



REHABILITATION: THE HEALTH STRATEGY OF THE 21ST CENTURY

Gerold STUCKI, MD, MS^{1-3*}, Jerome BICKENBACH, LLB, PhD^{1-3*}, Christoph GUTENBRUNNER, MD⁴ and John MELVIN, MD^{2,5}

From the ¹Department of Health Sciences and Health Policy, Faculty of Humanities and Social Sciences, University of Lucerne, Lucerne, ²Swiss Paraplegic Research (SPF), Nottwil, ³ICF Research Branch, a cooperation partner within the World Health Organization Collaborating Centre for the Family of International Classifications in Germany (at DIMDI), Nottwil, Switzerland, ⁴Department of Rehabilitation Medicine, Hanover Medical School, Hanover, Germany, ⁵Sidney Kimmel Medical College, Thomas Jefferson University, Philadelphia, PA, USA. *Both of these authors contributed equally to this paper.

There is strong evidence that population ageing and the epidemiological transition to a higher incidence of chronic, non-communicable diseases will continue to profoundly impact societies worldwide, putting more pressure on healthcare systems to respond to the needs of the people they serve. These trends argue for the need to address what matters to people about their health: limitations in their functioning that affect their day-to-day actions and goals in life. From its inception, rehabilitation, 1 of the 4 health strategies identified in the Declaration of Alma Ata in 1978, has had functioning as its outcome of interest. Its practitioners are from fields that include physical and rehabilitation medicine, occupational therapy, physiotherapy, speech and language therapy, orthotics and prosthetics, psychology, and evaluators of functioning interventions, including assistive technologies. Demographic and epidemiological trends suggest that the key indicators of the health of populations will be not merely mortality and morbidity, but functioning as well. This, in turn, suggests that the primary focus of healthcare will need to respond to actual healthcare demands generated by the need for long-term management of chronic conditions, including, in particular, the scaling up and strengthening of rehabilitation. This is the case for thinking that rehabilitation will become the key health strategy of the 21st century.

Key words: rehabilitation; health strategy; functioning.

Accepted Dec 28, 2016; Epub ahead of print Jan 31, 2017

J Rehabil Med 2018; 50: 309–316

Correspondence address: Gerold Stucki, Swiss Paraplegic Research (SPF), Guido A. Zäch Institute, 6207 Nottwil, Switzerland. E-mail: gerold.stucki@paraplegie.ch

There is strong evidence that fundamental demographic and epidemiological trends (global ageing and the transition to a higher incidence and prevalence of chronic, non-communicable diseases), as well as advances in curative medicine, will profoundly impact societies worldwide. These trends, and their drivers and immediate consequences, arguably point to a significant shift in emphasis in healthcare and health policy to the long-term management of chronic conditions and impairments, which is the natural domain of rehabilitation.

The objectives of this paper are to assemble the best demographic and epidemiological evidence about future trends, in order to build on the current conceptualization of the health strategy of rehabilitation, compared with other health strategies, and, utilizing the powerful notion of functioning as a health indicator, set out the best case for the proposition that rehabilitation is the key health strategy for the 21st century.

WORLDWIDE POPULATION AGEING

Both the absolute number and proportion of the population of older people are increasing dramatically worldwide (1). Population ageing (the increasing proportion of older persons in the population) is arguably one of the most significant social transformations of the 21st century, with direct and obvious implications for healthcare and health policy, for many other sectors of society, including labour, housing, transportation, social protection, and for the very structure of families and intergenerational ties.

As Fig. 1 shows, the population worldwide aged 60 years or older is increasing dramatically (2, 3). Although currently high income countries, such as Japan, Germany and Finland, have the highest prevalence of older persons, in 30 years time 80% of the world population aged 60 years or older will live in low- and middle-income countries (3). Globally, the number of people over 60 years of age is increasing faster than any other age group (1).

These population ageing trends are not only unprecedented in human history, they affect all regions of the world. Ageing rates, moreover, will increase over time (4).

There are 2 key drivers of population ageing: increasing life expectancy and declining fertility rates (1). Both of these phenomena are the result of worldwide socioeconomic development and, especially, the astonishing success of healthcare over the last several decades. In high-income countries, increased life expectancy is principally the result of improved survival of people age 60 years or over; while in low-income countries reduced mortality at younger ages is more influential (1). In the last 30 years, especially, people have been surviving diseases and injuries (even as serious as spinal cord injury and cancer) that would in

