B. The Principles of Stroke Rehabilitation

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B1. Stroke Recovery

B1.1 Defining Recovery and Time Course Post-Stroke

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B1.1.1 Defining Different Types of Recovery

Q1. What is the difference between neurological recovery and functional recovery?

Answer

1. Neurological recovery is defined as recovery of neurological impairments and is often the result of brain recovery/reorganization; it has been increasingly recognized as being influenced by rehabilitation.
2. Functional recovery is defined as improvement in mobility and activities of daily living; it has long been known that it is influenced by rehabilitation.
3. Functional recovery is influenced by neurological recovery but is not dependent on it.

Discussion

Spontaneous or Intrinsic Neurological Recovery

As a general rule, the severity of the initial deficit is inversely proportional to the prognosis for recovery. Most spontaneous recovery occurs during the first 3-6 months after the stroke. The course of recovery negatively accelerates as a function of time and is a predictable phenomenon (Skilbeck et al. 1983). Skilbeck et al. (1983) studied 92 stroke survivors with a mean age of 67.5 years (range= 36-89) at final assessment, either 2 or 3 years after stroke. The majority of recovery was reported within the first 6 months, with continued but non-statistically significant recovery after 6 months. This type of recovery has, until recently, been regarded as largely inaccessible to medical intervention or manipulation. Neurological deficits resulting from a stroke are often referred to as impairments. These are determined primarily by the site and extent of the stroke.

Functional or Adaptive Recovery

Functional recovery refers to improvement of independence in areas such as self care and mobility. Recovery depends on the patient's motivation, ability to learn and family supports as well as the quality and intensity of therapy. This type of recovery is modifiable by interventions and is influenced by, but may occur independently of neurological recovery. Functional deficits are often referred to as disabilities and are measured in terms of functions such as activities of daily living.

B1.1.2 Mechanisms of Neurological Recovery

Neurological recovery is defined as recovery of neurological impairments and is often the result of brain recovery/reorganization.

Q2. Describe some the mechanisms which account for neurological recovery after a stroke.

Answers
Local Processes (Early Recovery)
1. Post-Stroke Edema
2. Reperfusion of the Ischemic Penumbra
3. Diaschisis

CNS Reorganization (Later Recovery)
4. Reorganization of the brain after a stroke is dependent not only on the lesion site, but also on the surrounding brain tissue and on remote locations that have structural connections with the injured area.

Discussion
While a number of processes have been identified as playing a role in neurological recovery following stroke, the role each plays is not completely understood. Recovery from stroke is often attributed to resolution of edema and return of circulation within the ischemic penumbra (Dombovy 1991). However, spontaneous recovery can be prolonged well past the resolution period of acute structural changes caused by the stroke, with recovery occurring 4-6 weeks post stroke (Brodal 1973). Furthermore, animal and human trials have indicated that the cerebral cortex undergoes functional and structural reorganization for weeks to months following injury with compensatory changes extending up to 6 months in more severe strokes (Green 2003). Recovery can be grouped into two categories: 1) local CNS processes (early recovery); 2) CNS reorganization (later recovery).

Local Processes (Early Recovery)
Local processes leading to initial clinical improvement occur independent of behaviour or stimuli.

Post-Stroke Edema
Edema surrounding the lesion may disrupt nearby neuronal functioning. Some of the early recovery may be due to resolution of edema surrounding the infarcted area (Lo 1986) and as the edema subsides, these neurons may regain function. This process may continue for up to 8 weeks but is generally completed much earlier (Inoue et al. 1980). Cerebral hemorrhages tend to be associated with more edema, which take longer to subside, but which may in turn be associated with a more dramatic recovery.

Reperfusion of the Ischemic Penumbra
Reperfusion of the ischemic penumbra is another local process which can facilitate early recovery. A focal ischemic injury consists of a core of low blood flow which eventually infarcts (Astrup et al 1981, Lyden and Zivin 2000), surrounded by a region of moderate blood flow, known as the ischemic penumbra (Astrup et al 1981, Lyden and Zivin 2000), which is at risk of infarction but is still salvageable. Reperfusion of this area causes affected and previously non-functioning neurons to resume functioning with subsequent clinical improvement.

