

Strategic Plan for Rehabilitation Services

Rehabilitasyon Servisleri için Stratejik Plan

Haim RING

Professor and Chairman, Neurological Rehabilitation Department, Loewenstein Hospital Rehabilitation Center, Raanana, Sackler Faculty of Medicine, Tel Aviv University, Ramat Aviv, Chairman, National Rehabilitation Council, Ministry of Health, Israel

Summary

Rehabilitation medicine systems all over the world faced nevertheless difficulties not only on economical grounds but in general, some of them even struggling to survive. In this context it is important to analyze what elements could or should policy makers and leaders of rehabilitation systems consider in order to maintain or even advance their position amidst the health system they live within, looking for a more stable and promising future. Five domains can be defined in research & development, strategic planning and creative thinking in rehabilitation medicine: 1-Measurement of clinical outcomes, 2-Including cost/effectiveness and quality assurance, 3-Services delivery: the continuum of care, 4-Technologies/procedures, 5-Pharmacological treatments, 6-Opportunities ("niches").

These domains will be described and analyzed vis-à-vis 30 years or personal involvement in this realm. However, each system - regional, national - or even facility should make a selection of what fits their strategic plan best, where whatever has been described can be easily incorporated, where human and material resources exist or can be acquired. The need for the justification of the services looks as a must but all the rest of the items described sub-serve this purpose and should be seriously considered. Above all, is our patients' quality of life we should strive to improve. *Türk J Phys Med Rehab 2007; 53 Suppl 2: 1-5.*

Key Words: Rehabilitation services, rehabilitation, physiatry

Özet

Tüm dünyadaki rehabilitasyon tıbbi sistemleri, ne yazık ki, sadece ekonomik zeminlerde değil, genel olarak da zorluklarla yüz yüzedir, hatta bazıları varlıklarını sağlayabilmek için çaba sarf etmektedirler. Bu bağlamda, daha istikrarlı ve umut verici bir gelecek aramak için, politikacıların ve rehabilitasyon sistemi liderlerinin, içinde yaşadıkları sağlık sisteminin merkezindeki pozisyonlarını korumak, hatta ilerletmek için hangi elemanların düşünülmesi gerektiğinin analizini yapmaları önemlidir. Rehabilitasyon tıbbında araştırma ve gelişim için stratejik planlama yapmak ve yaratıcı düşünmek için beş ilgi alanı tanımlanabilir: 1-Klinik sonuçların ölçülmesi (maliyet etkinliği ve kalite güvencesi dahil), 2-Hizmet dağıtımı: Bakımın devamı, 3-Teknolojiler/yöntemler, 4-Farmakolojik tedaviler, 5-Fırsatlar ("hücreler").

Burada bu ilgi alanları tanımlanacak ve 30 yıl için bu alandaki kişisel ilişkiyle karşılaştırılarak analiz edilecektir. Ancak, -bölgesel ya da ulusal- her sistem, hatta etkinlik, stratejik planlarına en iyi neyin uyduğunun, tanımlanmış herhangi bir şeyin nerede kolaylıkla kapsanabildiğinin, insan ve materyal kaynaklarının nerede çıktığının ya da kazanılabileceğinin seçimini yapmalıdır. Hizmetlerin varlığı için ihtiyaç gerekçesi şart gibi gözükür, fakat tanımlanan maddelerin kalanının tümü bu amaca hizmet eder ve ciddi olarak düşünülmelidir. Hastalarımızın yaşam kalitesi hepsinin üstündedir ve onu geliştirmek için çok çabalamalıyız. *Türk Fiz Tıp Rehab Derg 2007; 53 Özel Sayı 2: 1-5.*

Anahtar Kelimeler: Rehabilitasyon servisleri, rehabilitasyon, fiziyatri

Although almost universally recognized as "equal among equals" (1) - a valuable achievement by itself- rehabilitation medicine systems all over the world faced nevertheless difficulties, not only on economical grounds but in general (some of them even struggling to survive). In this context it is important to analyze what elements could or should policy makers and leaders of rehabilitation systems consider in order to maintain or even advance their position amidst the health system they live within,

looking for a more stable and promising future (2,3). Before proceeding with their description, some basic characteristics of rehabilitation, important for the analysis, are considered:

*Rehabilitation "is the process of helping a person to reach the fullest physical, psychological, social, vocational, avocational and educational potential consistent with his or her physiologic or anatomical impairment, environmental limitations, desires and life plans" (4). Hence, it is a multidimensional, interdisciplinary (5)

(physiatrist as a leader) and deals with chronic conditions along the axis of time. Someone as defined rehabilitation "as a problem solving process" (6).

*A physiatrist is a specialist in rehabilitation medicine that has completed a prolonged and complex training program and successfully passed the examinations (7). Far too many people that don't comply with this definition do "rehabilitation" and this should be one issue of concern for our profession and a standing "for action" item of PM&R professional organization wherever this occurs.

*Rehabilitation may take place in different venues: general hospital, acute and sub-acute rehabilitation in-patient facilities, day care or therapy sessions in the rehabilitation facility as out-patient, community based rehabilitation (CBR), including as a variant rehab centers' outreach facilities ("satellites") or even home care.

*Although quite rare for administrative reasons some integration may take place between different rehabilitation facilities: horizontal on the administrative level, vertical on services delivery, i.e. different facilities joining efforts in different stages of the rehabilitation. Also some regional integration can be made.

*Different management plans and contracts exist having as common denominator cost containment: global contracts (with or without utilization review), fee for service, prospective payment system (PPS) and more recently functional-related groups (FRG) and managed care (see further on in the text).

*Among the different characteristics of the rehabilitation set-up, the therapeutic conceptual basis is very important (6): it could be "task-oriented", with a more pragmatic approach, or "theory-based", with a rather cognitive, impairment oriented rationale. Both approaches have different implications regarding length of treatment and quality of the results or outcome.

Five domains can be defined: Measurement of clinical outcomes, services delivery: the continuum of care, technologies/procedures, pharmacological treatments, opportunities ("niches").

Measurement of clinical outcomes

We mean by that the skillful use of valid and reliable scales for function measurement, quality assurance, outcomes, cost benefit analysis, etc. (8-10). This domain helps rehabilitation systems, in fact, justifying their work. The measures can and should be performed in the different known dimensions of the ICDH-1 (11) namely impairment, disability and handicap or in the terms of the ICDH-2 (ICF) (12): body function and structure, activity and participation. The Rasch analysis has been of great help in analyzing scales properties, mainly unidimensionality (13-15). The basic measure would be at the beginning of the rehabilitation process and any other point during the process but in any case also at the end of it. The difference between the points can be defined as "effectiveness", gain or "delta" (16). The gain rate per day obtained by dividing the gain by the length of stay (LOS) is defined as "efficiency" and the ratio between the actual functional improvement and the theoretical one is called "efficacy". If measured or expressed regardless of the time factor it would be "absolute efficacy" and if considering it, "relative efficacy" (17). The measures can be expressed for a given population such as the department (18) or the entire facility and

compared with other similar facilities of the same (19) or different (20) continent. As expressed by Carl Granger (21) "the field of PM&R has the opportunity not simply to be recognized by our medical colleagues, but to take a leadership role in the measurement of clinical outcomes, including cost-effectiveness. New measures for different impairments should be developed (22,23).

This issue is also intimately related to the performance of clinical trials in our realm, more precisely randomized control trials (RCT) defined as "the cornerstone of medical rehabilitation (24). Although difficulties exist (25,26) there also solutions (27,28) and no doubt the use of valid and reliable scales is probably one of the most important of all. Also, of utmost importance is defining the outcomes itself (29-31). Each rehabilitation system should adopt a set of measures, and create a computerized data based with the demographic, clinical and functional data constantly recorded on an electronic data sheet. In this way the publication of a yearly report or simple average figures can be easily performed and also more complex ones such as cost/effectiveness and regression analysis etc, as well. Functional measures are also part of the accreditation process and not less important, of quality assurance (QA) programs. According to DeJong, outcomes should be disclosed as "...secrecy is incompatible with the needs for accountability and transparency and with the demands of evidence-based practice" (32).