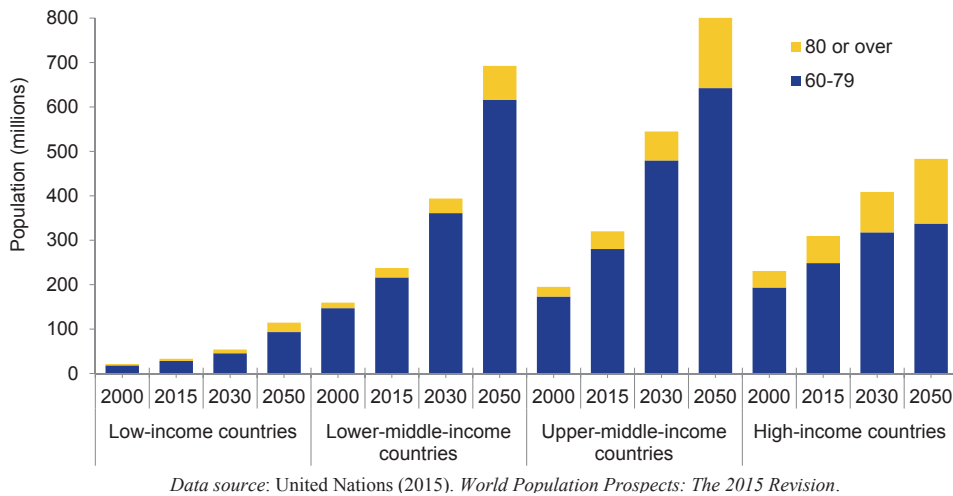


Fig. 1. Population aged 60–79, and 80 years and over, by development group 2000, 2015, 2030 and 2050. United Nations. Department of Economic and Social Affairs Population Division. World Population Ageing 2015. New York: United Nations; 2015. http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf.

earlier decades have led to their death. Better access to superior healthcare has also increased survivorship rates, even in low-income settings. Socio-economic development, mediated through reduced child mortality and enhanced gender equality, including access to education and family planning, has resulted in declining fertility rates (1, 2).

INCREASE IN PREVALENCE OF NON-COMMUNICABLE DISEASES

The late 20th and early 21st centuries have witnessed an epidemiological transition from communicable to non-communicable diseases (NCDs), most prominently cardiovascular and chronic respiratory diseases, cancer, diabetes, obesity, musculoskeletal conditions and mental health disorders (5). These diseases are either chronic or of long duration and slow progress. Though acquired across the life course, they are the major cause of adult mortality and morbidity worldwide (5): 63% of total deaths that occurred globally in 2008 were due to non-communicable diseases (6).

Like ageing, this trend too is a worldwide phenomenon, although the impact has been felt more acutely in low-income countries. In 2008, 80% of worldwide deaths (29 million) from non-communicable diseases occurred in low- and middle-income countries, and a higher proportion (48%) of the deaths in these countries were premature (under the age of 70 years) compared with high-income countries (26%) (6). Moreover, over 80% of deaths from cardiovascular diseases and diabetes, and almost 90% of deaths from chronic obstructive pulmonary disease, occur in low- and middle-income countries (6).

In the USA almost all Medicare spending is related to chronic conditions (7). The trend toward higher

NCD prevalence will increase over time: the percentage increase in cancer incidence by 2030, compared with 2008, for example, will be greater in low-income countries (82%) and is projected to be twice as high as in high-income countries (8). At the same time, low- and middle-income countries continue to experience the impact of communicable diseases as well and more than high-income countries.

The worldwide epidemic of non-communicable and, especially, chronic health problems is strongly linked to population ageing. Since NCDs disproportionately affect older people, the (incidence) and prevalence of these diseases will accelerate in the future as more people survive other health threats in younger age (9, 10). Currently, 23% of the total global burden for the world's population for all diseases and injuries is attributable to disorders in people aged 60 years or older, and the major contributors to this burden are NCDs, such as cardiovascular diseases, malignant neoplasms, chronic respiratory diseases, musculoskeletal diseases and neurological and mental disorders (10, 11). In the USA an estimated 35% of the total population burden of disease is attributable to chronic illnesses (12). Moreover, concurrent trends of globalization and urbanization bring with them the well-known risk factors for NCDs; tobacco and alcohol use, unhealthy diet, obesity and lack of exercise, which will further increase the prevalence of chronic health problems (8).

IMPACT OF THESE TRENDS ON FUNCTIONING AND DISABILITY

The impact of the combination of population ageing and the shift in prevalence to non-communicable health problems will be that a higher proportion of the world's

