SOCIETÀ ITALIANA GERONTOLOGIA E GERIATRIA

CONGRESSO NAZIONALE

52° Firenze, Palazzo dei Congressi
28 novembre - 2 dicembre 2007

1° Corso per Fisioterapisti e Terapisti Occupazionali
29-30 novembre 2007

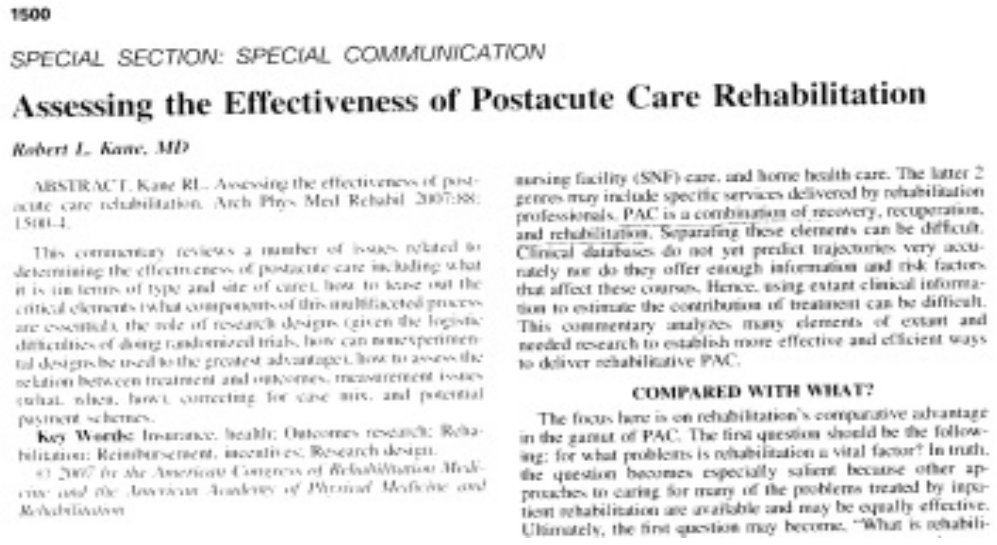
ISTITUTO CLINICO HUMANITAS

Riabilitazione geriatrica:Realtà e Prospettive

"Motor Relearning Program" un nuovo approccio al trattamento dell'emiplegico

Relatore Marco Pagani
29 novembre 2007

- Come riabilitatori siamo parte di un percorso che inizia nella stroke unit e finisce nel territorio.
- Il risultato lo si valuta alla fine del percorso….e negli anni



1500

SPECIAL SECTION: SPECIAL COMMUNICATION

Assessing the Effectiveness of Postacute Care Rehabilitation

Robert L. Kane, MD

ABSTRACT. Kane RL. Assessing the effectiveness of postacute care rehabilitation. Arch Phys Med Rehabil 2007;88: 1500–4.

This commentary reviews a number of issues related to determining the effectiveness of postacute care including what it is (in terms of type and site of care), how to tease out the critical elements (what components of this multifaceted process are essential), the role of research designs (given the logistic difficulties of doing randomized trials, how can nonexperimental designs be used to the greatest advantage), how to assess the relation between treatment and outcomes, measurement issues (what, when, how), correcting for case mix, and potential payment schemes.

Key Words: Insurance, health; Outcomes research; Rehabilitation; Reimbursement, incentives; Research design.

nursing facility (SNF) care, and home health care. The latter 2 genres may include specific services delivered by rehabilitation professionals. PAC is a combination of recovery, recuperation, and rehabilitation. Separating these elements can be difficult. Clinical databases do not yet predict trajectories very accurately nor do they offer enough information and risk factors that affect these courses. Hence, using extant clinical information to estimate the contribution of treatment can be difficult. This commentary analyzes many elements of extant and needed research to establish more effective and efficient ways to deliver rehabilitative PAC.

COMPARED WITH WHAT?

The focus here is on rehabilitation's comparative advantage in the gamut of PAC. The first question should be the following: for what problems is rehabilitation a vital factor? In truth, the question becomes especially salient because other approaches to caring for many of the problems treated by inpatient rehabilitation are available and may be equally effective. Ultimately, the first question may become, "What is rehabili-

- I risultati del trattamento riabilitativo dell'ictus non sono esaltanti ma la domanda è sempre la stessa:

- abbiamo fornito ai nostri pazienti lo stimolo sufficiente al cambiamento, abbiamo fatto della terapia riabilitativa o solo della riattivazione?

Clinical Rehabilitation 2003; **17**: 731–734

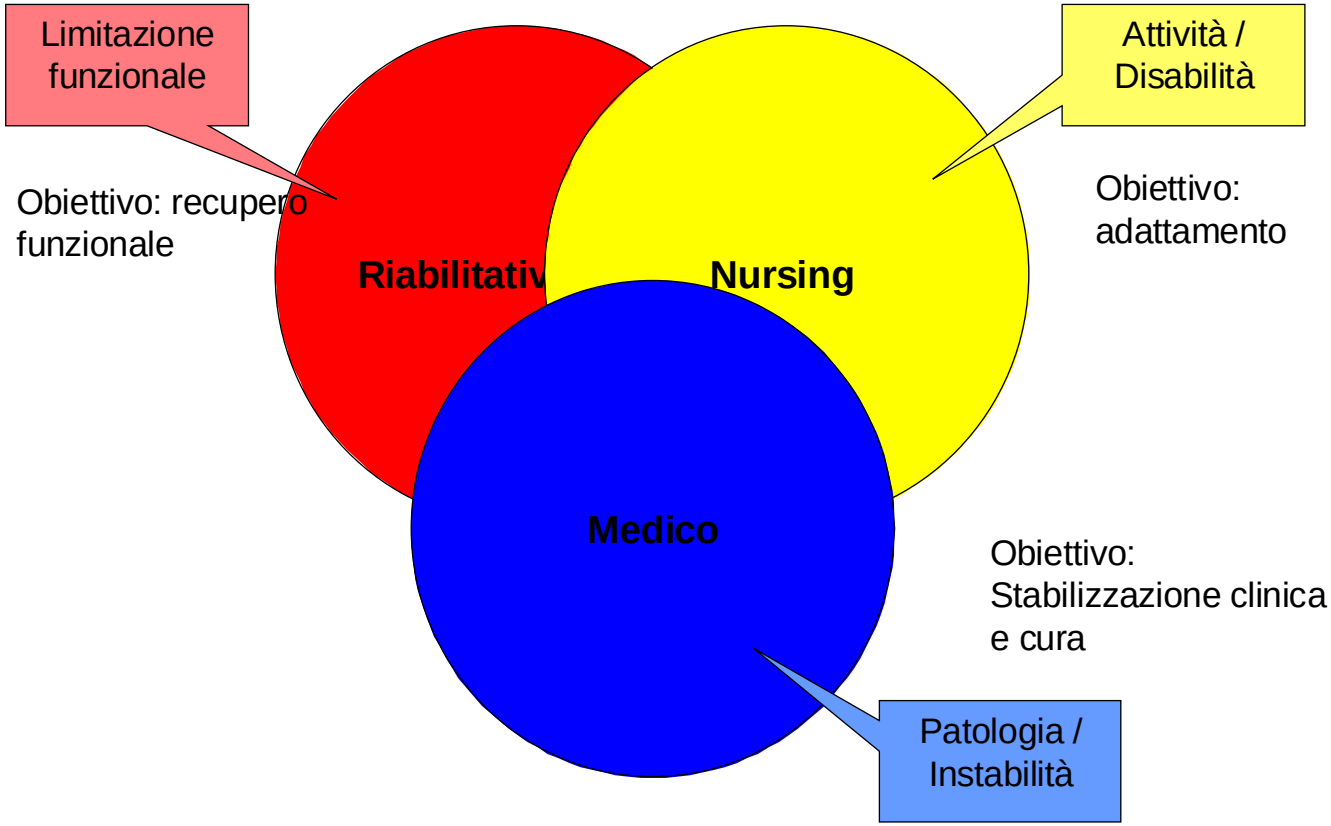
Bobath or Motor Relearning Programme? A follow-up one and four years post stroke

Birgitta Langhammer Faculty of Health Sciences, Oslo University College and **Johan K Stanghelle** Sunnaas Rehabilitation Hospital, Nesoddtangen, Norway

Received 9th November 2002; returned for revisions 14th April 2003; revised manuscript accepted 1st June 2003.

Motor function scores, measured by MAS and SMES, decreased after one year compared with the results three months post stroke (Table 1). The same decreasing tendency was seen in Barthel ADL index scores, indicating a lower level of independence in both groups (Table 1). The decreases in motor function and ADL were more pronounced and significant at four years follow-up. The scores four years after stroke were at a level similar to those of the first scores after the acute stroke, indicating a low degree of independence in ADL, motor function and transfer (Table 1). There were no significant differences between the groups in any of the tests.

La suddivisione dei compiti in riabilitazione



Bernardini, 2005

Il terapista è uno scienziato applicato del movimento

- Ogni approccio terapeutico diretto alla riabilitazione del paziente affetto da malattia neurologica è basato su alcune assunzioni di come il sistema nervoso centrale controlli i movimenti

- Gordon J Assumption underlyng Physical Therapy intevention:Theoretical and historical perspectives in Carr Sheperd Movement science Aspen

Ho bisogno di un modello teorico

- Esso da senso alle osservazioni isolate (dare un senso significa dare un ordine, una progressione, una casualità).
- permette di instaurare una gerarchia di interventi ed una progressione.
- trasforma l'arte in scienza.
- permette di misurare l'efficacia, permette di essere predittivo.

- Ogni teoria scientifica è figlia del proprio tempo ed è un salto, una reazione alla precedente.
- Prima del 1950 la terapia riabilitativa era centrata sul trattamento dei pazienti con esiti di poliomielite: trattamento molecolare, rieducazione muscolare.
- La poliomielite come malattia del neurone periferico .

- Quando la riabilitazione si è occupata di lesioni del SNC l'approccio molecolare era inadeguato: non spiegava, era insoddisfacente.
- Rivoluzione scientifica: sessione del Northwestern University nel 1964: The Northwestern University Special Therapeutic Exercise Project (NUSTEP).

Teorie di approccio “neuroterapeutico”, approccio facilitatorio.

- Il cervello controlla i movimenti non i muscoli.
- Il cervello lavora legando assieme la contrazione di diversi muscoli per produrre il movimento.
- Il disordine del movimento è un disordine di pattern di attivazione, non di muscoli.
- Il pattern anomalo del movimento deriva dalla lesione, dalla dissoluzione del controllo e quindi dalla liberazione dei centri inferiori dal controllo superiore

- Attualmente l'attuale approccio di neurofacilitazione è in crisi, nonostante sia il paradigma scientifico dominante.

- Il 97% delle terapiste inglesi utilizza metodiche secondo il concetto Bobath.

