extensive professional experience in the interaction with people experiencing disability and a focus on skills relevant to personal interaction and communication, motivation and health promotion.

Doctoral program in rehabilitation. Upon completion of an applied Master in rehabilitation studies and extensive experience in the area of specialization, highly committed alumni on the path to become clinical or community leaders (specialization in rehabilitation studies) or leaders in rehabilitation education, management or counseling may wish to pursue and qualify for an applied doctoral program in rehabilitation. The respective doctoral programs may be simply named "Doctor in Rehabilitation" and possibly abbreviated DR. Alternatives are Doctor in Rehabilitation and Health, possibly abbreviated as DRH.

Collaborative programs with professional disciplines

Students pursuing a professional science qualification in their professional discipline, e.g. in physiotherapy, occupational therapy, psychology, social work, speech-language pathology or nursing, may want to pursue a specialization in rehabilitation. For providers of programs in rehabilitation and functioning and providers of programs for the professional sciences it may thus be interesting to develop collaborative program for these students. Both, collaborative Masters degrees as well as doctoral degrees are conceivable.

RESEARCH TRAINING IN HUMAN FUNCTIONING SCIENCES AND INTEGRATIVE REHABILITATION SCIENCES

Training programs in the human functioning sciences and integrative rehabilitation sciences emphasize interdisciplinary and transdisciplinary research and the use of methods that can test complex hypotheses. They integrate adaptive processes comprising not only changes in individual capacity but also in performance in the interaction with the environment by changes in the environment to better accommodate individual needs. While much rehabilitation research has been conducted in

hospitals and other clinical settings, the integrative rehabilitation sciences conduct research in homes, workplaces, schools, recreational facilities, and community-based programs. This involves adapting to reduced access to subject and control groups, working with paraprofessionals and peers with disabilities in the data collection effort, and working with shared or existing databases. Consequently, research training curricula need to address these challenging issues.

There is thus great potential for full and collaborative programs in relation to the human functioning sciences and integrative rehabilitation sciences. They may, in the future, attract researchers from disciplines not usually or frequently involved with human functioning or disability and rehabilitation research. They are attractive to a wide range of students with a Bachelor or Master degree in the related disciplines, including psychology, sociology, economics or education. At the PhD level, the training in these fields is also of particular interest for students with a prior Masters qualification in public health. A qualification in the human functioning sciences or integrative rehabilitation sciences is also attractive for rehabilitation professionals who primarily want to pursue a research career.

The relevant modules for Masters and PhD programs in the human functioning sciences and integrative rehabilitation sciences are denoted in Table II. The contents of the modules specific to these sciences are described in an accompanying paper (11).

RESEARCH TRAINING IN BIOMEDICAL REHABILITATION SCIENCES AND ENGINEERING

A research career in biomedical rehabilitation sciences and engineering based on the biomedical model is attractive for students with a wide range of backgrounds. However, because of the quite distinct scientific approaches across the areas of biomedical rehabilitation sciences and engineering and the strong and varying required background in the natural sciences, it does not seem useful to train scientists in this field in a program solely dedicated to the biomedical rehabilitation sciences. Instead, collaborative Masters and PhD programs seem preferable. Most promising are collaborative programs with movement and/or sports sciences or engineering. The respective modules are denoted in Table II. They provide biomedical rehabilitation scientists with a common understanding of human functioning.

BIOSCIENCES IN REHABILITATION

The biosciences rely on methods established in the natural sciences. Research in the biosciences is generally not dedicated to a specific goal. It is of utmost relevance for rehabilitation and, conversely, rehabilitation has important questions for the biosciences. Research in relation to rehabilitation, for example, aims to explain the process and recovery of impairments and to explain the mechanism of rehabilitation interventions developed based on clinical observations. Those insights may be translated into new or modified interventions to minimize impairments and to facilitate recovery and repair. Typical examples are the neuro-plasticity of the brain, and methods to control devices using brain activity, for example in patients with amyotrophic lateral sclerosis.

It is questionable whether bio-scientists embarking in human functioning and rehabilitation research would benefit from a rehabilitation-related research qualification, e.g. in biomedical rehabilitation sciences and engineering. However, since scientists in biomedical rehabilitation sciences and engineering are increasingly collaborating with the biosciences, collaborating training programs may evolve in the future.

CONCLUSION

There is a need and potential for the development of academic programs in human functioning and rehabilitation. With the establishment of the theme, researchers embarking in these areas may in the future find increasingly attractive career opportunities. When initiating the process to develop programs, one may learn from, and co-operate with, public health.

The main purpose of this paper is to stimulate the discussion towards the creation of attractive and successful graduate and postgraduate rehabilitation research training programs. The author and the Editor of the *Journal of Rehabilitation Medicine* thus invite commentaries on the academic programs presented.

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