Services delivery: the continuum of care

One of the most critical aspects of rehabilitation work deals with the issue of where (place) and for how long (time) the treatment of a patient referred for rehabilitation should be (33). In in-patient rehabilitation it is called length of stay (LOS). One of the classical approaches in our country in the past was, "up to plateau" rehabilitation (i.e. until patients show no visible functional improvement) in-patient treatment. Under this approach, a stroke patient as an example, would typically spend in our facility over three month, completing most of his/her functional tasks and over 90% of them returning home (18). However, insurers all over found expenses of prolonged inpatient rehabilitation too high and started limiting the LOS with the result of patients being discharged with limited independence directly to the community (34,35). This led to the creation of day hospitals that in our case, shortened the in-patient LOS by one third to less than 60 days and is still decreasing. CBR is growing and developing, with the WHO consistently paying attention to it (36) and scholars rising questions on the evidence-based practices (37) as well ethical issues (38) of CBR in developing countries. The fractionation of the rehabilitation process in different venues and different time of treatment, created concerns regarding the preservation of the quality of care across the different alternatives, hence "the continuity of care" (39,40).

Another alternative is to define set periods of time, mainly in-patient. The FRG approach to determine LOS is a good example of this approach (41) where some parameters of the patient such as motor and cognitive performance and age, would dictate the LOS in in-patient rehabilitation.

An additional way of improving limited periods of time for rehabilitation is adopting systems that would allegedly make them more efficient. For instance the critical/clinical pathways (42-44) approach that dictates what and when different procedures

should be done as from the patient's admission and on. We have proposed an integrative pathway involving different existing alternatives (45) that has some characteristics of the managed care system but is performed under physiatrist conduction and with the patient/family participation (46).

All these is related to additional factors to be taken into consideration: the taxonomy of rehabilitation interventions or as defined by DeJong et al. (47) "The black box of rehabilitation" and risk adjusting both financial and clinical (48,49). No doubt this will improve satisfaction of both insurers and patients (50) and give the rehabilitation system more credibility and trust.

Technologies/procedures

The use of advanced technologies is probably one of the most promising aspects of our work that may bear some solutions to problems affecting rehabilitation systems (45-47,50). Along with solutions some problems may arise and rehabilitation experts should approach this realm positively but cautiously (51-53).

Virtual reality (VR) is a technology where an interactive, computer-generated environment that simulates the real world is created (54,55). It combines two (2D) or three-dimensional (3D) computer graphics with special display techniques giving the participant the feeling of being part of the illusive world. This situation may be used for different rehabilitation situation: sensory-motor training, perception deficits correction, aphasic syndromes treatments, etc. Our first experience was with the "street crossing" specially designed VR program aiming at correcting temporal-spatial deficits in post-stroke neglect syndrome patients (56). Patients, showed significant improvement in attention to left-sided stimuli (cars approaching from the left neglected side) as well in crossing the street.

Functional electrical stimulation (FES) is a non-invasive electrical stimulation technique. Our department has been active in the development and application of the Handmaster device consisting in a hybrid hand neuro-orthosis applied to the patients' forearm and wrist with stimulating electrodes embedded inside the orthosis (57). Five electrodes, personally adjusted for each patient in the optimal stimulating points over key muscle groups, will stimulate flexor, extensor and thenar eminence muscles.

Simultaneous multi-segment stimulation of additional body segments such as arm and leg can be performed with very promising results both in hand and leg function (58).

A novel wireless radio-frequency (RF) device for lower limb paralysis after central nervous system damage has been developed and tested in our department with very significant improvement in the various parameters of gait and reduction of falls (59).

There is growing evidence that FES treatment induces neural changes in the brain i.e. promotes cortical reorganization with subsequent functional improvement (60).