Edwards S. Neurological Physiotherapy Curchill Livingstone 2002

Crisi di risultati :

- A sei mesi dal fatto acuto solo il 60% dei pazienti è autonomo nelle BADL.
- il 40% dei sopravvissuti hanno una dipendenza nel cammino.
- Molti pazienti che recuperano il cammino dopo lo stroke hanno un rischio di caduta 4 volte superiore e di 10 volte superiore di frattura rispetto alla popolazione normale.

Strategies for stroke rehabilitation Dobkin Lancet neurology 3 528-36. 2004 .

- Approssimativamente il 35% dei pazienti non recuperano un uso funzionale dell'arto inferiore, ed il 20-25 % sono incapaci di camminare senza aiuto.
- A 6 mesi dalla lesione circa il 65% dei pazienti è incapace di utilizzare la mano per le usuali attività.

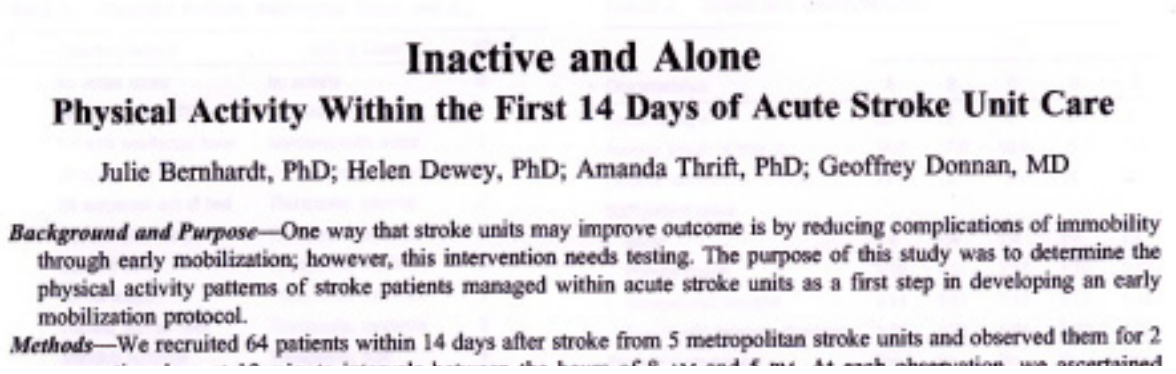
Dobkin Rehabilitation after stroke NEJM 2005,352; 1677-84

- L’entità del recupero sotto la guida di una terapista tende ad essere modesto, seppur utile clinicamente, come ad esempio 5 punti nell’indice di Barthel od un aumento della velocità del camino di 0.10 m/sec.

- Dobkin Rehabilitation after stroke NEJM 2005,352; 1677-84

Crisi della pratica terapeutica

- Nelle Stroke Unit il paziente passa più del 50% del tempo a letto, solo il 13% del tempo è speso in attività che potenzialmente sono in grado di prevenire le complicazioni o favorire il recupero.
- Rimane solo per il 60% del tempo



Inactive and Alone

Physical Activity Within the First 14 Days of Acute Stroke Unit Care

Julie Bernhardt, PhD; Helen Dewey, PhD; Amanda Thrift, PhD; Geoffrey Donnan, MD

Background and Purpose—One way that stroke units may improve outcome is by reducing complications of immobility through early mobilization; however, this intervention needs testing. The purpose of this study was to determine the physical activity patterns of stroke patients managed within acute stroke units as a first step in developing an early mobilization protocol.

Methods—We recruited 64 patients within 14 days after stroke from 5 metropolitan stroke units and observed them for 2

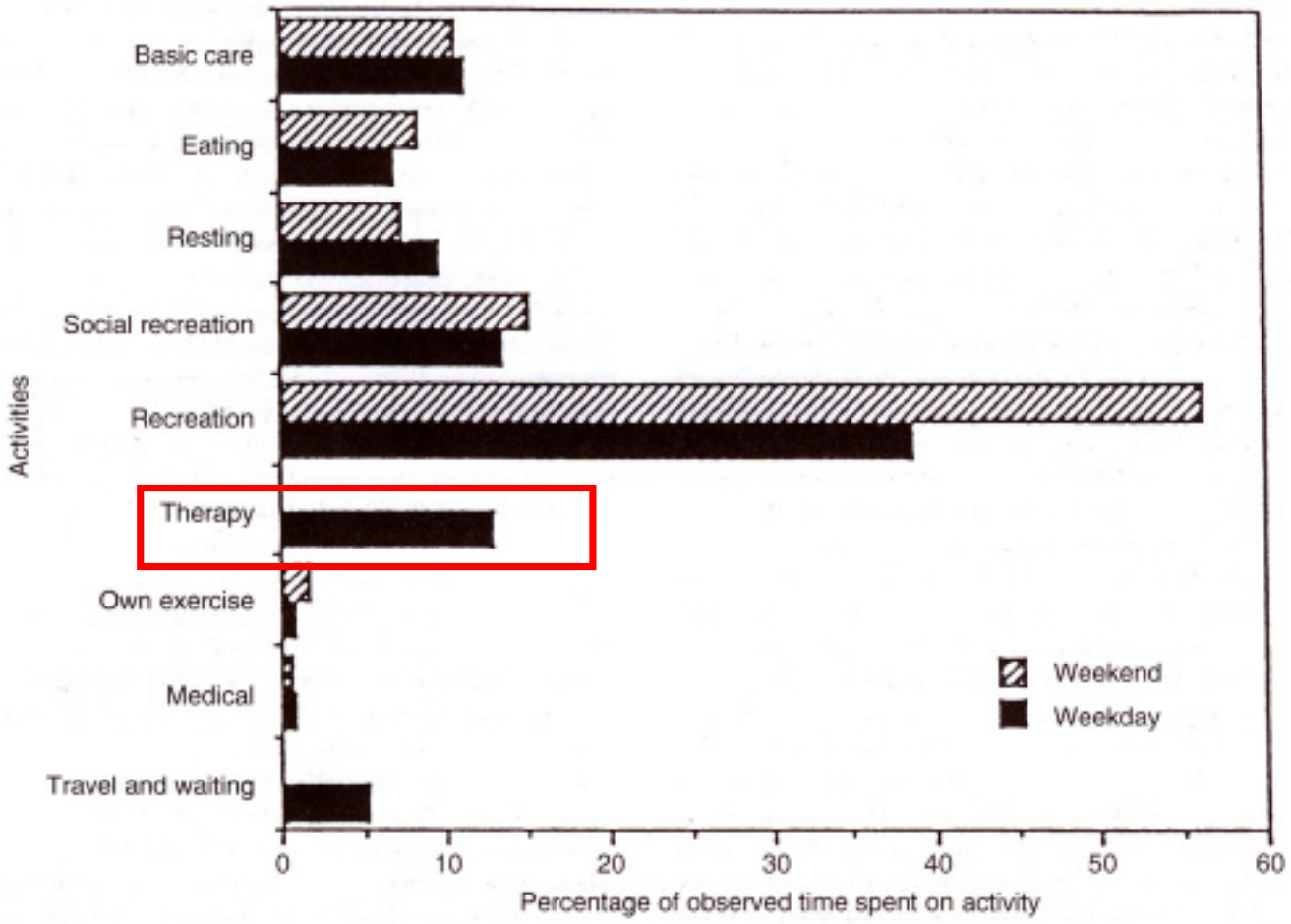


Fig. 1.2 Pattern of patients' activities during structured observations on weekdays and weekend. (From Tinson, D. J. (1989) How stroke patients spend their days. *International Disabilities Study*, **11**, 45–49, by permission)

Stroke rehabilitation: Does the therapy area provide a physical challenge?

Louise Ada[1], Fiona Mackey[2], Robert Heard[1] and Roger Adams[1]
[1]The University of Sydney [2]Illawarra Regional Hospital

It has been previously shown that stroke patients undergoing rehabilitation perform most physical activity under the supervision of a therapist when in the therapy area and very little activity when elsewhere. The aim of this paper was to identify conditions surrounding the performance of physical activity in the therapy area, in order to design strategies which would increase physical activity throughout the rehabilitation unit. Sixteen hemiplegic patients were observed in the therapy area. They were most active when with a therapist, whereas when alone, nearly two-thirds of their time was spent inactive. It appears that it is too difficult for patients to bridge the gap between fully-supervised and unsupervised practice. Strategies to provide patients with semi-supervised practice as a way of increasing the amount of overall physical activity, such as group sessions, are explored.
[Ada L, Mackey F, Heard R and Adams R: Stroke rehabilitation: Does the therapy area provide a physical challenge? *Australian Journal of Physiotherapy* 45: 33-38]

Key words: Cerebrovascular Disorders; Hemiplegia; Rehabilitation

Environmental factors in stroke rehabilitation

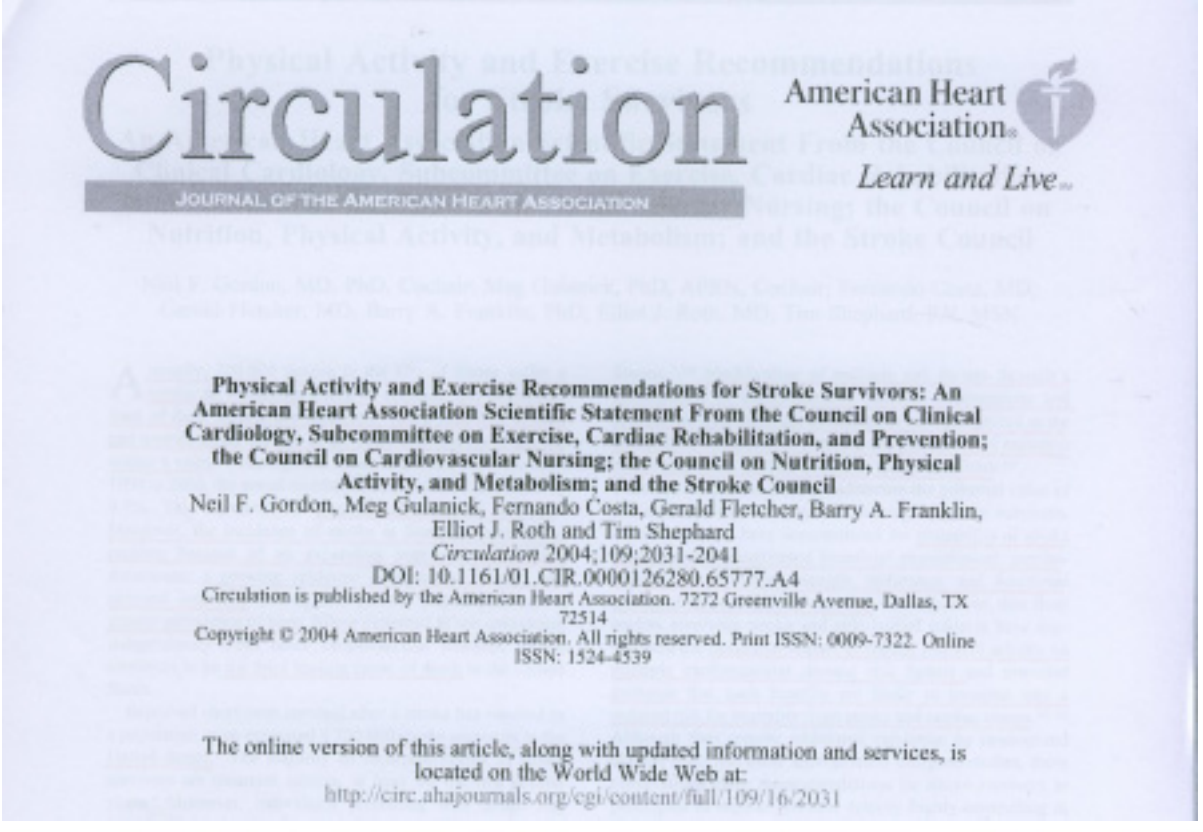
Being in hospital itself demotivates patients