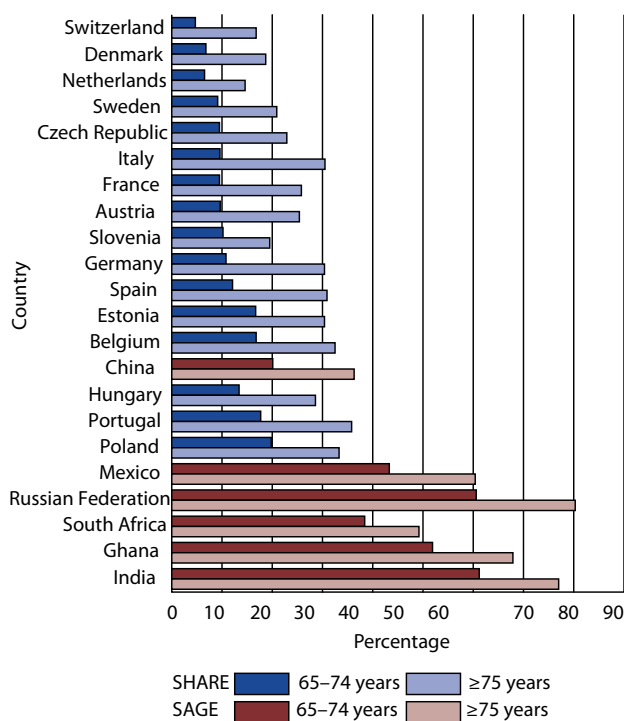
population will be living with one or more limitations in functioning, and so will be likely to experience disability. Limitations in functioning associated with chronic NCDs and ageing include long-term sensory, cognitive, mobility and other impairments as well as restrictions in activities, simple or complex. The burden of disease for NCDs in the older population is strongly determined by disability, rather than premature death. In short, although people worldwide are living longer, generally speaking, they are also living with more disability (13).

It is true that in high-income countries there is some evidence of a trend towards a reduction in the time lived with disability. An analysis carried out by the World Health Organization (WHO) in 2014 of large longitudinal studies conducted in high-income countries suggested that the prevalence of disability of such a level of severity as to require assistance from another person to carry out basic activities, such as eating and washing, may be declining slightly (3). However, that study also showed that there has been no significant change in less severe disability over the past 30 years, and that the evidence we have from low- and medium-income countries, although of lower quality, suggests the opposite trend; that is, an increase in the level of disability with age, linked to an increase in the number of underlying health conditions (multimorbidity).

It is important to bear in mind that, quite independently of the diseases and injuries we experience as we age, at the biological level, ageing is simply the gradual process of molecular and cellular deterioration that inevitably results in progressive impairments across all body functions, accompanied by a broad range of psychosocial changes. Muscle mass declines with age, articular cartilage loses strength and flexibility, and vision, hearing, and cognitive functions, including memory, tend to decline with age.

In other words, according to the WHO's International Classification of Functioning, Disability and Health (ICF) (14), ageing is the inevitable process of *capacity* decline, a process which, depending on a person's access to environmental facilitators or the presence of barriers, may also result in a permanent decrement or progressive decline in the *performance* of activities, simple or complex. In short, ageing is the process of declining health, usually linked to an increase in the experience of disability or the likelihood of experiencing disability (Fig. 2) (1).

Another significant feature of the ageing process is the phenomenon of multimorbidity. The issue here is not so much that of people developing several serious diseases or injuries at once, although that is not un-



Note: The five basic ADL items included in the analysis were eating, bathing, dressing, getting in and out of bed, and using the toilet.

Fig. 2. Percentage of population aged 65–74, and 75 years or older, with a limitation in 1 or more of 5 basic activities of daily living (ADL), by country. World Health Organization. World Report on Ageing and Health. Geneva: WHO; 2015. http://apps.who.int/iris/bitstream/10665/186463/1/9789240694811_eng.pdf?ua=1. SAGE: Study on global AGEing and adult health; SHARE: Survey of Health, Ageing and Retirement in Europe.

common. It is rather the more subtle phenomenon of accumulating several different chronic conditions at the same time, each of which might be of low or moderate severity, but together will produce a more severe level of decline in capacity (15). Disease combinations may worsen the impact on capacity associated with each disease on its own, and overall the impact of multimorbidity in older age may be far greater than the sum of the individual impacts expected from each health problem alone. Multimorbidity complicates treatment planning and has well-known adverse clinical effects, including polypharmacy and pursuing contradictory therapeutic regimes (16, 17). More importantly, multimorbidity affects the nature and extent of the impact of health on one's life. Even if the severe capacity limitations associated with blindness, deafness, immobility or profound cognitive decline are, at the population level, being "compressed" into the last segment of life, the accumulated impact on people's capacity of multimorbidity will nonetheless profoundly affect their lives as they age.

PREPARING THE HEALTH SYSTEM FOR THE EMERGING NEEDS OF PEOPLE LIVING WITH LIMITATIONS IN FUNCTIONING

Given these demographic and epidemiological trends and their impact on functioning and disability, society is clearly obliged to respond by preparing the health system for the emerging needs of the population. This is not only because it makes good economic sense to ensure that people maintain a high level of functioning despite chronic conditions and ageing, and continue to contribute productively to society, but also because it is in everyone's self-interest to create a society in which they can participate as fully as possible for as long as possible. And for countries who have signed and ratified the United Nations' *Convention on the Rights of Persons with Disabilities* (CRPD) (18) an effective societal response is a matter of human rights for those citizens whose level of health is suboptimal and who experience, or who are at risk of experiencing, disability.