Transcranial Doppler (TCD) is a technique for measuring cerebral blood flow through "windows" in the skull, of different brain arteries. In our department we have for the first time used the TCD technology to monitor changes in blood flow in the middle cerebral artery in both brain hemispheres simultaneously and correlate it with function as measured with the FIM, NIHSS and other scales, as well with cognitive function, speech, etc. The preliminary findings (61) lend further support to the cumulative knowledge that changes occur in both hemispheres and that TCD

measure may help monitoring, treating and even predicting outcome both in general (ADL) as well as specific functions such as language (62).

Robotics in rehabilitation is a novel and highly sophisticated technology with very promising applications in various rehabilitation, neurological as well orthopedic situations (63). This technique may allow for open label of pre-programmed ("menu") training programs that can be passive, active-assisted or active, for upper or lower limb training, uni or bi-lateral. The results of each session can be computer registered and stored for "off-line" analysis and re-consideration of the therapeutic strategy to be applied in each patient individually (64).

Constraint induced movement therapy (CIMT) CIMT or "force use" is a simple "low tech"- method of treatment of the paralytic limb, mostly the upper limb, based on the assumption that in patients with some potential for function, the "learned non-use" phenomena plays a role (65). The CIMT literally forces the patient to use the paralytic hand, improving function. The sound, non-paralytic, limb is placed in a mitt or sling restricting his/her movements and the affected upper limb is then forced to act for several hours a day on either specific or general everyday tasks.

Physiatrists and allied medical professions alike, to be prepared to understand, skillfully help patients adjust to these innovative technologies, as well be part of its research and development (66). Not less important to influence decision-makers on the incorporation of these technologies in the "basket of services" offered to the disabled people and rehabilitation systems.

One open question by now is the place of "complementary medicine" in the realm of rehabilitation (67,68). So far, the ideas are contradictory but it looks as some techniques such as acupuncture (69,70) are slowly gaining their place in rehabilitation.

Pharmacological treatments

New perspectives, however, are opened with the possible or practical use of drugs for specific "sui generis" situations in rehabilitation. No doubt the most significant advance in this regard has been the introduction of the botulinum toxin A for clinical use mainly in situations of spasticity (71,72) but also in focal dystonia, blepharospasm, torticollis and other well defined clinical situations. Additional experimental drugs have been for cognitive impairment (memory, etc.) with doubtful results and psychotropics for TBI patients' behavior disturbances. One promising item in this field is that of drug-driven neuromodulation. It is hoped that the administration of certain drugs such as d-amphetamines or l-dopa, along with traditional (PT, OT, etc.), semi- (CIMT) or advanced technological (FES, VR, robotic) treatments will induce neural changes in the damaged brain conducting to speech (73) motor (74,75), and other improvements based in the proven capacity of the brain to generate or undergo plastic changes underlying improvements in functions (76).

Breakthroughs?

Brain stem cells or other cells (Schwann, fibrocytes) implants (77-79) are in theory very promising for certain conditions - TBI, spinal cord injury, Parkinson, stroke, etc. -, the results, for the time being, meager. No doubt more efforts should be invested and combined with other techniques presented above.

Opportunities ("niches")

By these terms we understand situations where rehabilitation specialists and their team and/or facilities may have an advantage over other professions or facilities that create and opportunity for developing services improving both their income and image at the same time. As they might be the only ones able to do these or to doing it better, it can be a kind of "niche".

These can be: Musculoskeletal clinics/programs, myofascial pain, fibromyalgia, chronic pain, arthritic conditions, hand rehabilitation clinic, cancer rehabilitation (80,81), Respiratory rehabilitation, organ-transplant rehabilitation (82), multiple sclerosis (MS) clinic, primary care for the disabled (83), wellness promotion centers (sport+leisure), long term care for comatose patients, disability evaluations (large volumes), medico-legal opinions for corporations, large firms, etc., assessment of driving skills in the disabled (brain main.), occupational ergonomics (prevention), technology for disabled people (information center), R&D joint ventures with industry in technologies in disability, tele-rehabilitation, educational activities and publications.