Rehabilitation after stroke has been described as a process in which the patient and the healthcare system, through interaction and negotiation, try to reach agreement about activities to be emphasised and goals to be pursued.[1] Involvement and empowerment of the patient are implicit in, and integral to, this process. Participation in setting goals seems to have a positive impact on patients' motivation, and there is now consensus among professionals in stroke rehabilitation that the patient's degree of motivation will influence the outcome of an intervention. Consequently, an important element of any proposed intervention should be an assessment of

disturbance in patients with stroke is probably not the result of specific brain damage. Recently, researchers have begun to ask what characteristics enable patients to play an active part in managing their illness and recovery. Antonovsky has called this process "salutogenic orientation."[2]

The impact of environmental factors—for example, the effect of being in hospital—on the behaviour of patients with stroke, including their initiative and autonomy, is not well understood. Yet the low level of activity initiated by stroke patients when they are in hospital,[3-5] and the disempowering nature of their role as patients,[6] suggest that we should pay close attention

- L’usuale trattamento riabilitativo non è allenante l’endurance del soggetto.



Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION
American Heart Association.
Learn and Live.

Physical Activity and Exercise Recommendations for Stroke Survivors: An American Heart Association Scientific Statement From the Council on Clinical Cardiology, Subcommittee on Exercise, Cardiac Rehabilitation, and Prevention; the Council on Cardiovascular Nursing; the Council on Nutrition, Physical Activity, and Metabolism; and the Stroke Council

Neil F. Gordon, Meg Gulanick, Fernando Costa, Gerald Fletcher, Barry A. Franklin, Elliot J. Roth and Tim Shephard

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The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/cgi/content/full/109/16/2031

- L’usuale trattamento riabilitativo non è strutturato per sviluppare “la potenza”(forza per velocità) del gesto motorio.

- La potenza è parte fondamentale di diverse nostre attività della vita quotidiana: alzarsi dalla sedia, saltare, correre, non cadere, camminare.

- Studi scientifici hanno evidenziato che l’endurance e la potenza possono essere evocate ed allenate anche nei pazienti con esiti di ictus .

Faster Is Better

Implications for Speed-Intensive Gait Training After Stroke

Anouk Lamontagne, PhD, PT; Joyce Fung, PhD, PT

Background and Purpose—The instantaneous adaptations to speed and load changes during overground locomotion have major implications for mobility after stroke. We examined the extent to which stroke subjects could increase their overground walking speed with respect to speed and unloading changes.

Methods—Twelve subjects with a unilateral stroke were evaluated while walking overground full weight bearing (FWB) or with body weight support (BWS) at preferred or fast speed. On the basis of their preferred walking speed, subjects were classified as high (≥45 cm/s) or low functioning (<45 cm/s). Gait speed, temporal distance factors (TDFs), as well as movements and muscle activation of the lower limbs were measured and compared across the conditions.

Results—FWB-Fast condition induced marked (165%) increment in gait speed in all subjects. BWS at preferred speed induced faster speeds in low- but not the high-functioning subjects, whereas combined BWS and fast walking yielded further speed increments in the high-functioning subjects. Fast walking was associated with bilateral increases in joint excursion and muscle activation, as well as improved symmetry in some TDFs. BWS favored a hip flexion strategy in early swing while decreasing limb circumduction.

Conclusions—This study shows that stroke subjects can increase substantially their walking speed without deleterious effects. Fast walking induces marked speed-related improvements in body and limb kinematics and muscle activation patterns. BWS during overground walking also increases gait speed, but to a lesser extent and only in low-functioning subjects. The combination of BWS with fast speed produces the greatest increments in walking speed in all subjects. (***Stroke***. **2004;35:2543-2548.**)

Key Words: exercise ■ hemiplegia ■ locomotion ■ rehabilitation

Muscle Strengthening and Physical Conditioning to Reduce Impairment and Disability in Chronic Stroke Survivors

Luci Fuscaldi Teixeira-Salmela, PhD, PT, Sandra Jean Olney, PhD, PT, Sylvie Nadeau, PhD, PT, Brenda Brouwer, PhD

ABSTRACT. Teixeira-Salmela LF, Olney SJ, Nadeau S, Brouwer B. Muscle strengthening and physical conditioning to reduce impairment and disability in chronic stroke survivors. Arch Phys Med Rehabil 1999;80:1211-8.

Objective: To evaluate the impact of a program of muscle strengthening and physical conditioning on impairment and disability in chronic stroke subjects.

Design: A randomized pretest and posttest control group, followed by a single-group pretest and posttest design.

Subjects: Thirteen community-dwelling stroke survivors of at least 9 months.

Intervention: A 10-week (3 days/week) program consisting of a warm-up, aerobic exercises, lower extremity muscle strengthening, and a cool-down.

Main Outcome Measures: Peak isokinetic torque of the major muscle groups of the affected lower limb, quadriceps and ankle plantarflexor spasticity, gait speed, rate of stair climbing, the Human Activity Profile (HAP), and the Nottingham Health Profile (NHP) were recorded twice for the treatment group and three times for the control group.

Results: Significant improvements were found for all the selected outcome measures (HAP, NHP, and gait speed) for the treatment group ($p < .001$). In terms of overall training effects, the 13 subjects demonstrated increases in strength of the affected major muscle groups, in HAP and NHP profiles, and in gait speed and rate of stair climbing without concomitant increases in either quadriceps or ankle plantarflexor spasticity.

Conclusions: The 10-week combined program of muscle strengthening and physical conditioning resulted in gains in all measures of impairment and disability. These gains were not associated with measurable changes of spasticity in either quadriceps or ankle plantarflexors.

effects of stroke are variable and may include impairment in motor, emotional, and sensory systems, language, perception, and cognitive function.[2] Impairment of motor function involves paralysis or paresis of the muscles on one side of the body contralateral to the site of the brain lesion.[2] Damage to the descending neural pathways results in abnormal regulation of spinal motoneurons, causing alterations in postural and stretch reflexes and voluntary movement.[3] Abnormalities in the temporal and spatial recruitment of motor units slow the ability of muscles to generate tension, leading to prolonged agonist contractions.[3]

As a clinical phenomenon, stroke is associated with a significant survival rate, which declines slightly with increasing age to 79% in the 75- to 84-year-old age group and to 67% in patients older than 85 years.[4] Improved survival rates of stroke victims and the growing elderly population have increased the prevalence of stroke in Canadian society.[4] Despite intensive therapy during the first 6 months after stroke, a large proportion of stroke survivors are left with significant disabilities.[5] Disabilities compromise the participation of individuals in essential and meaningful life roles in the areas of self-care, productivity, and leisure. It has been acknowledged that prevention or reduction of disability after stroke is the most useful approach to minimizing costs both to society and in terms of individual suffering.[6] Residual disability in survivors has been difficult to estimate, however, and variability in subject populations, timing of assessments, and selection of measurement scales make comparisons and generalization difficult.[7]

Clinically, muscle weakness has been recognized as a limiting factor in the motor rehabilitation of stroke subjects.[8] Its importance relative to spasticity, however, has been debated. Strength training and strength measurement testing to monitor status and recovery after stroke have both emerged as controversial issues. Measurements of muscle strength have been established as predictors of gait performance of stroke subjects.[9] The torques generated mainly by the knee extensor, ankle

Randomized Clinical Trial of Therapeutic Exercise in Subacute Stroke

Pamela Duncan, PhD, FAPTA; Stephanie Studenski, MD, MPH; Lorie Richards, PhD; Steven Gollub, MD; Sue Min Lai, PhD; Dean Reker, PhD; Subashan Perera, PhD; Joni Yates, MPH; Victoria Koch, MPH; Sally Rigler, MD, MPH; Dallas Johnson, PhD

Background and Purpose—Rehabilitation care after stroke is highly variable and increasingly shorter in duration. The effect of therapeutic exercise on impairments and functional limitations after stroke is not clear. The objective of this study was to determine whether a structured, progressive, physiologically based exercise program for subacute stroke produces gains greater than those attributable to spontaneous recovery and usual care.

Methods—This randomized, controlled, single-blind clinical trial was conducted in a metropolitan area and 17 participating healthcare institutions. We included persons with stroke who were living in the community. One hundred patients (mean age, 70 years; mean Orpington score, 3.4) consented and were randomized from a screened sample of 582. Ninety-two subjects completed the trial. Intervention was a structured, progressive, physiologically based, therapist-supervised, in-home program of thirty-six 90-minute sessions over 12 weeks targeting flexibility, strength, balance, endurance, and upper-extremity function. Main outcome measures were postintervention strength (ankle and knee isometric peak torque, grip strength), upper- and lower-extremity motor control (Fugl Meyer), balance (Berg and functional reach), endurance (peak aerobic capacity and exercise duration), upper-extremity function (Wolf Motor Function Test), and mobility (timed 10-m walk and 6-minute walk distance).

Results—In the intention-to-treat multivariate analysis of variance testing the overall effect, the intervention produced greater gains than usual care (Wilk's $\lambda = 0.64$, $P = 0.0056$). Both intervention and usual care groups improved in strength, balance, upper- and lower-extremity motor control, upper-extremity function, and gait velocity. Gains for the intervention group exceeded those in the usual care group in balance, endurance, peak aerobic capacity, and mobility. Upper-extremity gains exceeded those in the usual care group only in patients with higher baseline function.