Diaschisis
Diaschisis is a state of low reactivity or depressed function as a result of a sudden interruption of major input to a part of the brain remote from the site of brain damage. With injury to one area of the brain, other areas of brain tissue are suddenly deprived of a major source of stimulation. Nudo et al. (2001) noted that diaschisis occurs early after injury and is an inhibition

or suppression of surrounding cortical tissue or of cortical regions at a distance that are interconnected with the injury core. The reversibility may be partially due to the resolution of edema, which may account for a portion of spontaneous recovery (Nudo et al 2001). Neuronal function may return following the resolution of diaschisis, particularly if the connected area of the brain is left intact. This is particularly true of noncortical structures after cortical injury (Lo 1986).

CNS Reorganization (Later Recovery)

Neurological reorganization plays an important role in the restoration of function. It can extend for a much longer period of time than local processes, such as the resolution of edema or reperfusion of the penumbra, and is of particular interest because it can be influenced by rehabilitation training. Nudo (2003a), based on animal research, has suggested that changes occurring during motor learning, i.e. synaptogenesis and increases in synaptic strength, are likely the same type of changes that occur during this part of recovery from stroke. This has been well shown after small, focal lesions in the motor cortex where the same principles of motor learning and development of functional connections are occurring in adjacent, undamaged tissue.

Nudo (2003a) reports that neuroplasticity post-stroke (with damage to the motor cortex as an example) is based on three main concepts: 1) In normal (non-stroke) brains, acquisition of skilled movements is associated with predictable functional changes within the motor cortex; 2) Injury to the motor cortex post-stroke results in functional changes in the remaining cortical tissue; 3) After a cortical stroke, these two observations interact so that reacquiring motor skills is associated with functional neurological reorganization occurring in the undamaged cortex (Nudo 2003a). This neuroplasticity or cortical reorganization is an important underlying rationale for rehabilitation and a major neurophysiological underpinning of neurological recovery post-stroke.

In conclusion, reorganization is dependent not only on the lesion site, but also on the surrounding environment, and on remote locations that have structural connections with the injured area.

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B1.2 Time Course of Recovery

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Q1. Describe the time course of stroke recovery.

Answers
1. The majority of neurological recovery occurs within the first 1-3 months.
2. Afterwards recovery may occur much more slowly for up to one year.

Discussion
Peak neurological recovery from stroke occurs within the first one to three months. A number of studies have shown that recovery may continue at a slower pace for at least 6 months; with up to 5% of patients continuing to recover for up to one-year. This is especially true with patients who are severely disabled at the time of initial examination (Bonita and Beaglehole 1988, Duncan et al. 1992, Ferucci et al. 1993, Kelley-Hayes et al. 1989, Wade et al. 1983, Wade et al. 1987) (see discussion below). Progress towards recovery may plateau at any stage of recovery with only a very small percentage of those with moderate to severe strokes (about 10%) achieving "full recovery ".

The return of motor power is not synonymous with recovery of function; function may be hampered by the inability to perform skilled co-ordinated movements, apraxias, sensory deficits, communication disorders as well as cognitive impairment. Functional improvements may occur in the absence of neurological recovery (Duncan and Lai 1997, Nakayama et al. 1994). Functional recovery (the ability to do activities despite limitations) and improvement in communication may continue for months after neurological recovery is complete.

Q2. Which factor has the greatest influence the time course of recovery post stroke?

Answer
1. Stroke severity – milder strokes reach maximal recovery sooner while more severe strokes take longer to reach maximal recovery.

Discussion

Time Course for Recovery Depends on Initial Severity of Impairments
Jorgensen et al. (1995a, 1995b) studied 1,197 acute stroke patients in what is referred to as the Copenhagen Stroke Study. This study consisted of a large unselected community-based population who were admitted to a 63 bed stroke unit. Impairments were classified using the Scandinavian Neurological Stroke Scale (SSS) and functional disability was defined according to the Barthel Index (BI). Typically, recovery for impairment and functional disability meant the highest recorded score in SSS and BI, respectively, with no further improvement.