Summary

We have presented the domains we believe are of utmost importance for a thinking process around how to improve the rehabilitation system situation, if necessary. Each system -regional, national- or even facility should make a selection of what fits their strategic plan where whatever has been described can be easily incorporated, where human and material resources exist or can be acquired. The need for the justification of the services looks as a must but all the rest of the items described sub-serve this purpose and should be seriously considered. Above all, is our patients' quality of life we should strive to improve (84-86).

References

- Ring H. International rehabilitation medicine: closing the gaps and globalization of the profession (Invited Editorial). *Am J Phys Med Rehabil* 2004;83:667-9.
- Chamberlain A. Advances in rehabilitation: an overview and odyssey. *Clin Med* 2003;3:62-7.
- Shangali H. Current and future trends in medical rehabilitation (editorial). *Prosthetics Orthotics Int* 2003;27:1.
- DeLisa J, Currie DM, Martin M. Rehabilitation Medicine - past, present and future. In: *Rehabilitation Medicine, Principles and Practice*. DeLisa J, Gans B (Eds.). Lippincor-Raven, Philadelphia - NY, 3rd edition; 1998.
- Bent N, Tennant A, Swift T, Posnett J, Scuffham P, Chamberlain MA. Team approach versus ad hoc health services for young people with physical disabilities: a retrospective cohort study. *Lancet* 2002;360:1280-6.
- Wade DT, de Jong BA. Recent advances in rehabilitation. *BMJ* 2000;320:1385-8.
- Ring H. Certification and measuring competency in Israel. *Arch. Phys Med Rehabil* 2000;81:1250-2.
- Barat M, Franchinogni F (Eds.). *Advances in Rehabilitation. Assessment in physical medicine and rehabilitation - views and perspectives*. Maugeri Foundation Books, Pavia - Italy, Vol 16; 2004.
- Dittmar SS, Gresham GE. *Functional assessment and outcome measures for the rehabilitation health professional*. Aspen publication, Gaithersburg, Maryland; 1997.
- Wade DT. *Measurement in neurological rehabilitation*. Oxford University Press, Oxford, UK; 1992.
- WHO. *International Classification of Impairment, Disability and Handicap*, Geneve; 1980.
- WHO. *International Classification of Function, Disability and Health*. Geneve; 2001.
- Tennant A, Penta M, Tesio L, Grimby G, Thonnard JL, Slade A, et al. Assessing and adjusting for cross-cultural validity of impairment and activity limitation through differential item functioning within the framework of the Rasch model: the PRO-ESOR project. *Med Care* 2004;42:1-13748.
- Tesio L. Measurement in clinical vs. biological medicine: the Rasch model as a bridge on a widening gap. *J Appl Meas* 2004;5:362-6.
- Lundgren-Nilsson A, Grimby G, Ring H, Tesio L, Lawton G, Slade A, et al. Cross-cultural validity of functional independence measure items in stroke: a study using Rasch analysis. *J Rehabil Med* 2005;37:23-31.
- Stineman MG, Hamilton BB, Goin JE, Granger CV. Functional gain and length of stay for major rehabilitation impairment categories. *Arch Phys Med Rehabil* 1996;75:68-78.
- Drubach DA, Kelly MP, Taragano FE. The Montebello rehabilitation factor score. *J Nurse Rehabil* 1994;12:189-98.