Conclusions—This structured, progressive program of therapeutic exercise in persons who had completed acute rehabilitation services produced gains in endurance, balance, and mobility beyond those attributable to spontaneous recovery and usual care. **(*Stroke*. 2003;34:2173-2180.)**

Key Words: exercise ■ outcome ■ rehabilitation

Task-Oriented Aerobic Exercise in Chronic Hemiparetic Stroke: Training Protocols and Treatment Effects

R.F. Macko, F.M. Ivey, and L.W. Forrester

Stroke is the leading cause of disability in older Americans. Each year 750,000 Americans suffer a stroke, two thirds of whom are left with neurological deficits that persistently impair function. Principal among them is hemiparetic gait that limits mobility and increases fall risk, promoting a sedentary lifestyle. These events propagate disability by physical deconditioning and "learned non-use," with further functional declines accelerated by the sarcopenia and fitness decrements of advancing age. Conventional rehabilitation care typically provides little or no structured therapeutic exercise beyond the subacute stroke recovery period, based on natural history studies showing little or no further functional motor recovery beyond 6 months after stroke. Emerging evidence suggests that new models of task-oriented exercise have the potential to improve motor function even years after stroke. This article presents treadmill as a task-oriented training paradigm to optimize locomotor relearning while eliciting cardiovascular conditioning in chronic stroke patients. Protocols for exercise testing and longitudinal aerobic training progression are presented that provide fundamental formulas that safely approach the complex task of customizing aerobic training to gait deficit severity in the high CVD risk stroke population. The beneficial effects of 6 months task-oriented treadmill exercise on cardiovascular–metabolic fitness, energy cost of hemiparetic gait, ADL mobility task performance, and leg strength are discussed with respect to the central and peripheral neuromuscular adaptations targeted by the training. Collectively, these findings constitute one initial experience in a much broader neuroscience and exercise rehabilitation development of task-oriented training paradigms that offer a multisystems approach to improving both neurological and cardiovascular health outcomes in the chronic stroke population. **Key words:** *aerobic training, hemiplegia, rehabilitation, stroke*

Physical inactivity propagates the disability of stroke through profound cardiovascular deconditioning and learned non-use.[1,2] Individuals who have suffered a stroke tend to be older, with incidence rates nearly doubling each successive decade in advancing age; 90% of cases occur in those >55 years.[3] The progressive reductions in VO_{2max} and sarcopenia of advancing age further threaten stroke survivors' ability to meet the elevated energy demands of hemiparetic gait and to accomplish activity of daily living (ADL) functions. As our population continues to age, the number of strokes in the United States will double, reaching 1.5 million annually by 2050.[3] The central health issues in this burgeoning sec- health in the chronic phase of stroke are a significant and ongoing area of public health research.

Current Models of Care

Current rehabilitation models do not systematically provide adequate exercise to reverse the physical deconditioning, sufficient task-repetition to optimize motor learning, or maintenance exercise to sustain long-term health benefits after stroke (**Figure 1**). Conventional care is focused on the subacute period (i.e., initial 3 to 6 months)

R.F. Macko, MD, is Professor, Departments of Neurology and Medicine, Divisions of Gerontology and Rehabilitation Medicine, Baltimore Veterans Affairs Medical Center and

- Ciò indirettamente pone in discussione l’attuale qualità degli approcci fisioterapici, soprattutto in considerazione del fatto che molti di questi, sono basati su assunzioni teoriche che non possono essere ancora a lungo facilmente supportate, su idee sorpassate di cosa sia la plasticità neuronale

- Il lavoro di Bobath è del 1978 , Kabat del 1953 il testo della Davis è del 2000, la bibliografia cui fanno riferimento è della prima metà del secolo scorso (Magnus 1926, Sherrington del 1913 anche se scritti innovativi di Bernstein sono del 1967) e che le neuroscienze sono andate avanti (la riorganizzazione cerebrale di Nudo è del 2001, le mappe corticali mobili sono state dimostrate con la PET).

Ma è cambiato il paradigma

- Lo sviluppo delle neuroscienze ha modificato radicalmente le nostre conoscenze sia del funzionamento normale del cervello che di quello che accade dopo una lesione cerebrale.

- Il recupero precoce dopo l'insulto cerebrale dipende dalla risoluzione dell'edema, delle alterazioni dei flussi ionici, dei processi ossidativi ed infiammatori e delle alterazioni della concentrazione dei neurotrasmettitori.

Strategies for stroke rehabilitation Dobkin Lancet neurology 3 528-36. 2004)

- Ma il recupero motorio prosegue per mesi, e questa parte del recupero motorio appare dipendente sostanzialmente dalla plasticità corticale, cioè da una riorganizzazione dell'attività cerebrale , dal recupero di connessioni sinaptiche all'interno del tessuto cerebrale vitale.

Stein Motor recovery strategies after stroke Top strokeRehab 2004, 2:12-22

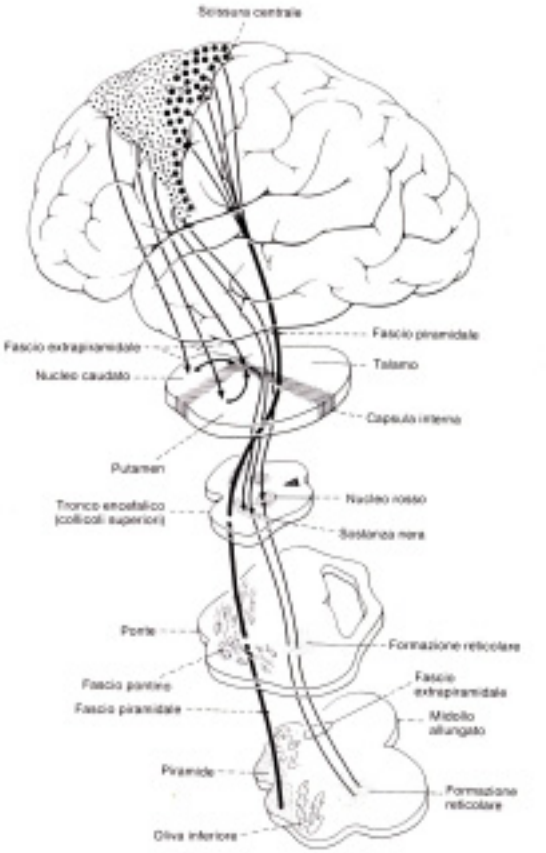


FIG. 23-2. Immagine schematica dei sistemi piramidale ed extrapiramidale (Modificata da Benda CE, Cobb S: Med 21: 66-142, 1942)

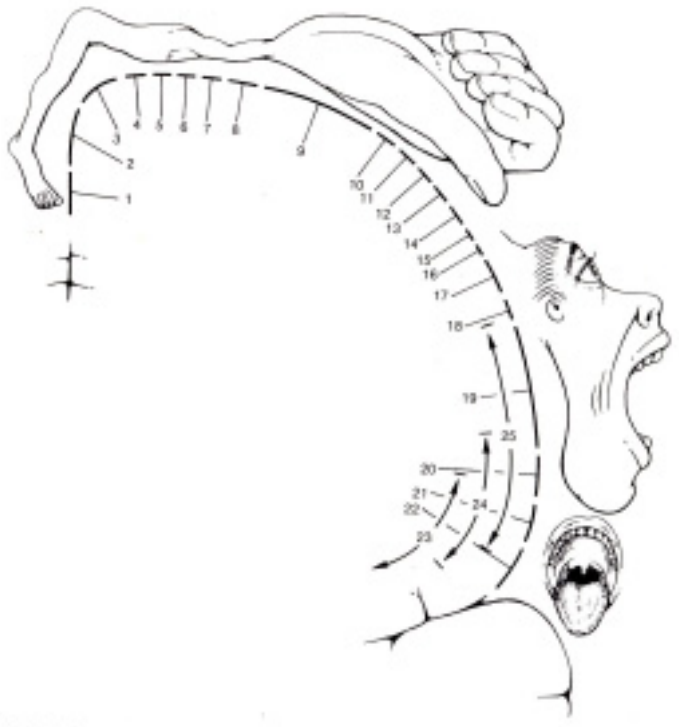


FIG. 23-4. Omunculus motorio, che mostra i rapporti dei centri motori con la rappresentazione corticale. **1.** Dita del piede. **2.** Caviglia. **3.** Ginocchio. **4.** Anca. **5.** Tronco. **6.** Spalla. **7.** Gomito. **8.** Polso. **9.** Mano. **10.** Mignolo. **11.** Anulare. **12.** Medio. **13.** Indice. **14.** Pollice. **15.** Collo. **16.** Sopracciglia. **17.** Palpebre e globo oculare. **18.** Faccia. **19.** Labbra. **20.** Mandibola. **21.** Lingua. **22.** Deglutizione. **23.** Masticazione. **24.** Salivazione. **25.** Vocalizzazione. (Modificata da Penfield W, Rasmussen T: The Cerebral Cortex of Man. New York, Macmillan, 1950)

Ma l'omunculus motorio da un punto di vista riabilitativo è un nichilismo terapeutico !

- Evidenze recenti pur confermando il rilievo dell'omunculus motorio, indicano che il modello è molto più complesso :
- La rappresentazione del movimento individuale è distribuita in maniera estesa con sovrapposizioni nella corteccia motoria, con una rappresentazione complessa a mosaico.
- I singoli movimenti individuali sono rappresentati in multiple posizioni spazialmente discontinue all'interno dell'area di rappresentazione.

- Il singolo muscolo ha rappresentazioni corticali multiple con parziale sovrapposizione con quelle di altri muscoli.
- I neuroni corticali contraggono contatti monosinaptici con diversi motoneuroni.
- Le regioni corticali locali, contenenti le multiple sovrapposte rappresentazioni, comunicano ampiamente attraverso una rete neurale di connessioni orizzontali.

- Studi sull'animale evidenziano la mutabilità, la non fissità, della attività funzionale nella corteccia motoria e sensitiva.
- La rappresentazione corticale della mappa è modificata dall'esperienza sia nelle aree sensitive che nelle aree motorie.

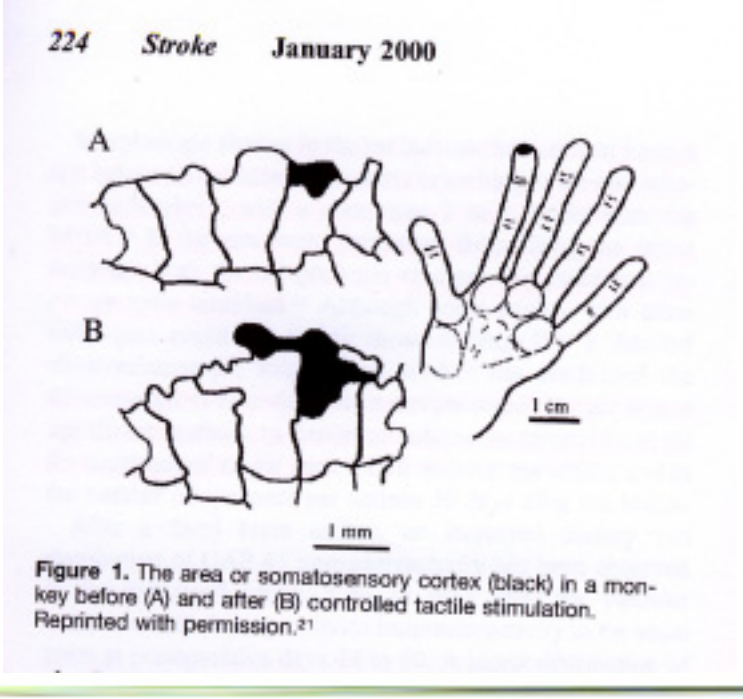


Figure 1. The area or somatosensory cortex (black) in a monkey before (A) and after (B) controlled tactile stimulation. Reprinted with permission.[21]

- La rappresentazione degli specifici movimenti che sono usati per adempiere ripetutamente e con successo un compito motorio si espandono selettivamente a livello della rappresentazione corticale a spese di altre aree corticali.