At the time of the initial assessment, 41% of patients had mild strokes, 26% moderate and 19% severe, reflecting the severity of their neurological impairment as measured by the SSS. As a group, 95% of all patients reached their best neurological level within 11 weeks, on average. 95% of patients with mild strokes had reached their maximal neurological recovery within six weeks; for patients with moderate, severe and very severe strokes, 95% of the group had achieved their maximal recovery within 10, 15 and 13 respectively. Neurological recovery occurred on average two weeks earlier than functional recovery. The specific timeline for neurological and functional disability recovery is presented in Tables 3.4 and 3.5. In surviving patients, the best neurological recovery occurred within 4.5 weeks in 80% of the patients, while best ADL function was achieved by 6 weeks. For 95% of the patients, best neurological recovery was reached by 11 weeks and best ADL function within 12.5 weeks.

In another study, Jorgensen and associates (1995c) reported that best walking function was reached within four weeks for patients with mild paresis of the affected lower extremity, six weeks for those with moderate paresis and 11 weeks for severe paralysis. Consequently, the time course of both neurological and functional recovery was strongly related to both initial stroke severity and functional disability. Jorgensen et al. (1995a, 1995b, 1995c), as noted above, two-thirds of all stroke survivors have mild to moderate strokes and are able to achieve independence in ADL

Based on these observations one can safely conclude that the initial severity of the stroke is inversely proportional to the final functional outcome, with the majority of patients who suffer mild strokes demonstrating no or only mild disabilities, while the majority of patients suffering very severe strokes still experience severe or very severe deficits even after the completion of rehabilitation.

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B1.3 Mechanism of Reorganization Post Stroke

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Case Study

A 62 year old male developed a MCA infarct which has primarily affected the motor cortex, resulting in hemiplegia. At the time of admission to stroke rehabilitation he had some distal movements of his affected leg and no movements of his affected arm.

Q1. Describe reorganization of the affected hemisphere post-stroke in association with motor recovery.

Answer

1. Following a stroke, brain reorganization in response to relearning motor activities, involves primarily the contralateral (affected) hemisphere.
2. Reorganization in response to training occurs along the cortical rim of the infarction with increased recruitment of secondary cortical areas such as supplementary motor area and premotor cortex in the contralateral (affected) hemisphere.
3. Ipsilateral cortical involvement is more prominent early on; however, persistence of ipsilateral cortical involvement is generally associated with larger strokes and a poorer recovery.

Discussion

Clinical Studies

Numerous theories and hypothesis have been forwarded to explain neurological recovery following stroke. Functional brain imaging offers an opportunity to evaluate those theories and actually visualize recovery within the brain following a stroke. Functional MRI, PET and transcranial magnetic stimulation have all been used to assess motor activation after stroke (Thirumala et al. 2002).

Normals. Cramer (2003) notes that, “in normal right-handed persons, performance of a unilateral motor task by the right hand is associated with activation that is largely contralateral, with brain activity ipsilateral to the active hand being small by comparison (Kim et al. 1993). In contrast, there is greater ipsilateral activation for movements by the left hand.”

Reorganization in Adjacent Brain Tissue. Cramer (2003) noted that after a stroke in humans, movement of the affected hand resulted in three patterns of cortical reorganization that were not mutually exclusive of each other and which may occur concomitantly:

1. A greater degree of bilateral motor cortex activity was seen with recruitment of the motor network of the ipsilateral (unaffected hemisphere) (Cramer 2003).

2. There was increased recruitment of secondary cortical areas such as supplementary motor area (SMA) and premotor cortex in the contralateral (affected) hemisphere (Cramer 2003).
3. Recruitment along the cortical rim of the infarct was seen (Cramer 2003).

The predominate pattern of reorganization, which correlates with therapy-related improvements in upper extremity movements, involves increased in fMRI activity in the premotor cortex and supplementary motor area (SMA) and secondary somatosensory cortex contralateral to the affected limbs (Johansen-Berg et al. 2002). Similarly, Liepert et al. (2000) found that the area of cortical representation of the affected hand increased dramatically with the use of constraint-induced movement therapy. It is also known that after a stroke, finger-tapping activates the same motor regions as those activated by the same task in non-stroke controls, but to a larger extent, including involvement of the unaffected hemisphere (Cramer et al. 1997). Most clinical studies examining patterns of cortical reorganization post-stroke have described either an anterior (Weiller et al. 1993) or posterior (Cramer and Bastings 2000, Pineiro et al. 2001, Rossini et al. 1998) shift in the site of activation within the stroke-affected hemisphere.