Although shifting the focus of the healthcare system onto age-specific NCDs is a sensible strategy, it threatens to overlook the more salient feature of the health impact of these trends, namely that people are living longer but with more disability. In other words, the more notable health impact of ageing and NCDs on people's lives will be that they will experience more limitations in their capacity to do, and to become, what they wish. Although premature mortality is an obvious health concern, at some stage in life mortality can no longer be argued to be premature. Despite this, concerns about functioning, including pain, mobility and self-care and independence, are always legitimate, whatever the person's age. The goal of healthcare, therefore, must include, as a central outcome of interest, that of optimizing functioning in the face of inevitable disability, across all domains of life (19).

The challenge then becomes how health systems might be re-designed to most effectively respond to the demographic and epidemiological trends that will dominate the 21st century, given that the salient impact of these trends will be a dramatic increase in the non-fatal health outcomes associated with impairments of the mind and body and associated declines in capacity and performance across all areas of life. What are the health strategies available to healthcare systems to meet this challenge?

REHABILITATION: ONE OF THE FIVE MAIN HEALTH STRATEGIES

Since the Declaration of Alma Ata in 1978 (20), promotion, prevention, cure and rehabilitation have been recognized as the health strategies to achieve and main-

tain population health. More recently, within the context of the initiative for universal health coverage, the WHO has recognized palliative care as an additional strategy (21). Prevention aims to reduce the occurrence (incidence) of diseases, injuries and other health conditions through targeting risk factors with the long-term aim of reducing prevalence. Health promotion aims to optimize people's intrinsic biological health. The curative strategy aims to eliminate or control disease conditions, thereby eliminating or minimalizing their impact on people's capacity. Palliative care optimizes quality of life by relieving symptoms, pain, and mental distress during the process of dying. Rehabilitation, finally, aims to optimize people's functioning associated with diseases, injuries and other health conditions in the context of an individual's position in life and resources and in interaction with the physical, human-built, attitudinal and social environment (22).

These health strategies can be used to paint a broad-brush portrait of the history of healthcare in the last 2 centuries (23). In the 19th century, because of poor nourishment, lack of hygiene, and infectious diseases, the death of infants and children was commonplace worldwide, but, in addition, life expectancy was very low even in high-income countries. For most of that century the curative strategy had almost no impact on the health of society. What drove improvements in health was a dramatic increase in economic performance and social progress in the Western world. This allowed for better nutrition for all, not just the wealthy. Construction of clean water and sewage systems and improved housing conditions led to better hygiene. In retrospect, we recognize that these improvements were preventive, making it the dominant strategy in the 19th century (24).

The curative strategy was the dominant strategy in the 20th century. This strategy was instrumental in addressing the challenges of injuries caused by war and violence, providing new approaches to combating infectious diseases through antibiotics, and targeted molecular therapies for cancer and autoimmune diseases. As the curative and preventive strategies joined forces towards the end of the 19th century and the beginning of the 20th century, and the causes of diseases, stunting, and other threats to health became better understood, many of the common lethal diseases became more controllable (25) and, for example, HIV-AIDS, lupus and breast cancer were transformed into chronic health conditions. During this time much of the focus of prevention shifted to individual lifestyle and behaviour, and toward the end of the 20th century, shifted again to address broader social determinants (27, 28). These changes (socioeconomic improvement, an increase in scientific and technological progress,

and a broader understanding of prevention) were the major drivers of improvements in health, resulting in the current life expectancy of 75–85 years in the most developed countries (29–30).

As a public health strategy, health promotion was very much a product of the 20th century as it arose out of the optimism from the previous successes of cure and prevention and a renewed awareness of the responsibilities of the high-income countries toward the health of the rest of the world (31). Whether this optimism is justified remains to be seen, especially in light of public health disasters, such as the obesity epidemic in the USA, fostered by industry-influenced academic and governmental recommendations (32).

Which of these traditional health strategies should we turn to in order to meet the challenges of the 21st century and beyond? Certainly the curative health strategy is not, at least at present, a realistic solution for most of the high-burden NCDs, or for that matter age-specific problems, such as geriatric syndromes and frailty. On the other hand, according to the WHO, a large percentage of NCDs are preventable through a reduction in the major behavioural risk factors of tobacco use, physical inactivity, harmful use of alcohol and unhealthy diet (8, 9). Whatever our successes in the future in this regard, however, short of genetic modification, NCDs will continue to dominate population health. Ageing, of course, is inevitable and older people are more likely to have multiple, coexistent, and interrelated health problems. This fact, together with geriatric syndromes, frailty and impaired cognition, continence, gait, and balance, suggests the need for a more thorough “retooling” of the healthcare system and workforce to meet the health challenge of ageing (33, 34).