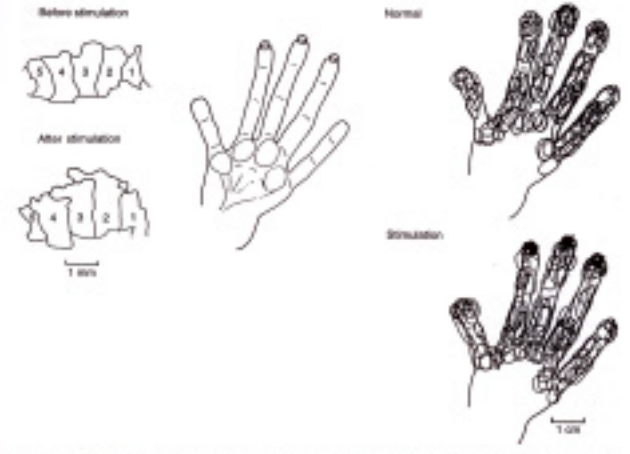


Fig. 1.1 Repetitive use of fingers 2, 3, 4 caused expansion of the cortical representation of these fingers. Outlines of regions in cortical area 3b represent surfaces of fingers before and after training. Maps of glabrous fields are identified for recording sites within area 3b before and after training. (Reprinted from Jenkins, W. M., Merzenich, M. M., Ochs, M. T. *et al.* (1990) Functional reorganization of primary somatosensory cortex in adult owl monkeys after behaviorally controlled tactile stimulation. *Journal of Physiology*, **63**, 82–104, with permission)

- Anche nell'uomo la mappa motoria corticale è modificabile dall'esperienza.
- Ad esempio è stata evidenziata l' espansione dell'area corticale delle dita in ciechi che utilizzano la lettura Braille o in musicisti. Queste modificazioni della mappa corticale riflettono lo sviluppo di capacità evolute e sono provocate da *un ripetuto training e dalla pratica continua.*
- Al contrario la restrizione dell'attività è associata ad una coartazione della rappresentazione corticale, come si verifica con l'amputazione e l'immobilità.

Increased cortical representation of the fingers of the left hand in string p...
Elbert, Thomas; Pantev, Christo; Wienbruch, Christian; Rockstroh, Brigitte; T...
Science; Oct 13, 1995; 270, 5234; ProQuest Medical Library
pg. 305

Increased Cortical Representation of the Fingers of the Left Hand in String Players

Thomas Elbert, Christo Pantev, Christian Wienbruch, Brigitte Rockstroh, Edward Taub

Magnetic source imaging revealed that the cortical representation of the digits of the left hand of string players was larger than that in controls. The effect was smallest for the left thumb, and no such differences were observed for the representations of the right hand digits. The amount of cortical reorganization in the representation of the fingering digits was correlated with the age at which the person had begun to play. These results suggest that the representation of different parts of the body in the primary somatosensory cortex of humans depends on use and changes to conform to the current needs and experiences of the individual.

though not as active as the fingers, engages in relatively frequent small shifts of position and pressure. The right hand, which manipulates the bow, participates in a task involving much less individual finger movement and fluctuation in tactile and pressure input. Here, we present data from magnetic source imaging that indicates that the cerebral cortices of string players are different from the cortices of controls in that the representation of the digits of the left hand is substantially enlarged in the cortices of string players.

Nine musicians (six violinists, two cellists, and one guitarist) who had played their instruments for a mean period of 11.7 years (range, 7 to 17 years) served as subjects for our study. Six nonmusicians served as controls (*15*). The mean age for both

- E’ stato altresì evidenziato sia nell’uomo che nell’animale da esperimento , che le basi della acquisizione, trattenimento e recupero delle informazioni del cervello sano, non sono differenti da quelli che seguono ad una lesione.

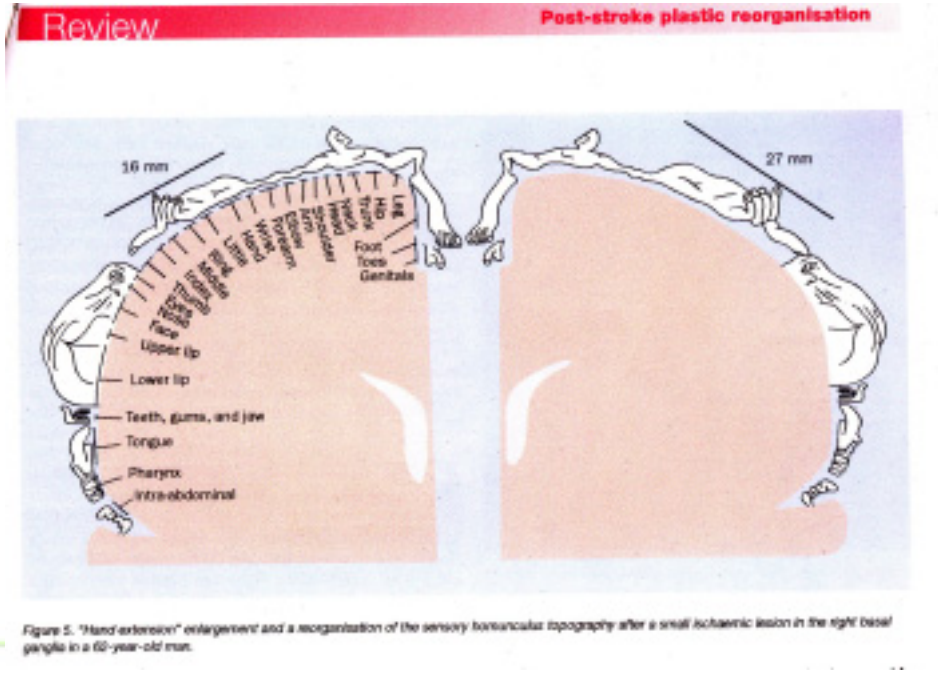


Figure 5. "Hand extension" enlargement and a reorganisation of the sensory homunculus topography after a small ischaemic lesion in the right basal ganglia in a 62-year-old man.

La neurobiologia dell'adattamento neurale indotto dalla riabilitazione nasce da studi sull'animale.

- Nel ratto dopo una lesione corticale, il recupero motorio spontaneo è associato ad una diminuzione della rappresentazione della mano .
- Ad 1 mese dalla lesione l'area di rappresentazione della mano è ridotta alla metà dell'estensione precedente.

- Nei mesi successivi si assiste, in associazione con un progressivo recupero della funzionalità della mano, ad una progressiva espansione della sua rappresentazione, che raggiunge il 75% dell'area originale dopo 4 mesi.

- Nel ratto sottoposto a training postlesionale viene **mantenuta** la rappresentazione a livello corticale della mano ed anzi vi è una espansione dell'area perilesionale di circa del 10%.

- Nudo R: Role of adaptive plasticity in recovery of function after demage to motor cortex Muscle & nerve 24, 1000-10019 2001.

Neural Substrates for the Effects of Rehabilitative Training on Motor Recovery After Ischemic Infarct

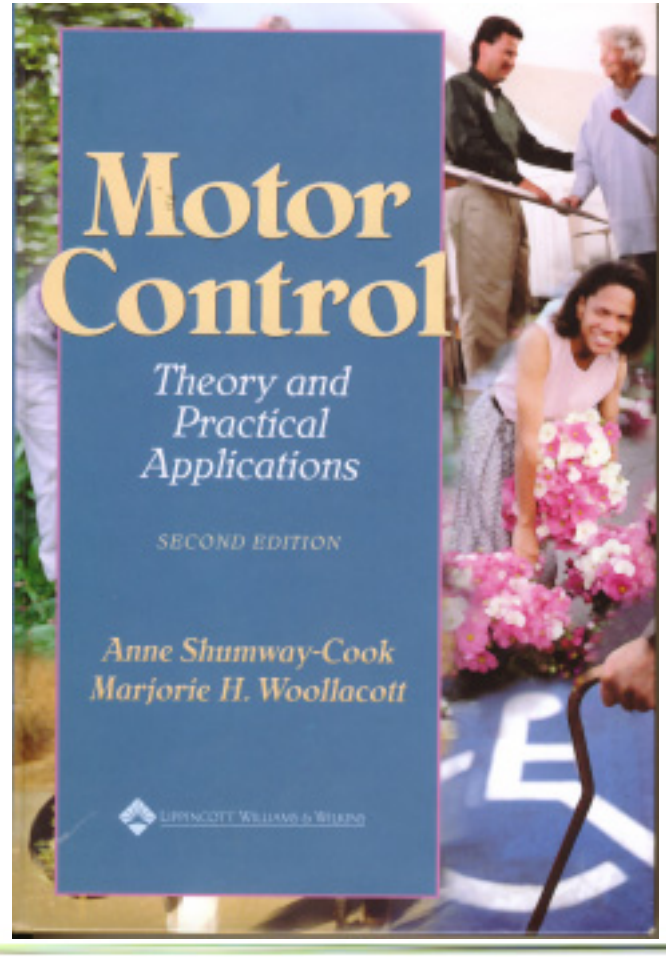
Randolph J. Nudo,* Birute M. Wise, Frank SiFuentes, Garrett W. Milliken†

Substantial functional reorganization takes place in the motor cortex of adult primates after a focal ischemic infarct, as might occur in stroke. A subtotal lesion confined to a small portion of the representation of one hand was previously shown to result in a further loss of hand territory in the adjacent, undamaged cortex of adult squirrel monkeys. In the present study, retraining of skilled hand use after similar infarcts resulted in prevention of the loss of hand territory adjacent to the infarct. In some instances, the hand representations expanded into regions formerly occupied by representations of the elbow and shoulder. Functional reorganization in the undamaged motor cortex was accompanied by behavioral recovery of skilled hand function. These results suggest that, after local damage to the motor cortex, rehabilitative training can shape subsequent reorganization in the adjacent intact cortex, and that the undamaged motor cortex may play an important role in motor recovery.

The motor cortex is thought to be important in the initiation of voluntary motor actions, especially those associated with fine manipulative abilities. Thus, a stroke or other injury to the motor cortex results in weakness and paralysis in the contralateral musculature and disruption of skilled limb use (1). However, a gradual return of some motor abilities often occurs in the weeks and months after injury (2). At least in humans, complete recovery of function in distal musculature, including independent control of digits, is rare (3).

Neurophysiological and neuroanatomical bases have been sought to account for functional motor recovery after cortical injury. It is assumed that other parts of the motor system must "take over" the func-

Motor control



- E interesse non come il SNC produca il movimento , ma ***come controlli l'apparato motore.***

- Il cervello lavora con feedback e feedforward loop, usando l'imput sensoriale o programmi motori per guidare i movimento e monitorarlo .

- In realtà il controllo del movimento è molto più complesso: problema del tempo , dell'efficienza, della biomeccanica, dell'ambiente , del compito, dell'individuo.