In conclusion, in humans, following stroke recovery, motor activity in the affected hand results in recruitment of cortical areas along the infarct rim, secondary motor areas in the contralateral hemisphere and ipsilateral hemisphere motor areas. The predominant pattern seen is increased activation of secondary (surrounding) cortical regions of the affected hemisphere.

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B2. Stroke Rehabilitation Triage

B2.1 Stroke Severity

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Q1. Describe the three bands of stroke severity?

Answers
1. Upper band – milder strokes.
2. Middle band – moderate strokes.
3. Lower band – severe strokes.

Q2. Which of the three bands does not usually require in-patient rehabilitation?

Answer
1. Upper band or the milder stroke patient.

Q3. Which of the three bands is most likely to benefit from and be admitted to stroke rehabilitation?

Answer
1. Middle band or the moderately severe stroke patient.

Discussion

Levels of Severity of Stroke Rehab Patients
Garraway et al. (1981, 1985) first proposed the concept of **three bands** of stroke patients based upon stroke severity.

The **upper band** were basically milder strokes who showed minimal deficits. These patients generally have an early (5-7 days post onset) FIM score (see above) >80. These patients can generally be managed at home if outpatient resources are available and there are no specific issues to be addressed on an inpatient stroke unit. More specifically Stineman et al. (1998a) have defined these patients as having a motor FIM>62 at the time of rehab admission (Table 1). These patients are in rehabilitation a median of less than 2 weeks (American data). Milder stroke patients do not need inpatient rehabilitation, make limited rehabilitation gains (due to a ceiling effect) and can be rehabilitated in a community/outpatient setting without negative functional outcomes.

The **middle band** of patients suffered moderately severe strokes; they were conscious and had a clinically significant hemiplegia/hemiparesis. Such patients have an early FIM score of 40-80 and more specifically a motor FIM between 38-62 (Stineman et al. 1998a) (Table 1). These patients frequently demonstrate marked improvements in all areas although they are often

partially dependent in most areas by discharge. Over 85% are discharged to the community (Stineman et al. 1998a). These patients are best managed in a comprehensive, well-staffed and intensive rehab unit. Moderately severe stroke patients make the most benefit from stroke rehabilitation and are the most common admissions to a stroke rehabilitation unit.

The **lower band** of patients were the most severe strokes, unconscious at onset with severe unilateral or bilateral paresis. Alternatively such patients may have serious medical co-morbidity which adds to the stroke disability. Such patients have an early FIM score <40. Alternatively, motor FIM scores <37 have been associated with the lower band (Stineman 1998a). These patients are unlikely to achieve functional independence, regardless of treatment, unless they are younger (see below), and they have the longest rehab stays as well as the smallest likelihood of community discharge (Stineman et al. 1998a). However, although the stroke is so severe they often can't progress sufficiently to be discharged home, these patients do make significant gains. Where these patients are rehabilitation candidates they are best managed in a less intensive rehab program.

Ontario Stroke Rehabilitation Consensus Panel Standard 7

Standard #7 of the Ontario Stroke Rehabilitation Consensus Panel has noted, *"Stroke survivors will receive the appropriate intensity and duration of clinically relevant therapies across that care continuum based on individual need and tolerance. (Evidence Level 1); (adapted from HSFO BPG 13 and CSS BPR 5.3).*

Mild Stroke: *Stroke survivors discharged to the community will be provided with ambulatory services for one hour of each appropriate therapy, two to five times per week, as tolerated by the patient and as indicated by patient need. If only one discipline is required (e.g., speech-language pathology), then the stroke survivor will be provide with that one service. (Evidence Level 3)*

Moderate Stroke: *Survivors of a moderate stroke will receive a minimum of one hour of direct therapy time for each relevant core therapy, with an individualized treatment plan, for a minimum of five days a week, by the interprofessional stroke team based on individual need and tolerance. (Evidence Level 3)*

Severe Stroke: *Survivors of a severe stroke who are Rehab Ready will receive the frequency and duration of therapy that can be tolerated; the interprofessional team will increase the frequency and duration as tolerance improves to a minimum target of one hour of direct therapy time for each relevant core therapy, with an individualized treatment plan, for a minimum of five days per week, by the interprofessional stroke team based on individual need and tolerance. (Evidence Level 1)"*

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B2.2 Impact of Age on Recovery/Rehabilitation

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The second predictor of functional outcome following stroke is age, although it is a lesser factor and considerably more controversial than stroke severity.