- Ring H, Feder M, Schwartz J, Samuels G. Functional measures of first stroke in inpatient rehabilitation: The use of the FIM total score with a clinical rationale. *Arch Phys Med Rehabil* 1997;78:630-5.
- Haigh R, Tennant A, Biering-Sorensen F, Grimby G, Marincek C, Phillips S, et al. The use of outcome measures in physical medicine and rehabilitation within Europe. *J Rehabil Med* 2001;33:273-8.
- Tesio L, Granger CV, Perruca L, Franchignoni F, Battaglia MA, Russell CF. The FIM instrument in the United States and Italy: a comparative study. *Am J Phys Med Rehabil* 2002;81:168-76.
- Granger CV. Letter to the Editor. *Am J Phys Med Rehabil* 2000:197.
- Catz A, Itzkovich M, Agranov G, Ring H, Tamir A. SCIM-Spinal cord independence measure: A new disability scale for patients with spinal cord lesions. *Spinal Cord J* 1997;35:850-6.
- Tesio L, Perruca L, Franchignoni F, Battaglia MA. A short measure of balance in multiple sclerosis: validation through Rasch analysis. *Funct Neurol* 1997;12:255-65.
- DeLisa JA. Clinical trials, the cornerstone of medical rehabilitation. *Am J Phys Med Rehabil* 2003;82(suppl):S1-S2.
- Whyte J. Clinical trials in rehabilitation: what are the obstacles? *Am J Phys Med Rehabil* 2003;82(suppl):S16-S21.
- Wade DT. Barriers to rehabilitation research, and overcoming them. *Clin Rehabil* 2003;17:1-4.
- Johnston MV. Desiderata for clinical trials in medical rehabilitation. *Am J Phys Med Rehabil* 2003;82(suppl):S3-S7.
- Fuhrer MJ. Overview of clinical trials in medical rehabilitation. Impetuses, challenges, and needed future directions. *Am J Phys Med Rehabil* 2003;82(suppl):S8-S15.
- Stineman MG. Defining the population, treatments, and outcomes of interest. Reconciling the rules of biology with meaningfulness. *Am J Phys Med Rehabil* 2001;80:147-59.
- Melvin J. Outcomes research in rehabilitation. Scope and challenges. *Am J Phys Med Rehabil* 2001;80:78-82.
- Wade DT. Outcomes measures for clinical rehabilitation trials. Impairment, function, quality of life, or value? *Am J Phys Med Rehabil* 2003;82(suppl):S26-S31.
- DeJong G. The case of public disclosure of rehabilitation outcomes and the cultural barriers in health care to public disclosure. In: *Advances in Rehabilitation Medicine* (Soroker N, Ring H, Eds.), Monduzzi (Bologna, Italy), 2003:531-40.
- Hoening H, Sloane R, Horner RD, Zolkewitz M, Duncan PW, Hamilton BB. A taxonomy for classification of stroke rehabilitation services. *Arch Phys Med Rehabil* 2000;81:853-62.
- Ottenbacher KJ, Smith PM, Illig SB, Fiedler RC, Granger CV. Length of stay and hospital readmission for persons with disabilities. *Am J Public Health* 2000;90:1920-3.
- Treger I, Ring H, Schwartz R. Hospital disposition after stroke in a national survey of acute CVA. *Arch Phys Med Rehabil* (In Press).
- WHO Disability & Rehabilitation Team (DAR). Report of the second informal meeting on medical rehabilitation. Geneva, 2003.
- Pinkenflugel H, Wolfers I, Huijsman R. The evidence base for community-based rehabilitation: a literature review. *Int J Rehabil Res* 2005;28:187-201.
- Turmusani M, Vreede A, Wirz SL. Some ethical issues in community-based rehabilitation initiatives in developing countries. *Disabil Rehabil* 2002;24:558-64.