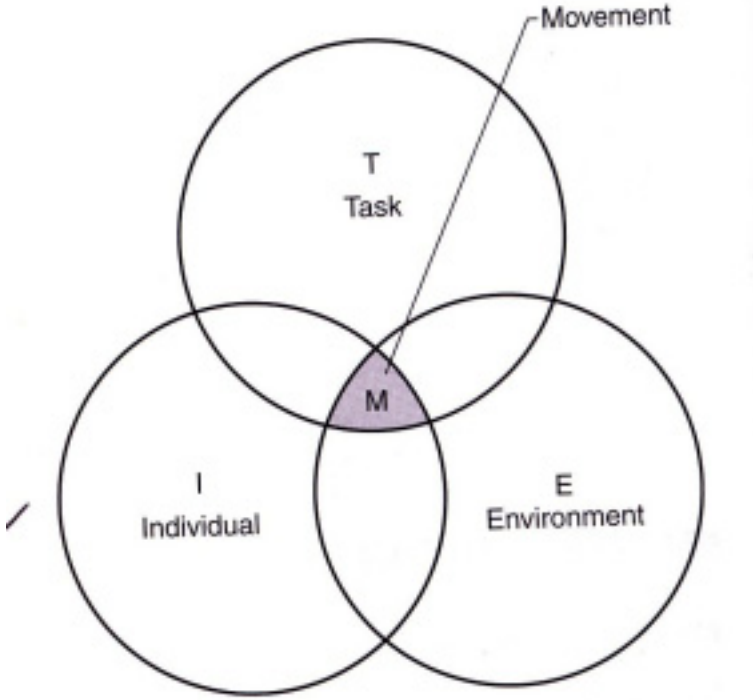


FIGURE 1-1. Movement emerges from an interaction between the individual, the task, and the environment.

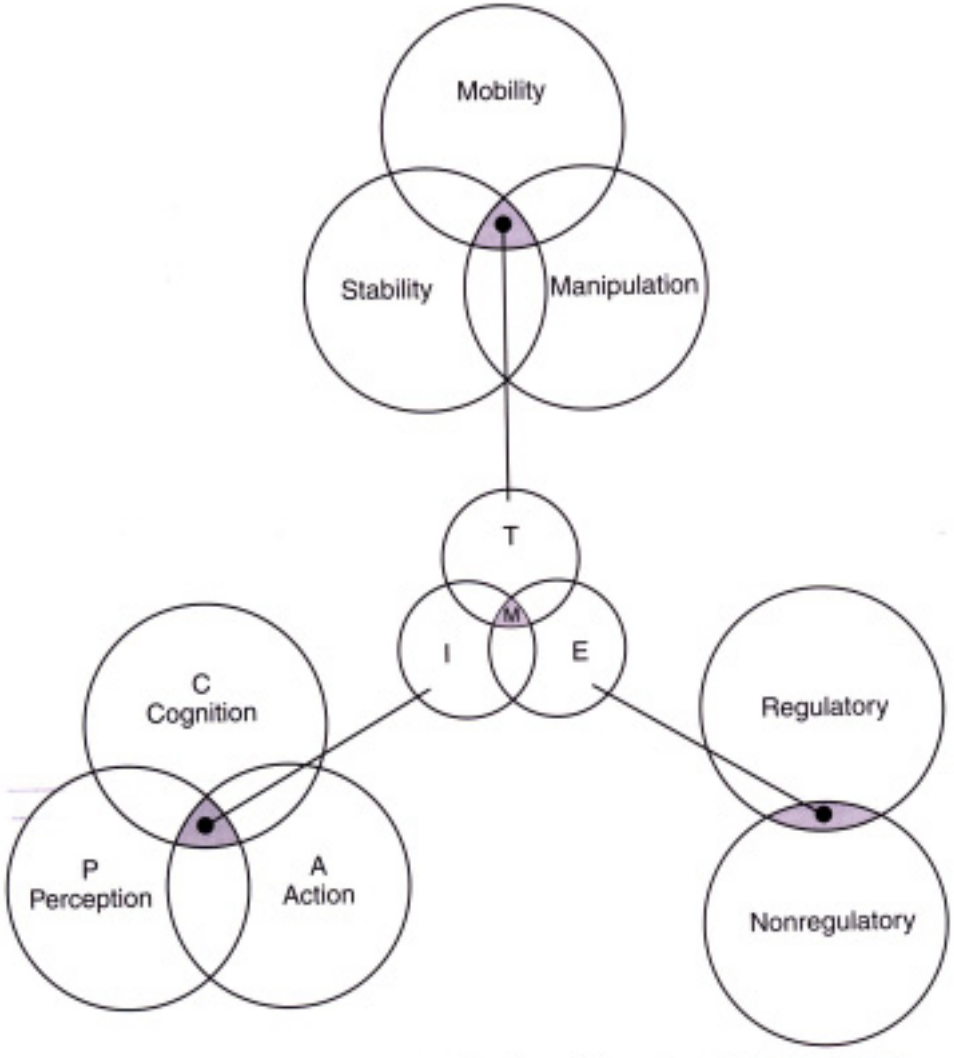


FIGURE 1-2. Factors within the individual, the task, and the environment affect the organization of movement. Factors within the individual include the interaction of *perception, cognition, and action (motor) systems.* Environmental constraints on movement are divided into both regulatory and nonregulatory factors. Finally, attributes of the task contribute to the organization of functional movement.

- E stato dimostrato che un normale pattern di movimento è possibile anche quando tutte le sensazioni da un arto sono eliminate, molti movimenti sono preplanned (programmi motori), la latenza temporale dei riflessi non permette esecuzione di movimenti esplosivi .
- I riflessi possono essere inibiti od addirittura invertiti a seconda della situazione e del compito.
- Il controllo posturale è contemporaneo o anticipatorio rispetto a movimento.

Effects of Task Goal and Personal Preference on Seated Reaching Kinematics After Stroke

Ching-yi Wu, ScD, OTR; May-kuen Wong, MD; Keh-chung Lin, ScD, OTR; Hsieh-ching Chen, PhD

Background and Purpose—Current theories of motor control in rehabilitation focus on how the nervous system responds to many types of external and internal constraints to execute motor behavior to accomplish a task. However, the dynamic interplay between these 2 constraints remains unclear. This study examined the impact of some aspects of internal and external constraints on motor performance in persons with stroke.

Methods—Twenty-seven persons with stroke used the uninvolved arms to perform an upper-extremity reaching task under 4 experimental conditions, formed by the crossing of functional goals and personal preferences. For the higher level of a functional goal, subjects took a drink from a can of beverage. For the lower level of a functional goal, subjects brought the can to the mouth without drinking. The level of personal preferences was determined, by interview, by the degree of predilection for particular beverages.

Results—Significant and large effects of functional goals and personal preference were found in the variables of movement time and reaction time. However, the data trend of the 4 testing conditions varied according to presence of visuospatial neglect and side of lesion.

Conclusions—Offering choices for the treatment activities and incorporating functional goals to therapeutic tasks might enhance response rate or movement efficiency, depending on the side of the lesion and presence of visuospatial neglect. The findings suggest that the consideration of the neglect phenomenon is a necessity when rehabilitative treatment planning incorporates constraint factors. (***Stroke.*** **2001;32:70-76.)**

Key Words: hemiplegia ■ motor activity ■ neglect ■ rehabilitation

Early and Repetitive Stimulation of the Arm Can Substantially Improve the Long-Term Outcome After Stroke: A 5-Year Follow-up Study of a Randomized Trial

Hilde Feys, PT, PhD; Willy De Weerdt, PT, PhD; Geert Verbeke, PhD; Gail Cox Steck, PT; Chris Capiau, PT, MSc; Carlotte Kiekens, MD; Eddy Dejaeger, MD, PhD; Gustaaf Van Hoydonck, PT; Guido Vermeersch, MD; Patrick Cras, MD, PhD

Background and Purpose—Several studies have investigated the effect of therapeutic interventions for the arm in the acute phase after stroke, with follow-ups at a maximum of 12 months. The aim of this study was to examine the effect of repetitive sensorimotor training of the arm at 5 years after stroke.

Subjects and Methods—One hundred consecutive stroke patients were randomly allocated either to an experimental group that received daily additional sensorimotor stimulation of the arm or to a control group. The intervention period was 6 weeks. Assessments of the patients were made before, midway, and after intervention, and at 6 and 12 months after stroke. In this study, 62 patients were reassessed at 5 years after stroke. The Brunnström-Fugl-Meyer (BFM) test, Action Research Arm (ARA) test, and Barthel index (BI) were used as the primary outcome measures.

Results—At the 5-year follow-up, there was a statistically significant difference for both the BFM and ARA tests in favor of the experimental group. The mean differences in improvement between the groups from the initial evaluation to the 5-year assessment corresponded to 17 points on the BFM and 17.4 on the ARA. No effect was found for the BI. The treatment was most effective in patients with a severe initial motor deficit.

Conclusions—Adding a specific intervention for the arm during the acute phase after a stroke resulted in a clinically meaningful and long-lasting effect on motor function. The effect can be attributed to early, repetitive, and targeted stimulation. (***Stroke.*** **2004;35:924-929.)**

Key Words: stroke ■ rehabilitation ■ clinical trial

- Problema dell'enfasi sugli aspetti positivi del danno : spasticità, sinergie, alterato controllo posturale.

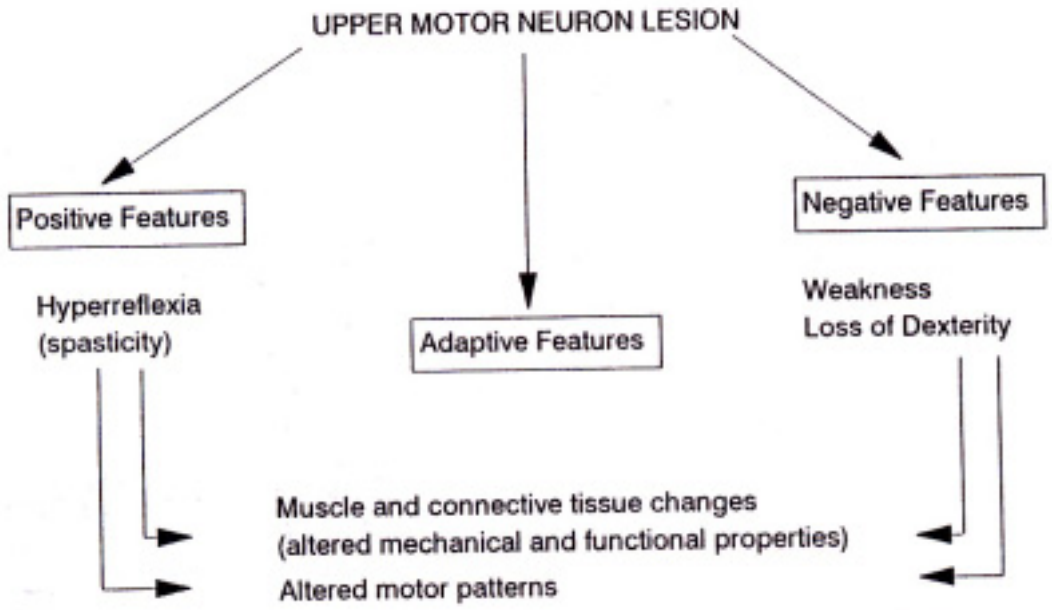


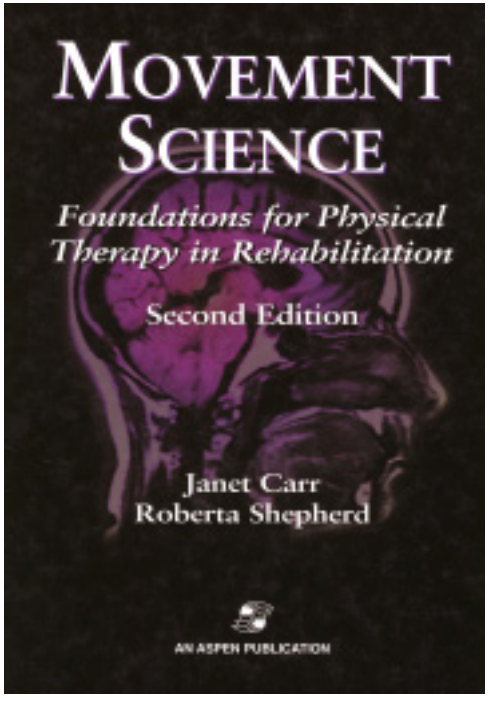
Fig. 8.1 The positive, negative and adaptive features of the upper motor neuron syndrome