Taking ageing and the epidemic of NCD together, in other words, strongly suggests that health policy should aim not merely at expanding NCD prevention programmes but also scaling up that health strategy whose explicit objective is to optimize the levels of functioning experienced by people across the lifespan; namely rehabilitation.

THE CHARACTER OF REHABILITATION AND THE REHABILITATION STRATEGY

Although a comprehensive history of rehabilitation has yet to be written, it is clear that the origins and evolution of rehabilitation science and practice, at least in the USA and Europe, are closely linked to the needs of veterans with permanent injuries returning from wars. For example, armour makers of the medieval era were skilled in making functionally effective hand and leg prostheses for returning soldiers (35). In the UK and

the USA in particular, addressing the needs of injured veterans was a principal driver of the developing practice of rehabilitation specialties (36, 37).

The moral force of assisting soldiers who fought for their country and needed to return to their previous life and employment was very powerful. It was an easy argument to make that society owed its soldiers its assistance, and for this reason, for example in the USA, the earliest legislative recognition of the needs of disabled veterans and the value of rehabilitation services were addressed to veterans (39). In the USA, soon after the First World War, specialties of physical and speech therapy and orthotics and prosthetics began to serve the parallel needs of persons injured at work or otherwise limited in mobility, sensory or cognitive capacity. The rise in rehabilitation professionalization linked with developing specialties such as orthopaedic surgery and “physiatry” or physical medicine in the late 1930s. Research in the emerging science of rehabilitation and engineering expanded after the Second World War, initially to serve the needs of veteran amputees, but later for the civilian population too (40, 41).

In many European countries, including Switzerland and Germany, rehabilitation had its roots primarily in, or in parallel with, the century-long tradition of physical modalities and health resort or spa treatments with their holistic approach to physical and mental health. That is why the Germany-based *Journal of Physical and Rehabilitation Medicine* still carries the name “*Kurortmedizin*” (health resort medicine) in German. These approaches aimed to improve body functions and activities as well as quality of life and participation and were applied mainly for chronic health conditions. Interestingly, in some instances, university departments for physical therapy (referring not to the physical body but physical modalities such as electrical currents, heat and cold) were not only the predecessors of physical and rehabilitation medicine, but were at the same time the roots of related medical specialties, including radiology, as in Munich, and rheumatology, as in Zurich. However, already in the late 19th century such treatments were included in the social security system aiming to prevent social compensation payments (42). Another root, in particular for the development of orthoses, prosthesis and assistive devices, was the care for congenital disability (so-called “cripple care”).

Rehabilitation specialists and researchers have always been clear about the aims and methods of this health strategy: rehabilitation does not explicitly aim to prevent, reverse or undo the damage caused by disease or injury, but rather to restore functioning, ameliorate the impact of the reduction in capacity, and minimize further effects of the initial health problem (13, 22,

43–45). The focus of rehabilitation is on living with a health condition, often a chronic or incurable condition with a progressively debilitating trajectory (characteristic both of some chronic illnesses, such as arthritis and dementia, and the ageing process itself). Also, early rehabilitation aims towards minimizing disability after the occurrence of acute disease and trauma. Although the primary focus is on the decrement in capacity in domains of functioning, rehabilitation science and practice, since its inception, has intuitively understood that enhancing what people can do in their lives will also involve some form of environmental modification. This may be a prosthetic hand or other prosthesis, or a mobility aid, such as a cane or wheelchair, a sensory aid, such as glasses or hearing aid, or indeed any form of assistive technology.

With this focus, it was a short step, taken roughly mid-20th century, for specialties such as occupational therapy to expand the range of environmental modification to include facilitating alterations to the home environment to enhance independence, or the work or educational environments to make it possible for the person with reduced capacity in physical or mental domains of functioning to participate fully in these realms of social life (46). The massive growth in the development of assistive technologies, and the more recent international efforts to increase equity of distribution worldwide by lower prices and wider markets (47), further extends the impact of rehabilitation as a health strategy, aimed at optimizing functioning.

Against the background of multimorbidity and the challenge of maintaining biological health in light of these co-morbidities, for rehabilitation to reach its goal, it must be combined with suitable interventions rooted in the curative and promotive strategies. Both the curative and promotive strategies in these populations pose unique challenges. Most health promotion programmes currently focus on keeping the public healthy and ignore the issue of what needs to be done to keep people who are living with impairments and disability healthy. This is ironic, since people living with NCDs and ageing are, in epidemiological terms, populations at risk, and hence likely to benefit from such interventions.