39. Dixon TP. Rehabilitation across the continuum: managing the challenges. *Arch Phys Med Rehabil* 1997;78:115-9.
40. Claesson L, Gosman-Hedstrom G, Johanneson M, Fagerberg B, Blomstrand C. Resource utilization and costs of a stroke unit care integrated in a care continuum. *Stroke* 2000;31:2569-77.
41. Stineman MG. The story of function-related groups - please, first do not harm. *Arch Phys Med Rehabil* 2001;82:553-7.
42. Sulch D, Perez I, Melbourn A, Kalra L. Randomized controlled trial of integrated (managed) care pathway for stroke rehabilitation. *Stroke* 2000;31:1929-34.
43. Panzarasa S, Madde S, Quagliani S, Pistarini C, Stefanelli M. Evidence-based careflow management systems: the case of post-stroke rehabilitation. *J Biomed Inform* 2002;35:123-39.
44. Francheschini M, Aliboni S, Rizzi B, Agosti M, on behalf of the IRC. Stroke rehabilitation pathways and procedures in Italy. *Eur Med Phys* 2004;40:251-6.
45. Ring H. Shames Rehabilitation funding and rehabilitation outcomes: do one affect the other? (Invited review). *Critical Reviews PMR (USA)* 2006;18:173-86.
46. Strax TE. Consumer, advocate, provider: a paradox requiring a new identity paradigm. *Arch Phys Med Rehabil* 2003;84:943-5.
47. DeJong G, Horn SD, Gassaway JA, Slavin MD, Dijkers MP. Toward a taxonomy of rehabilitation interventions: using an inductive approach to examine the "black box" of rehabilitation. *Arch Phys Med Rehabil* 2004;85:678-86.
48. Iezzoni LI. Risk adjusting rehabilitation outcomes. An overview of methodological issues. *Am J Phys Med Rehabil* 2004;83:316-26.
49. Giaquinto S. Comorbidity in post-stroke rehabilitation. *Eur J Neurol* 2003;10:235-8.
50. Franchignoni F, Ottonello M, Benevolo E, Tesio L. Satisfaction with hospital rehabilitation: is it related to life satisfaction, functional status, age or education? *J Rehabil Med* 2002;34:105-8.
51. Ring H. Technology in Rehabilitation. *Europa Medicophysica* 2003; 39:3-6.
52. Gok H, Ring H, Arasil T. Assistive technology in rehabilitation: current issues and future trends. *J Rheumatol Med Rehabil* 2003;14:118-26.
53. Ring H, Keren O, Zwecker M, Dynia A. The usage of medical technologies in rehabilitation medicine settings in Israel: the TECHNO-R 2005 survey. *Isr Med Assoc J (IMAJ)* (In Press).
54. Ring H. Is neurological rehabilitation ready for "immersion" in the virtual reality world? *Disabil Rehabil* 1998;20:98-101.
55. Rizzo AA. Virtual reality and disability: emergence and challenge. *Disabil Rehabil* 2002;11-12:567-9.
56. Katz N, Ring H, Naveh Y, Kizony R, Feintuch U, Weiss PL. Interactive virtual environment training for safe street crossing of right hemisphere stroke patients with unilateral spatial neglect. *Disabil Rehabil* 2005;27:1235-43.
57. Ring H, Rosenthal N. Controlled study of neuroprosthetic functional electrical stimulation in sub-acute post-stroke patients. *J Rehabil Med* 2005;37:32-6.
58. Alon G, Ring H. Gait and hand function enhancement following training with a multisegmental hybrid-orthosis stimulation system in stroke patients. *Stroke Cerebrovascular Dis J* 2003;12:209-16.
59. Hausdorff JM, Ring H. Effects of a new RF controlled neuroprosthesis on gait symmetry and rhythmicity in patients with chronic hemiparesis. *Am J Phys Med Rehabil* (In press).
60. Ring H, Weingarden H. Neuromodulation by FES of limb paralysis after stroke. *Acta Neurochirurgica* 2007;Suppl 97:375-80.
61. Treger I, Streifler JY, Ring H. The relationship between mean flow velocity and functional and neurological parameters of ischemic stroke patients undergoing rehabilitation. *Arch Phys Med Rehabil* 2005;86:427-30.