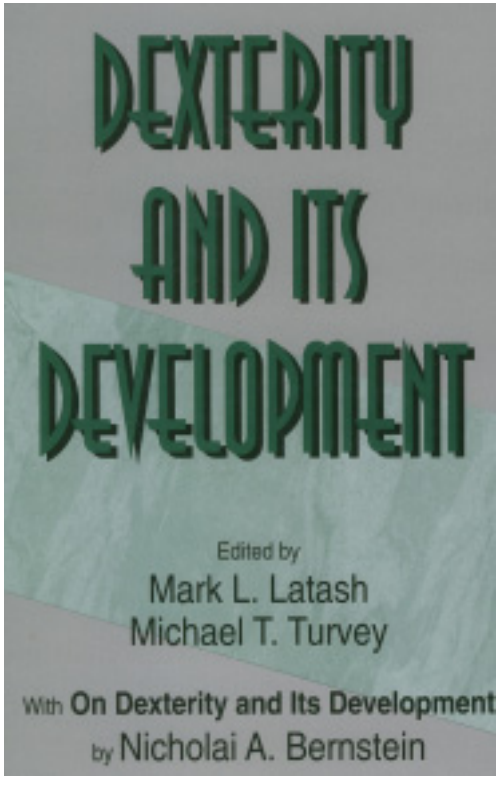
Ed ora viene il bello ….

Motor Relearning program

Il Motor Relearning Program (MRP Carr Sheperd) enfatizza il recupero del controllo motorio in attività funzionali specifiche (task specific) della vita quotidiana, iniziato il più precocemente possibile dopo l'ictus,appena la persona è stabile clinicamente.

Motor relearning program





National Clinical Guidelines for Stroke 2002

- Vi è evidenza crescente relativamente ai vantaggi di un training task-specific o di un approccio pratico rispetto ad un approccio incentrato sull'impairment (grado di evidenza A).
- Fornire al paziente l'opportunità di praticare (ripetere più volte) il compito (task) è l'elemento più importante perché la riabilitazione sia efficace.

Clinical Rehabilitation 2004; **18**: 833–862

The impact of physical therapy on functional outcomes after stroke: what's the evidence?

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Received 23rd March 2004; returned for revisions 10th June 2004; revised manuscript accepted 25th July 2004.

Objective: To determine the evidence for physical therapy interventions aimed at improving functional outcome after stroke.
Methods: MEDLINE, CINAHL, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, DARE, PEDro, EMBASE and DocOnline were searched for controlled studies. Physical therapy was divided into 10 intervention categories, which were analysed separately. If statistical pooling (weighted summary effect sizes) was not possible due to lack of comparability between interventions, patient characteristics and measures of outcome, a best-research synthesis was performed. This best-research synthesis was based on

- Based on the result from 2 RTCS there is strong (level 1a) evidence that the Motor Relearning Approach is superior to placebo on achieving improvement in functional otcome
- Ripetitive Task specific Training techniques improve upper extremity functioning

Motor Relearning program

- E’ una pratica terapeutica differente rispetto alla facilitazione neuromuscolare, infatti con l’esercizio implica un training specifico del controllo motorio alla ricerca dell’attività muscolare e di movimenti funzionali dell’arto affetto e la prevenzione di attività compensatorie.

SPREAD

Stroke Prevention And Educational Awareness Diffusion

IV Edizione

Ictus cerebrale:

linee guida italiane di prevenzione e trattamento

Sintesi e raccomandazioni

Stesura del 15 marzo 2005

Physiotherapy treatment approaches for the recovery of postural control and lower limb function following stroke

Pollock A, Baer G, Pomeroy V, Langhorne P

Summary

Physiotherapy using a mix of components from different treatment approaches appears best for promoting functional independence following stroke; no single physiotherapy approach is clearly best for promoting recovery after stroke

A stroke interrupts the blood flow to the brain, often leading to damage to some brain functions. This can cause paralysis of some parts of the body or other difficulties with various physical functions. Physiotherapy is an important part of rehabilitation for people who have had a stroke. A number of physiotherapy approaches have been developed based on different ideas about how people recover after a stroke. This review found there is no evidence that any one approach was clearly better than another for improving leg strength, balance, walking speed or the ability to perform everyday tasks. However, physiotherapy using a mixture of components from the different approaches was better than no treatment or placebo treatment for improving aspects of function following a stroke.

Motor Relearning program

- Il MRP ipotizza che un esercizio ripetitivo ed il training in compiti della vita reale possa essere lo stimolo critico per la riorganizzazione cerebrale , cioè la creazione di nuove o più efficienti connessioni all'interno del tessuto cerebrale rimasto.

Motor Relearning program

E’ fondamentale che l’esercizio sia

- un training attivo ed intensivo.
- in compiti funzionalmente e, da un punto di vista comportamentale.
- significativi e rilevanti per il soggetto.
- compiuti in un ambiente stimolante e ricco .

Motor Relearning program

L'obiettivo della fisioterapia deve essere quello di fornire l'opportunità all'individuo di recuperare le capacità motorie ottimali ed elaborate in compiti funzionali evoluti ed aumentare il livello di forza, resistenza e benessere fisico.

La pratica continua è il metodo per raggiungere questo obiettivo.

Motor Relearning program

Tutte le attività della vita quotidiana sono skill motori: avvengono attraverso l'attivazione di sinergie funzionali , fatte da componenti di movimento che, quando eseguite contemporaneamente, in una sequenza appropriata sia da un punto di vista spaziale che temporale, costituiscono il compito motorio controllato.

Motor Relearning program

Alcune componenti sono più necessarie ed essenziali al compito motorio e sono definite come “determinanti o necessità biomeccaniche”, essendo esse gli elementi chiave da cui dipende quella attività.

Questi sono gli elementi chiave che il paziente deve apprender come attivare e controllare, in una corretta sequenza spaziale e temporale per essere in grado di compiere quel compito.

Motor Relearning program

Il MRP implica che il paziente pratichi attività funzionali , in cui era esperto prima dell'ictus, aiutato dalla terapista , che struttura, spiega, controlla e rinvia informazioni ed organizza la pratica e l'ambiente.

Inoltre implica che il soggetto sperimenti da solo od in gruppo le nuove acquisizioni

Motor Relearning program

Un modo per aumentare poi la quantità di training e di pratica è che il terapista abbandoni il modello uno a uno per un modello in cui il paziente pratichi non solo in sessioni di training individuali, ma anche in gruppo.

Motor Relearning program

Il training di gruppo può essere organizzato in circuiti di stazioni di lavoro in cui i pazienti si esercitano in coppia.

ORIGINAL ARTICLE

Circuit Class Therapy Versus Individual Physiotherapy Sessions During Inpatient Stroke Rehabilitation: A Controlled Trial

Coralie K. English, PhD, Susan L. Hillier, PhD, Kathy R. Stiller, PhD, Andrea Warden-Flood, PhD[1]

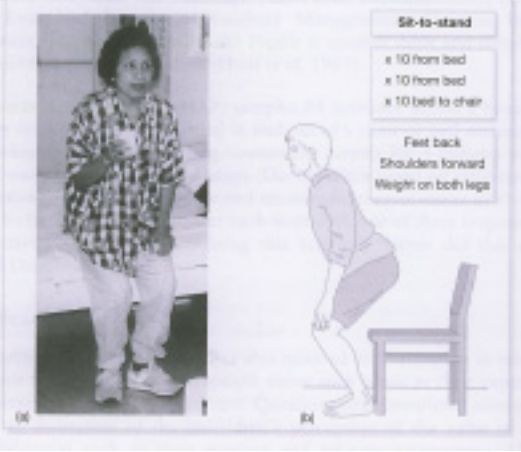
ABSTRACT. English CK, Hillier SL, Stiller KR, Warden-Flood A. Circuit class therapy versus individual physiotherapy sessions during inpatient stroke rehabilitation: a controlled trial. Arch Phys Med Rehabil 2007;88:955-63.

Objective: To compare the effectiveness of circuit class therapy and individual physiotherapy (PT) sessions in improving walking ability and functional balance for people recovering from stroke.

Design: Nonrandomized, single-blind controlled trial.

IT IS WELL ESTABLISHED that positive cortical reorganization poststroke in both the animal[1-3] and human[4,5] cortex is driven by activity and repetitive practice of new tasks. Furthermore, 2 recent meta-analyses[6,7] have concluded that recovery of motor function in persons with stroke is best

FIGURE 1.8 *(a) Sit-to-stand station. Holding a glass of water reinforces the need to balance. (b) The line drawing illustrates the action and the number of repetitions to be performed.*



Motor Relearning program

Lavorare in coppia aumenta la motivazione,aggiungendo componenti di competizione e cooperazione al lavoro e di apprendimento dall'osservazione dell'altro paziente; con adeguati tempi di riposo si mantengono attenzione ed entusiasmo.

Motor Relearning program

Il MRP si basa su quattro presupposti fondamentali per il processo di apprendimento di attività motoria evoluta, essenziali anche per il recupero motorio dopo un ictus:

- eliminazione dell'attività muscolare non necessaria
- feedback
- pratica
- interrelazione tra controllo posturale e movimento.

Motor Relearning program

La pratica del compito motorio e' organizzata in quattro step:

STEP 1:

- Osservazione
- Comparazione
- Analisi

- STEP 2:
- Identificazione dell'obiettivo
- Istruzione
- pratica

Motor Relearning Program

STEP 3:

- Rivalutazione
- Trasferibilità
- Flessibilità

- STEP 4:
- Pratica in contesti diversi
- Organizzazione dell'automonitoraggio
- Coinvolgimento dello staff e dei familiari

Qualche ulteriore elemento di riflessione indotto dalla MRP

I nuovi sviluppi delle neuroscienze e le pratiche riabilitative da essi derivate hanno posto in discussione alcuni capisaldi delle pratiche riabilitative tradizionali:

La spasticità

La controindicazione al rinforzo muscolare in riabilitazione neuromotoria.