Animal Studies

The impact of stroke and recovery with age in animals is not entirely clear. In one study examining the effects of age on the development of ischemic injury in rats, the authors discovered that young rats were more affected by the stroke than old rats as exhibited by more pronounced neurological impairments and poorer performance in a water maze task (Shapira et al. 2002). Histological evaluation also revealed more damage in young rats (Shapira et al. 2002). On the other hand, it has been noted that in rats, the duration of motor impairment post brain lesion increases with age (Brown et al. 2003). The regenerative response of neurons and glial cells, though largely preserved with age, appears to be delayed or occurs at a diminished rate the older the animal (Popa-Wagner et al. 1999, Whittemore et al. 1985). Reactive neuronal synaptogenesis declines (Scheff et al. 1978), sprouting responses are less robust (Schauwecker et al. 1995, Whittemore et al. 1985) and synaptic replacement rates diminish (Cotman and Anderson 1988).

In a recent study using older rats subjected to middle cerebral artery occlusions, Linder et al. (2003) showed that although the resulting infarcts were small, rats showed significant functional deficits in forelimb abduction, somatosensory function, fine motor control (staircase reaching test) and motor speed and endurance (bar pressing test). Animal stroke models similar to that presented by Lidner et al (2003), which make use of older animals and stress functional rather that histological outcomes, may more closely mimic the clinical setting and might better evaluate the efficacy of rehabilitative strategies in the recovery of function that could benefit older patients suffering from chronic functional disabilities.

In conclusion, older animals do exhibit recovery post-stroke, although generally recovery is more rapid and to a greater extent the younger the animal. This correlates with a decline in the rate of formation of new neuronal connections or synaptogenesis. Therefore older animals do improve post-stroke but it takes longer and occurs to a lesser extent. For that reason, age may not be a consistent predictor of functional recovery after stroke.

Clinical Studies

In humans, age is an important risk factor for stroke (Kugler et al. 2003), with people in the general population having a 0.25% risk of stroke per year (Kolominsky-Rabas et al. 1998, Williams et al. 1999), a number which doubles every decade over the age of 50. The incidence of stroke increases to 3.5% at the age of 85 (Jamrozik et al. 1999). In humans, age has long been thought to diminish post-stroke neurological recovery (Nakayama et al. 1994, Pohjasvaara et al. 1997).

In a cohort study of 2219 patients, Kugler et al. (2003) studied the effect of patient age on early stroke recovery. The authors found that relative improvement decreased with increasing age: patients younger than 55 years achieved 67% of the maximum possible improvement compared with only 50% for patients above 55 years ($p < 0.001$). They also found that age had a significant but relatively small impact on the speed of recovery with younger patients demonstrating a

slightly faster functional recovery ($p < 0.001$). The authors concluded that although age had a significant impact it nevertheless was a poor predictor of individual functional recovery after stroke and could not be regarded as a limiting factor in the rehabilitation of stroke patients. However, younger patients did demonstrate a more complete recovery.

A prospective study that included 561 patients admitted to an inpatient stroke rehabilitation program found that age alone was a significant predictor of total FIM score and Motor FIM score at discharge, but not of FIM change (Bagg et al. 2002). For both total FIM score and Motor FIM score at discharge, age alone accounted for only 3% of the variance in outcome. The results from this study suggest that advanced age alone is not a justifiable reason to deny patients access to rehabilitation given the questionable clinical relevance of this factor (Bagg et al. 2002).

In conclusion, in humans, age has a small but significant effect on the speed and completeness of recovery. However, because older stroke patients do recover, albeit at a slower rate, and the overall impact of age is relatively small, age in and of itself is a poor predictor of functional recovery after stroke.