Although the objective of rehabilitation is well known, unlike the other health strategies rehabilitation has never enjoyed a particularly high level of public recognition and regard. It is difficult to imagine, for example, any other health strategy or health professional attracting the kind of criticism that has been levelled by disability activists against rehabilitation: that it forces persons with disabilities into a dependent social role rather than seeking their independence (48). Arguably, this stance can be explained by the need for

disability advocates to identify themselves as a “discrete and insular minority” in order to enhance their political case for recognition as a socially marginalized group. Yet once this political agenda is set aside, and rehabilitation is understood as a service, universally available to anyone with functioning needs, then this critique disappears (49). More often, especially in high-income settings, rehabilitation is written off either as a highly specialized service for athletes or an optional, post-injury service for return-to-work or general recovery after surgery. Because of this image, low- and medium-income countries, struggling to put into place adequate curative and preventive strategies, may be tempted to sideline rehabilitation as a kind of luxury health service that can be postponed.

FUNCTIONING, FUNCTIONING INFORMATION AND REHABILITATION

Only relatively recently have rehabilitation professionals themselves taken on the conceptual task of clarifying their rationale and role as providing a distinct, and equally important, health strategy (23). In no small part this conceptual task been made possible by the WHO’s ICF, which has provided: (i) the framework for the most appropriate conceptual model of rehabilitation as a health strategy (43–44, 50); (ii) the conceptualization, development and organization of functioning and rehabilitation research (22); (iii) the classification of rehabilitation services (51, 52); and (iv) the basis for an information reference system for collecting functioning information relevant, not merely to rehabilitation service delivery and assessment, but across the healthcare system (53).

Within the conceptual framework of the ICF, a person’s state of health is understood as a combination of levels of functioning, across domains of body functions and structures. This complex phenomenon yields a capacity to carry out some action or task, from the very simple to the very complex, where capacity is understood as the intrinsic ability to carry out the action irrespective of any environmental barriers or facilitators that might be in place. Arguably, this notion of capacity is fully aligned with our commonsense understanding of health as an attribute of an individual (“under the skin” so to speak), rather than the person’s environment. This sense of capacity also allows us to make sense of the role of the person’s overall “environment”, understood very broadly to encompass the basic elements of air, light, gravity, all features of the climate and physical environment, the full range of human-built environments, other people, their attitudes, beliefs and values, and all aspects of cultural, social, economic and political environments. Different configurations of

these environmental factors may substantially affect the manner in which the health state of the individual is experienced in his or her actual environment. Although this environmental context is not the individual's health as such, it is highly determinative of what, given the individual's health, he or she can actually *perform* by way of actions.

In short, in terms of the conceptual model presented in the ICF, when a person experiences a problem in functioning in their lives, or disability, we can both identify and measure that event as a degree of actually-observed *performance* understood as the outcome of an interaction between a person's health state (measurable as capacity) and the facilitators and barriers present in the person's environment. The ICF allows us to conceptualize and, with appropriate assessment instrumentation, measure the problems in functioning that are linked to health states, such as those resulting, in particular, from ageing and NCDs. As the ICF is also a classification that provides an international standard common language to describe capacity and performance, it gives us the scientific means for describing, and potentially measuring, at the individual and population levels, the full impact of the demographic and epidemiological trends that will define the 21st century.

CONCLUSION

Rehabilitation as a health strategy, incorporating rehabilitation medicine, the rehabilitation therapies and assistive technology, is poised to become the key health strategy of the 21st century. With the help of the conceptual model and information reference system provided by the ICF, it is now possible to capture the relationship between rehabilitation's objective of optimizing functioning and the powerful demographic and epidemiological trends whose impact will be, across the population worldwide, to create decrements in functioning that can be measured both at the clinical or individual level, and at the population level. Recently, relying on its own model of the 6 basic components of the health system, the WHO has described in detail the policy, financial, service, human resource, technological and informational barriers to scaling up rehabilitation services worldwide (54, 55). Overcoming these obstacles will not be easy, especially in low- and medium-income countries; in some settings, only small, incremental changes to healthcare systems facilitating the scaling up of rehabilitation services may be feasible. But, given the future that the world is facing, and the impact of population ageing and the shift towards NCDs, there is a powerful argument for making the investment so that the rehabilitative health strategy fulfils its promise in the 21st century.

ACKNOWLEDGEMENTS

The authors would like to thank Professor Alarcos Cieza for fruitful discussions, and Susanne Stucki and Cristiana Baffone for their support in the preparation of the manuscript.

