CONTRIBUTION OF THE SCIENTIFIC FIELD OF PHYSICAL AND REHABILITATION MEDICINE TO IMPROVEMENTS IN HEALTH-RELATED REHABILITATION AT ALL LEVELS OF THE HEALTHCARE SYSTEM: A DISCUSSION PAPER

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Rehabilitation is an important health strategy that should be implemented at all levels of the healthcare system and at all levels of care. Scientific evidence is vital to strengthen rehabilitation; therefore, research in the scientific field of Physical and Rehabilitation Medicine (PRM) should be implemented and linked to all levels of the healthcare system. PRM research can be categorized into 5 areas: (i) biosciences in rehabilitation; (ii) biomedical rehabilitation sciences and engineering; (iii) clinical PRM sciences; (iv) integrative rehabilitation sciences; and (v) human functioning sciences. At the level of the healthcare system, rehabilitation can be divided into micro-, meso- and macro-levels. This paper discusses the contribution of the five above research areas to health-related rehabilitation at the different levels of the healthcare system. The contribution of PRM research can have synergistic value and facilitate improvements and implementation of scientific evidence in rehabilitation at all levels of healthcare. From a broader perspective, improved understanding of the contribution of each area of the scientific field of PRM and the priorities for the healthcare system that are set by relevant stakeholders will contribute to the advancement and rapid attainment of overall goals.

Key words: rehabilitation; scientific field; health system; physical and rehabilitation medicine.

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The global prevalence of health conditions has shifted to an increase in non-communicable health conditions, which include ageing, metabolic syndromes, severe health conditions (e.g. cancer), and injury. These can lead to increased issues regarding functioning.

The World Health Organization (WHO) addresses the management of this global issue in their publications. The Global Disability Action Plan (GDAP), 2014 (1), set out 3 major aims: (i) to remove barriers and improve access to health services and programmes; (ii) to strengthen and extend rehabilitation, habilitation, assistive technology, assistance and support services, and community-based rehabilitation; and (iii) to strengthen the collection of relevant and internationally comparable data on disability and support research on disability and related services. The GDAP includes proposal inputs for the member states to improve rehabilitation and success indicators. The document Rehabilitation in Health Systems, 2017 (2), sets out recommendations for governments and stakeholders to strengthen and expand rehabilitation. This document is based on scientific evidence; however, evidence to support the recommendations needs to be further improved at all levels of the healthcare system.

Research can provide scientific evidence to improve all fields, including rehabilitation. Since rehabilitation comprises a large area of medicine, the aim of this paper is to demonstrate the contribution of the different areas of Physical and Rehabilitation Medicine (PRM) research (3) to rehabilitation in the healthcare system (4). This will facilitate understanding of the contribution of the scientific field of PRM to improvements in rehabilitation, demonstrate synergistic value, and facilitate improvements in rehabilitation at all levels of the healthcare system. From a broader perspective, improved understanding of the contribution of each area of the scientific field of PRM, and how they relate to the priorities of healthcare systems designed by the relevant stakeholders, will contribute to the advancement and rapid attainment of the overall goals of the rehabilitation.

DEFINITION OF REHABILITATION

The term “rehabilitation” is often misunderstood or used in a broader sense than originally intended.
Rehabilitation is often thought of as treatment after surgery or trauma and during palliative care. This understanding is not fully incorrect; however, it leads to a misconception of rehabilitation. The definition of rehabilitation has been formulated by experts and included in the World Report on Disability, as “a set of measures that assist individuals who experience, or are likely to experience, disability to achieve and maintain optimal functioning in interaction with their environments” (5). However, rehabilitation is also a health strategy, which is “based on WHO’s integrative model of functioning, disability and health (ICF) that applies and integrates approaches to assess functioning, optimize a person’s capacity, strengthen the resources of the person, and provide a facilitating environment, with the goal to enable persons with health conditions experiencing or likely to experience disability to achieve and maintain optimal functioning in interaction with their environment” (6). There are other definitions of rehabilitation, but they all agree that rehabilitation aims to achieve and maintain optimal functioning. Since environmental factors also play a role in addition to the field of medicine, other stakeholders should also be involved in order to achieve this goal.

As stated above, rehabilitation can be defined both as a health strategy and as a set of interventions/measures. Reflecting on these definitions, rehabilitation should be integrated into all levels of the healthcare system: micro-, meso- and macro-levels.