Rinforzo muscolare e condizionamento

L’obbiettivo della fisioterapia nella patologia neurologica è quello di ottimizzare la performance motoria.

Le maggiori limitazioni dopo un ictus sono rappresentate dalla debolezza muscolare, dalla contrattura dei tessuti molli, dalla mancanza di resistenza e di fittness.

ORIGINAL ARTICLE

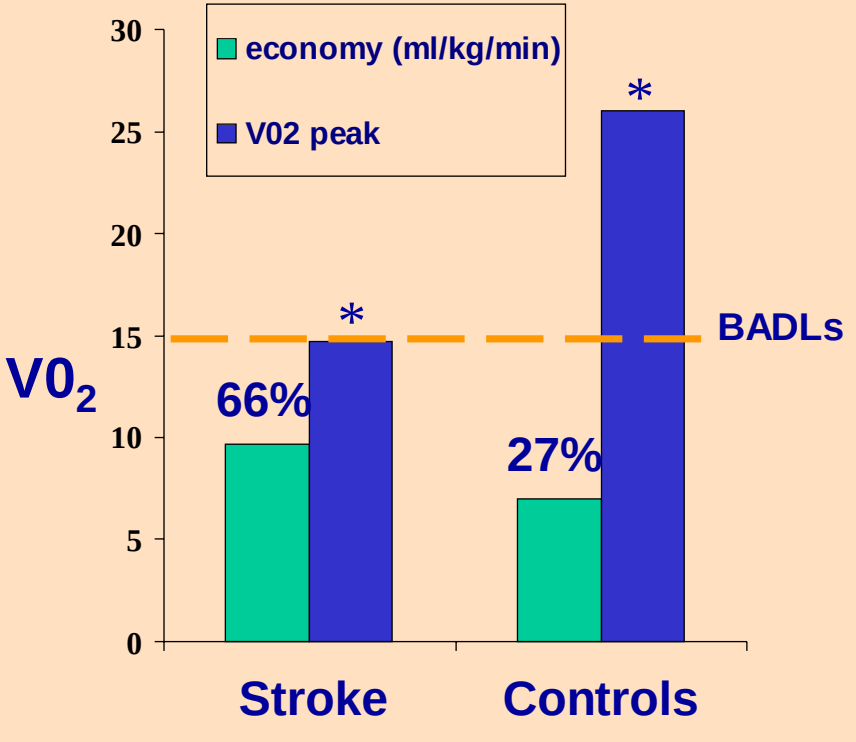
Reduced Ambulatory Activity After Stroke: The Role of Balance, Gait, and Cardiovascular Fitness

Kathleen M. Michael, PhD, RN, CRRN, Jerilyn K. Allen, ScD, RN, Richard F. Macko, MD

ABSTRACT. Michael KM, Allen JK, Macko RF. Reduced ambulatory activity after stroke: the role of balance, gait, and cardiovascular fitness. Arch Phys Med Rehabil 2005;86:

Key Words: Balance; Hemiparesis; Physical effort; Physical fitness; Rehabilitation; Stroke.

Chronic Stroke Patients: Diminished Fitness Reserve



- Ne consegue che il training di forza è necessario dopo un ictus per migliorare la capacità di generazione di forza del muscolo e l'efficienza del muscolo debole di migliorare la propria performance motoria

- Nonostante la sua importanza, il training di forza è stato eliminato da diversi programmi riabilitativi per la preoccupazione che l'esercizio, causando uno sforzo, aumentasse la spasticità, la cocontrazione, pattern motori abnormi.

- Ma la ricerca scientifica ha dimostrato che l'aumento dello sforzo fisico associato al training di forza non solo non potenzia la spasticità , la cocontrazione o le sincinesie, ma anzi è in grado di aumentare non solo la forza muscolare, ma anche le prestazioni funzionali e di diminuire la spasticità .

- Molti pazienti affetti da ictus sono anziani , per i quali vanno considerate anche la comorbilità le condizioni di ipomobilità, perdita della riserva cardiovascolare precedente, la sedentarietà.

- Conseguentemente la riduzione della forza muscolare conseguente all'ictus si somma alla preesistente riduzione della flessibilità , della forza, della resistenza e della fittness fisica, compromettendo in maniera significativa le capacità del paziente di recuperare le necessarie capacità motorie.

Prescrizione dell'esercizio

- Il dosaggio dell'esercizio deve essere progressivamente aumentato attraverso un aumento delle ripetizioni, del numero dei set o della resistenza prevista. E' necessario arrivare al punto della fatica, ma non del dolore.
- Il massimo risultato nel soggetto normale viene ottenuto con un esercizio di intensità submassimale: in generale 10 ripetizioni all'80% del 1RM.

Esercizi di rinforzo muscolare

- 5-10 minuti di riscaldamento(calistenici, stretching, esercizi ROM)
- esercizi aerobi : passeggiare , step o cyclette
- esercizi di rinforzo (anca, ginocchio e caviglia flessori ed estensori)
- 5-10 minuti di raffreddamento (rilassamento muscolare,stretching).
- Gli esercizi di rinforzo consistono in contrazione isometrica, concentrica ed eccentrica; 3 set di 10 ripetizioni al 50% di 1RM, aumentate all'80%. La resistenza è assicurata da pesi , bande elastiche, Rivalutazione ed adeguamento 1 RM ogni 2 settimane.

Luci Fuscaldi Teixteira-Salmela:Muscle strengthening and physical conditioning to reduce impairment and disability in chronic stroke survivors Arch Phys Med Rehab 80 1211. 1999

Duncan: Randomized clinical trial of therapeutic exercise in subacute stroke Stroke 2003; 34: 2173-2180

Esercizi per mantenere lunghezza muscolare e flessibilità

- Sia una contrattura che un aumento dello stiffness del muscolo sono una comune sequela dell'ictus , appaiono svilupparsi rapidamente ed hanno un potente effetto negativo sulle capacità della persona di esercitarsi e riguadagnare una performance effettiva.

- La perdita di lunghezza è particolarmente frequente e densa di conseguenze a livello dei muscoli del polpaccio, in grado di condizionare negativamente la capacità di stare in piedi, di camminare di salire e scendere le scale.

- Ci sono pochi dati certi su cui basare la prescrizione dello stretching, ma sembra necessario mantenere uno stiramento per almeno 20 secondi e ripeterlo 4-5 volte al giorno . Ci sono poche evidenze scientifiche sull'uso di splint, va considerato anche l'effetto negativo di indurre un learned non uso e l'alterazione della biomeccanica muscolare.

Condizionamento fisico

- La riduzione delle prestazioni funzionali del soggetto in esiti di ictus dipende dalla combinazione della diminuzione del numero delle unità motorie reclutabili durante l'esercizio,da una diminuzione delle capacità ossidative e da una riduzione della riserva cardiovascolare dalla comorbilità o da inattività.

Ma nonostante queste evidenze un esercizio aerobio viene raramente prescritto al paziente in esiti di ictus cerebrale per la preoccupazione che questo possa determinare un aumento della spasticità.

- E’ stato ripetutamente dimostrato che le persone anziane sono in grado di aumentare il loro fitness con un esercizio aerobio.
- L’esercizio aerobio non aumenta la spasticità.
- L’esercizio aerobio aumenta l’endurance del soggetto.

- Smith: Task oriented exercise improve hamstring strenght and spastic reflex in chronic stroke patients Stroke 1999; 30 2112-2118

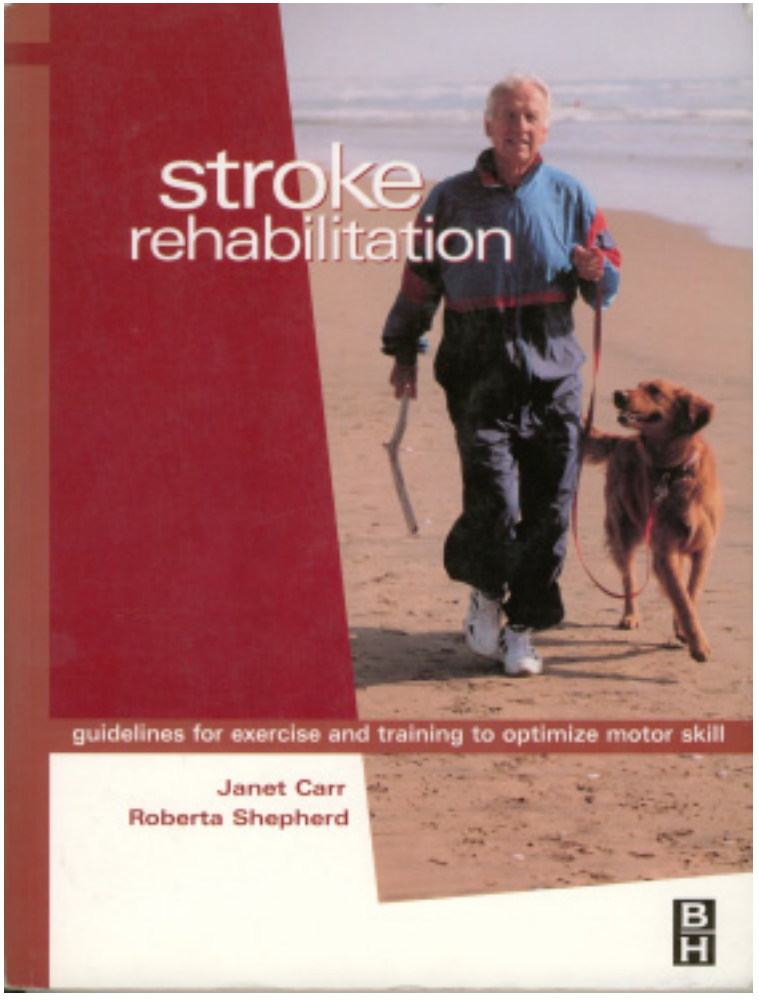
Prescrizione per l'endurance

- Inizialmente il training comporta un lavoro corrispondente al 40-60% della VO2 max, progredendo ad un volume di tre volte alla settimana per 30 minuti.
- L'intensità successivamente è progressivamente aumentata fino al max carico tollerato.
- L'attività è preceduta e seguita da 10 minuti di riscaldamento e raffreddamento.
- Per mantenere il condizionamento l'attività deve essere mantenuta.

- Kelly: Cardiorespiratory fitness and walking ability in subacute stroke patients Arch phys med rehabil 84, 1780. 2003

E ora dalle ipotesi alla pratica …

(Ed.re Alinari) N.° 34688. VOLTERRA — Laboratorio di Alabastri.


stroke
rehabilitation
guidelines for exercise and training to optimize motor skill
Janet Carr
Roberta Shepherd
BH

Grazie