REFERENCES

1. World Health Organization. World report on ageing and health. Geneva: WHO; 2015.
2. United Nations. Department of Economic and Social Affairs Population Division. World Population Ageing 2015. New York: United Nations; 2015. Available from: http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf.
3. Chatterji S, Byles J, Cutler D, Seeman T, Verdes E. Health, functioning and disability in older adults – present status and future implications. *Lancet* 2015; 385: 563–575.
4. United Nations. Department of Economic and Social Affairs Population Division. World Population Ageing 2009. New York: United Nations; 2009. Available from: http://www.un.org/esa/population/publications/WPA2009/WPA2009_WorkingPaper.pdf.
5. World Health Organization. Preventing chronic diseases: a vital investment. WHO global Report. Geneva: WHO; 2005.
6. World Health Organization. Global Action Plan for the prevention and control of Noncommunicable diseases 2013–2020. 2012 [cited 2016 Nov 30]. Available from: http://apps.who.int/iris/bitstream/10665/94384/1/9789241506236_eng.pdf.
7. Institute of Medicine. Living well with chronic illness: a call for public health action. Washington, DC: The National Academies Press; 2012.
8. World Health Organization. Global Status Report on non-communicable diseases, 2010. Geneva: WHO; 2011 [cited 2016 Nov 30]. Available from: http://www.who.int/nmh/publications/ncd_report_full_en.pdf.
9. World Health Organization. Global status report on non-communicable diseases, 2014. Geneva: WHO; 2014 [cited 2016 Nov 30]. Available from: http://apps.who.int/iris/bitstream/10665/148114/1/9789241564854_eng.pdf.
10. Prince MJ, Wu F, Guo Y, Gutierrez Robledo LM, O'Donnell M, Sullivan R, et al. The burden of disease in older people and implications for health policy and practice. *Lancet* 2015; 385: 549–562.
11. GBD 2013 DALY and HALE Collaborators, Murray CJL, Barber RM, Foreman KJ, Abbasoglu Ozgoren A, Abd-Allah F, et al. Global, regional, and national disability-adjusted life years (DALYs) for 306 diseases and injuries and healthy life expectancy (HALE) for 188 countries, 1990–2013: quantifying the epidemiological transition. *Lancet* 2015; 386: 2145–2191.
12. Michaud CM, McKenna MT, Begg S, Tomijima N, Majmudar M, Bulzacchelli MT, et al. The burden of disease and injury in the United States 1996. *Pop Health Metrics* 2006; 4: 11.
13. World Health Organization, World Bank. World report on disability. Geneva: WHO; 2011.
14. World Health Organization. The International Classification of Functioning, Disability and Health (ICF). Geneva: WHO; 2001.
15. Marengoni A, Angleman S, Melis R, Mangialasche F, Karp A, Garmen A, et al. Aging with multimorbidity: a systematic review of the literature. *Ageing Res Rev* 2011; 10: 430–439.
16. Tinetti ME, Bogardus ST Jr, Agostini JV. Potential pitfalls of disease-specific guidelines for patients with multiple conditions. *N Engl J Med* 2004; 35: 2870–2874.
17. Boyd CM, Darer J, Boult C, Fried LP, Boult L, Wu AW. Clinical practice guidelines and quality of care for older patients with multiple comorbid diseases: implications for pay for performance. *JAMA* 2005; 294: 716–724.