Rehabilitation at the micro-level. Rehabilitation at the micro-level includes rehabilitation programmes for specific health conditions (e.g. stroke, cancer). However, rehabilitation should also be implemented both at the level of healthcare (primary, secondary, and tertiary levels of healthcare services) and throughout healthcare services (habilitation, pre-habilitation, acute, post-acute and long term rehabilitation) (Fig. 1). Pre-habilitation is defined as an educational programme and pre-operative physical and/or psychological conditioning, enhancing functional and mental capacity aimed at improving postoperative functional outcomes (7). Rehabilitation at the micro-level works directly to provide the best intervention for the patient. Although large studies of rehabilitation programmes have been conducted, improvements are needed to increase efficiency and outcomes for patients’ needs.

Fig. 1. (A) Phases of rehabilitation service provision for congenital diseases/disability; (B) chronic progressive diseases; (C) chronic non-progressive diseases; (D) after acute incidents.
Rehabilitation at the meso-level. Rehabilitation at the meso-level includes the healthcare workforce providing rehabilitation services and the rehabilitation service organization itself (8). Interestingly, due to the nature of rehabilitation, most treatments will be more effective and provide better outcomes if rehabilitation is delivered by multiprofessional teams (including PRM specialist, physiotherapist, occupational therapist, psychotherapist or psychologist, orthotist and prosthetist, rehabilitation nurse, community based-rehabilitation worker, etc.) (8).

Rehabilitation service organization varies worldwide; for example, it may comprise a single profession or multiprofessional teams; and rehabilitation equipment may range from simple to advanced, depending on the context, type and level of rehabilitation services. Although this variation could provide the flexibility to organize rehabilitation services even in rural areas, it also requires minimum standards to describe rehabilitation service organization in order to achieve optimal functioning for people in need. A group of researchers have therefore proposed a classification to describe rehabilitation service organization; the International Classification of Service Organization in Rehabilitation (ICSO-R) (8). The ICSO-R consists of 3 dimensions: provider, funding, and service delivery. Each dimension has several categories. A second version of the ICSO-R (ICSO-R 2.0 (9)) has been developed after testing, implementing and receiving comments from international experts. The ICSO-R 2.0 comprises only 2 dimensions; provider and service delivery, as the funding dimension has been distributed into each of these dimensions.

The ICSO-R classification can be used in various ways: to describe rehabilitation service organization; to support situation analysis of the provision of rehabilitation services in healthcare systems at the national or provincial level and to prototype the service (10, 11); to develop recommendations for implementation of rehabilitation services (11); for quality management in rehabilitation services (12); and to describe the setting in clinical trials, which may have a strong influence on rehabilitation outcomes. Thus, the ICSO-R is a useful tool for many purposes; however, further research into its implementation is necessary.

Rehabilitation at the macro-level. Rehabilitation is 1 of 5 health strategies, together with curative, preventive, palliative and supportive strategies. Therefore rehabilitation should be explicitly mentioned and implemented within the healthcare system in every country.

To support the strengthening of rehabilitation at the healthcare system level, WHO has formulated a rehabilitation support package (13) to enable countries to strengthen rehabilitation in the healthcare system. The package starts by analysing rehabilitation in the healthcare system, then enables recommendations, project implementation, evaluation and monitoring.

Other activities related to strengthening rehabilitation in healthcare systems have been reported: in Egypt (14), Ukraine (15) and the Democratic People’s Republic of Korea (16). These 3 activities use sounding methodology (17), including collecting information related to rehabilitation at the country level, using a rehabilitation service assessment tool (11), site visits, analysis of gaps, and listing and prioritizing recommendations and projects for improvement (10).

**PHYSICAL AND REHABILITATION MEDICINE RESEARCH**

Rehabilitation has been proposed as a health strategy for the 21st century (18). Improvements in rehabilitation at all levels of the healthcare system are urgently needed in order to increase the unmet need for rehabilitation worldwide. However, this development must not neglect the quality of rehabilitation itself. Scientific evidence is therefore important to support improvements in the rehabilitation field at all levels of the healthcare system.