62. Treger I, Lutzki L, Gil M, Ring H. TCD monitoring during language tasks in stroke patients with aphasia. *Disabil Rehabil* 2007;29:1177-83.
63. Hogan N, Krebs HI. Interactive robots for neuro-rehabilitation. *Res Neurol Neurosci* 2004;22:349-58.
64. Ring H, Treger I, Faran S. Robot-assisted therapy of neuromuscular training of sub-acute stroke patients-a feasibility study (Submitted).
65. Alberts JL, Butler AJ, Wolf SL. The effects of constraint-induced therapy on precision grip: a preliminary study. *Neurorehabil Neural Repair* 2004;18:25-258.
66. Soroker N, Ring H. Retrospective analysis of trends in current PM&R research as reflected in the 2nd ISPRM world congress Prague, 2003 (Editorial). *Disabil Rehabil* 2004;26:687-93.
67. Laures J, Shisler R. Complementary and alternative medical approaches to treating adult neurogenic communication disorders: a review. *Disabil Rehabil* 2004;26:315-25.
68. Johnston L. Alternative, complementary, energy-based medicine for spinal cord injury. *Acta Neurochi* 2005;93(suppl):155-8.
69. Paterson C, Britten N. Acupuncture as a complex intervention: a holistic model. *J Altern Complement Med* 2004;10:791-801.
70. Gould A, MacPherson H. Patient perspectives on outcomes after treatment with acupuncture. *J Altern Complement Med* 2001;7:261-8.
71. Ward AB, Aguilar M, DeBeyl Z, Gedin S, Kanovsky P, Molteni F, et al. Use of botulinum toxin A in management of adult spasticity - a European consensus statement. *J Rehabil Med* 2003;35:98-9.
72. Kinnett D. Botulinum toxin A injections in children: technique and dosing issues. *Am J Phys Med Rehabil* 2004;83(suppl):S59-S64.
73. Walker-Batson D, Curtis S, Natarajan R, Ford J, Dronkers N, Salmemon E, et al. A double-blind, placebo-controlled study of the use of amphetamine in the treatment of aphasia. *Stroke* 2001;32:2093-8.
74. Scheidtmann K. Advances in adjuvant pharmacotherapy for motor rehabilitation: effects of levodopa. *Restor Neurol Neurosci* 2004;393-8.
75. Walker-Batson D, Smith P, Curtis S, Unwin DH. Neuromodulation paired with learning dependent practice to enhance poststroke recovery. *Restor Neurol Neurosci* 2004;387-92.
76. Nadeau SE. A paradigm shift in neurorehabilitation. *Lancet Neurol* 2002; 1: 126-30.
77. Savitz SI, Rosenbaum DM, Dinsmore JH, Wechsler LR, Caplan LR. Cell transplantation for stroke. *Ann Neurol* 2002; 52:266-75.
78. McDonald JW, Becker D. Spinal cord injury: promising interventions and realistic goals. *Am J Phys Med Rehabil* 2003;82(suppl):538-49.
79. Lakatos A, Franklin RJ. Transplant mediated repair of the central nervous system: an imminent solution? *Curr Opin Neurol* 2002;15:701-5.
80. DeLisa JA. A history of cancer rehabilitation. *Cancer* 2001;92(suppl):970-4.
81. Gerber LH. Cancer rehabilitation into the future. *Cancer* 2001;92(suppl):975-9.
82. Young MA, Stiens SA. Rehabilitation aspects of organ transplant. In: Braddom RL, Buschbacher RM, Dumitru D, editors. *Physical Medicine and Rehabilitation*. 2nd ed. Philadelphia PA: WB Saunders Co 2000. p. 1385-400.
83. Flax HJ. The future of physical medicine and rehabilitation. *Am J Phys Med Rehabil* 2000;79:79-86.
84. Tulskey DS, Rosenthal M. Measurement of quality of life in rehabilitation medicine: emerging issues. *Arch Phys Med Rehabil* 2003; 84(suppl):S1-S2.
85. Ware JE. Conceptualization and measurement of health-related quality of life: comments on an evolving field. *Arch Phys Med Rehabil* 2003;84(suppl):S43-S51.
86. Franchignoni F, Tesio L, Ottonello M, Benevolo E. Life Satisfaction Index: Italian version and validation of a short form. *Am J Phys Med Rehabil* 1999;78:509-15.