18. United Nations. Convention on the Rights of Persons with Disabilities, G.A. Res. 2006 [cited 2016 Nov 30]. Available from: <http://www.un.org/esa/socdev/enable/rights/convtexte.htm>.
19. DeLisa JA, Martin GA, Currie DM. Rehabilitation medicine: past, present, and future. In: DeLisa JA and Gans B, editors. Rehabilitation medicine: principles and practice. Philadelphia: JB Lippincott Co.; 1993.
20. World Health Organization. Declaration of Alma-Ata. International Conference on Primary Health Care, Alma-Ata, USSR, 6–12 September 1978. 1978 [cited 2016 Nov 30]. Available from: http://www.who.int/publications/almaata_declaration_en.pdf?ua=1.
21. World Health Organization. Universal Health Coverage [cited 2016 Nov 30]. Available from: <http://www.who.int/mediacentre/factsheets/fs395/en/>.
22. Stucki G, Cieza A, Melvin J. The International Classification of Functioning, Disability and Health: a unifying model for the conceptual description of the rehabilitation strategy. *J Rehabil Med* 2007; 39: 279–285.
23. Stucki G. Olle Höök Lectureship 2015: the World Health Organization's paradigm shift and implementation of the International Classification of Functioning, Disability and Health in Rehabilitation. *J Rehabil Med* 2016; 48: 486–493.
24. Porter R. The greatest benefit to mankind: a medical history of humanity from antiquity to the present. London: Harper Collins; 1997.
25. Weatherall D, Greenwood B, Chee HL, Wasi P. Chapter 5: Science and technology for disease control: past, present, and future. In: Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, Evans DB, et al, editors. Disease control priorities in developing countries, 2nd edn. Washington (DC): The World Bank; New York: Oxford University Press; 2006.
26. Marmot MG, Wilkinson RG, editors. Social determinants of health. Oxford: Oxford University Press; 1999.
27. Stansfeld S, Head J, Ferrie J. Short-term disability, sickness absence, and social gradients in the Whitehall II study. *Int J Law Psychiatry* 1999; 22: 425–439.
28. Institute of Medicine. An integrated framework for assessing the value of community-based prevention. Washington, DC: The National Academies Press; 2012.
29. Beeson PB. Changes in medical therapy during the past half century. *Medicine (Baltimore)* 1980; 59: 79–99.
30. Cooter JR, Pickstone J. Medicine in the twentieth century. Amsterdam: Harwood; 2000.
31. World Health Organization. The World Health Report 2002: reducing risks, promoting healthy life. Geneva: WHO; 2002.
32. Teichholz N. The big fat surprise: why meat, butter and cheese belong in a healthy diet. New York: Simon & Schuster; 2015.
33. Beard JR, Bloom DE. Towards a comprehensive public health response to population ageing. *Lancet* 2015; 385: 658–661.
34. Institute of Medicine. Retooling for an aging America: building the health care workforce. Washington, DC: The National Academies Press; 2008.
35. Institute of Medicine. Enabling America: assessing the role of rehabilitation science and engineering. Washington, DC: The National Academies Press; 1997.
36. Fox F. Physical remedies for disabled soldiers. London: Bailliére, Tindale and Cox; 1917.
37. Stiker H-J. A history of disability. Ann Arbor: University of Michigan Press; 1999.
38. Sullivan OM, Snortum KO. Disabled persons: their education and rehabilitation. New York: The Century Co.; 1926.
39. Liachowitz CH. Disability as a social construct: legislative roots. Philadelphia: University of Pennsylvania Press; 1988.
40. Kessler HH. The crippled and the disabled: rehabilitation of the physically handicapped in the United States. New York: Columbia University Press; 1935.
41. World Health Organization. Expert Committee on Disability Prevention and Rehabilitation. Disability prevention and rehabilitation. Technical Report Series 668. Geneva: World Health Organization; 1981.
42. Gutenbrunner C, Hildebrandt G (Hrsg.): Handbuch der Balneologie und medi-zinischen Klimatologie. Berlin: Springer-Verlag; 1998, p. 731–758.
43. Gutenbrunner C, Meyer T, Melvin J, Stucki G. Towards a conceptual description of physical and rehabilitation medicine. *J Rehabil Med* 2011; 43: 760–764.
44. Meyer T, Gutenbrunner C, Bickenbach J, Cieza A, Melvin J, Stucki G. Towards a conceptual description of rehabilitation as a health strategy. *J Rehabil Med* 2011; 43: 765–769.
45. Gutenbrunner C, Ward AB, Chamberlain MA, editors. The White Book on Physical and Rehabilitation Medicine in Europe. *J Rehabil Med* 2007; Suppl 45: 6–47.
46. Serrett KD. Philosophical and historical roots of occupational therapy. Philadelphia PA: Haworth Press; 1985.
47. World Health Organization. Global Cooperation on Assistive Technology (GATE). [Cited 2016 Nov 30]. Available from: http://www.who.int/phi/implementation/assistive_technology/phi_gate/en/.
48. Albrecht GL. The disability business: rehabilitation in America. Newbury Park, CA: Sage; 1992.
49. Bickenbach J. Universally designed social policy: when disability disappears? *Disabil Rehabil* 2014; 36: 1320–1327.
50. Stucki G, Melvin J. The International Classification of Functioning, Disability and Health: a unifying model for the conceptual description of physical and rehabilitation medicine. *J Rehabil Med* 2007; 39: 286–292.
51. Meyer T, Gutenbrunner C, Kiekens C, Skempes D, Melvin JL, Schedler K, et al. ISPRM Discussion paper: proposing a conceptual description of health-related rehabilitation services. *J Rehabil Med* 2014; 46: 1–6.
52. Gutenbrunner C, Bickenbach J, Kiekens C, Meyer T, Skempes D, Nugraha B, et al. ISPRM discussion paper: proposing dimensions for an international classification system for service organization in health-related rehabilitation *J Rehabil Med* 2015; 47: 809–815.
53. Stucki G, Bickenbach J, Melvin J. Strengthening rehabilitation in health systems worldwide by integrating information on functioning in national health information systems. *Am J Phys Med Rehabil* 2016 Dec 15 [Epub ahead of print].
54. World Health Organization. Monitoring the building blocks of health systems: a handbook of indicators and their measurement strategies. Geneva: WHO; 2010.
55. World Health Organization. Global Disability Action Plan 2014–2021: better health for all people with disability. Geneva: WHO; 2014.