The scientific field of PRM is relatively large. Other fields of medicine focus mainly on specific bodily systems, but this is not the case for PRM, which is based on the bio-psycho-social model of functioning and disability, and can be divided into 5 areas, according to the WHO International Classification of Functioning, Disability and Health (ICF) (19) (see Fig. 2). These areas are:

- **Biosciences in rehabilitation.** “The biosciences, the basic sciences from the partial perspective based on the biomedical model of disease (3). This area aim to explain body injury, adaptation and repair from the molecular to the cellular, organ system and organism level; and to identify targets for biomedical interventions to improve body functions and structures” (21).

- **Biomedical rehabilitation sciences and engineering.** “These refer to the partial perspective interested in the biomedical aspect of functioning can be called biomedical rehabilitation sciences and engineering (3). The Biomedical rehabilitation sciences and engineering are applied sciences that study diagnostic measures and interventions including physical modalities suitable to minimize impairment, control symptoms and to optimize people’s capacity”, robotic as well as nanotechnology for rehabilitation intervention. (21).

- **Clinical PRM sciences.** This field aims to provide the best care in PRM (3). It has goal to enabling
people with health conditions experiencing or likely to experience disability to achieve and maintain optimal functioning in interaction with their immediate environment. Clinical research in rehabilitation is one example. The outcome from this study including efficiency, clinical guidelines, and standards, quality management, education and training of professional rehabilitation” (21).

- **Integrative rehabilitation sciences.** Integrative rehabilitation sciences design and study of rehabilitation systems, services, comprehensive assessments, and intervention programmes, which integrate biomedical, personal and environmental factor approaches to optimize people’s performance (21).

- **Human functioning sciences.** “Human functioning sciences aim to understand human functioning and to identify targets for comprehensive interventions” (21). Human functioning sciences contribute to the minimization of the experience of disability in the population.

Gutenbrunner et al. (20) elaborated categories based on this concept and developed a topic list. The topic list was applied to structure scientific program at the ISPRM World Congresses in 2015 (Berlin) and 2016 (Kuala Lumpur). A subsequent revision of congress topic list was published, based on analyses from both congresses (21) (see topic list in Table I).

**CONTRIBUTION OF PHYSICAL AND REHABILITATION MEDICINE RESEARCH TO HEALTHCARE SYSTEM LEVELS**

Improved understanding of the contribution of the areas of the scientific field of PRM to the healthcare system levels will demonstrate synergistic value for
Contribution of the scientific field of PRM to the healthcare system

Comprehensively improving rehabilitation as a health strategy. However, it is clear that there are interrelations and overlap between the contribution of these areas (Fig. 3).

Biosciences and biomedical and engineering in rehabilitation can be linked with the healthcare system and their contribution categorized into pre-micro- and micro-levels of. The term “pre-micro-level” is used for basic sciences that are not directly covered at the level of the healthcare system. However, this category must not be neglected, as it is an important, relevant and integral part of the scientific research supporting the overall healthcare system. The pre-micro-level covers other scientific fields in the preclinical setting, e.g. study of the pathomechanisms of diseases at the cellular level or in animal models. Biosciences and biomedical and engineering in rehabilitation are based on research in cells, animals and humans. Examples of research in these fields include: microRNAs that mediate the anticancer effect of physical activity (22); the role of immune cells in multiple sclerosis (23); and regulation of pain by non-neuronal cells and inflammation (24). Research in animal models can be designed to study the pathomechanism of diseases, interventions, and to observe functioning, such as gait analysis in animal stroke models (25). An example of biomedical and engineering in rehabilitation in the animal model is research into exoskeletons for neurological disorders (26). Examples of bioscience research in humans (micro-level) include study of the pathomechanism of disease in patients with fibromyalgia syndrome (27, 28) and alterations at the molecular level to develop more effective treatments (29) (see Table II).

Clinical PRM sciences can be linked with the healthcare system and their contribution categorized into both micro- and meso-level. In addition to supporting best practice treatment for the patients (micro-level), researches also include education and training for PRM professionals (meso level) (8). Examples of clinical PRM research at the micro-level are studies comparing rehabilitation treatments in chronic low back pain (30) and breast cancer survivors (31). An example of clinical PRM science at the meso-level is teamwork communication for rehabilitation professionals (32) (see Table II).

Integrative rehabilitation sciences can be linked with the healthcare system and their contribution categorized into micro- to macro-level. At the micro-level, an example is the economic evaluation of vocational rehabilitation for patients with chronic musculoskeletal pain (33). At the meso-level, an example is the description of rehabilitation service organization (8, 9) and research related to return to work (34) (see Table II). Macro-level research includes the development of rehabilitation situation assessment tools and WHO support packages for the country- or province-level (11, 13), implementation of these tools to develop national health action plans for disability and rehabilitation (14, 16), analysis and implementation of WHO documents (35), and implementation of clinical quality management for rehabilitation in Malaysia (12) (see Table II).

Human functioning sciences can be linked with the healthcare system and their contribution placed in the macro-level of healthcare system. Examples include the development of ICF Core Sets, validity of ICF Core Sets for specific health conditions (36), and development of functioning properties to be used in the International Classification of Disease – 11 (ICD-11) (37). The use of ICF at individual level is categorized at the micro-level, which is under the area of clinical PRM sciences (see Table II).
Scientific evidence is an important factor in many fields, including health. In rehabilitation, scientific research should be synergized to strengthen rehabilitation at all levels of the healthcare system. Scientific areas of PRM can provide valuable scientific evidence, support best practice, and strengthen rehabilitation at all levels of the healthcare system. This can be seen as a model for relevant stakeholders to prioritize research in the fields of PRM in order to reach the goal of improving rehabilitation at all levels of healthcare.

**Table II.** Examples of research in different areas of the scientific field of Physical and Rehabilitation Medicine (PRM), divided into pre-micro-, micro-, meso-, and macro-levels of the healthcare system

| Macro | Human Functioning Sciences | Integrative Sciences |
|-------|-----------------------------|---------------------|
|       | International Classification of Functioning, Disability and Health (ICF) (19) | Development of ICF |
|       | The IASP classification of chronic pain for ICD-11: functioning properties of chronic pain (37) | Development of functioning properties for chronic pain to be used in ICD-11 |
|       | Principles of Assessment of Rehabilitation Services in Health System: Learning from Experiences (11) | Developing tool to assess rehabilitation service at health system level in country/province |
|       | Situation analysis of rehabilitation service to support the national disability and rehabilitation plan in the Democratic People’s Republic of Korea (16) | Development of an action plan at country level |
|       | Responding to the World Health Organization (WHO) Global Disability Action Plan (GDAP) in Egypt: A Technical Consultancy to develop a National Disability, Health and Rehabilitation Plan (14) | |
|       | Analysis and implementation of a World Health Organization health report: methodological concepts and strategies (35) | |
|       | Implementation of Clinical Quality Management for Rehabilitation in Malaysia (12) | |

| Meso | Integrative Sciences |
|------|---------------------|
|      | ISPRM Discussion Paper: Proposing Dimensions for an International Classification System for Service Organization in Health-Related Rehabilitation (8) | |
|      | Adaptation of a Guide to Equip Employers to Manage the Gradual Return to Work of Individuals with a Musculoskeletal Disorder (34) | |
|      | Inter-professional communication and interaction in the neurological rehabilitation team: a literature review. (32) | |

| Micro | Clinical PRM Sciences |
|------|----------------------|
|      | Comparison of the effects of stability exercise and balance exercise on muscle activity in female patients with chronic low back pain (30) | |
|      | Influence of a Multimodal and Multimodal-Aerobic Therapy Concept on Health-Related Quality of Life in Breast Cancer Survivors (31) | |
|      | Performance of brief ICF-sleep disorders and obesity core set in obstructive sleep apnoea patients (38) | |
|      | Use of the ICF | |

| Pre-Micro | Biomedical Rehabilitation Sciences and Engineering |
|-----------|------------------------------------------------|
|           | Rehabilitation soft exoskeleton for rodents (26) | |
|           | Inhibition of miR-497 improves functional outcome after ischemic stroke by enhancing neuronal autophagy in young and aged rats (42). | |
|           | A novel model for studying voltage-gated ion channel gene expression during reversible ischemic stroke (25) | |
|           | Pain regulation by non-neuronal cells and inflammation (24) | |

ICF: International Classification of Functioning, Disability and Health; IASP: International Association for the Study of Pain; ICD: International Classification of Diseases; WHO: World Health Organization; GDAP: Global Disability Action Plan; ISPRM: International Society of Physical and Rehabilitation Medicine; miRNA: Micro ribonucleic acid.

**CONCLUSION**

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