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B3. Admission to Stroke Rehabilitation

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Canadian Stroke Strategy Standards: Recommendation 5.1 Initial Stroke Rehabilitation Assessment (Lindsay et al. 2008)

All persons with stroke should be assessed for their rehabilitation needs.

i. All people admitted to hospital with acute stroke should have an initial assessment by rehabilitation professionals as soon as possible after admission [Evidence Level A] (RCP), preferably within the first 24 to 48 hours [Evidence Level C] (NZ).

ii. All people with acute stroke with any residual stroke-related impairments who are not admitted to hospital should undergo a comprehensive outpatient assessment(s) for functional impairment, which includes a cognitive evaluation, screening for depression, screening of fitness to drive, as well as functional assessments for potential rehabilitation treatment [Evidence Level A] (RCP), preferably within 2 weeks [Evidence Level C].

iii. Clinicians should use standardized, valid assessment tools to evaluate the patient's stroke-related impairments and functional status [Evidence Level C] (ASA, RCP-P). See complete guideline for a table of recommended tools.

iv. Survivors of a severe or moderate stroke should be reassessed at regular intervals for their rehabilitation needs [Evidence Level C] (HSFO).

Note: Outpatient rehabilitation includes day hospital, outpatient ambulatory care and home-based rehabilitation.

Case Study

A 52 year old male is referred to rehabilitation after being admitted to an acute neurological service with a diagnosis of stroke. This gentleman had atrial fibrillation and had suffered a moderate sized infarct involving the left hemisphere 5 days previously. He was left with a right hemiplegia, with only some proximal motor recovery in the lower extremity and no motor recovery of the upper extremity. He also presented with a significant expressive or Broca's aphasia.

Q1. How would you assess this gentleman for admission to a stroke rehabilitation unit?

Answer

1. Assessment needs to be performed by an individual experienced in rehabilitation.
2. Screening examination should include medical information, neurological examination, well standardized function or disability measure and a mental status screening test.

Discussion

A screening examination for rehabilitation should be performed as soon as the patient's medical and neurological condition permits, by a person experienced in rehabilitation (Gresham et al. 1995). The screening examination should incorporate medical information, neurological examination, use of a well-standardized disability (e.g., activities of daily living) instrument and a mental status screening test. Asberg and Nydevik (1991) felt that the optimal timing for stroke rehab assessment was 5-7 days post-stroke onset, although recent trends have been towards decreasing that time, since onset.

Q2. What would be your criteria for admission to a stroke rehabilitation unit?

Answers

1. Must have functional deficits secondary to a stroke.
2. Must be able to learn (severe dementia, receptive aphasia not likely to benefit from stroke rehabilitation).
3. Must be able to physically participate (sit in wheelchair for an hour at a time, medically able to participate).

Discussion
Threshold criteria for admission to a comprehensive rehabilitation program include medical stability, the presence of a functional deficit, the ability to learn, and enough physical endurance to sit unsupported for at least one hour and to participate actively in rehabilitation (Gresham et al. 1995). Admission to an interdisciplinary program should be limited to patients who have more than one type of disability and who therefore require the services of two or more rehabilitation disciplines. Patients with a single disability can benefit from individual services, but generally, do not require an interdisciplinary program (Gresham et al. 1995).

Case Study (continued)
This man has a supportive family (wife is working, 2 grown daughters) and lives in a large town about 50 miles or 80 kilometers away with a community hospital and an 8 bed general rehabilitation unit.

Q3. What are the pros and cons of being rehabilitated close to home?

Answers
1. **Pros:** Closer to home – better family and friends support, easier discharge planning, less stressful for the family.
2. **Cons:** Lack of specialized stroke rehabilitation has been shown to result in poorer outcomes.

Q4. Describe those elements of a stroke rehabilitation unit necessary for its success.

Answers
Comprehensive stroke rehabilitation units include:
1. Continuity of care.
2. Experienced interdisciplinary team.
3. Careful attention to comorbidities and complications.
4. Early goal-directed treatment.
5. Systematic assessment of progress.
6. Education.
7. Attention to psychosocial issues.
8. Early comprehensive discharge planning.

Case Study (continued)

The patient is eager to begin rehabilitation but anticoagulation has just been initiated and the nurse manager expresses concerns about the "heaviness" (requiring a lot of nursing care) of the patient.

Q5. What would be your advice regarding admitting the patient to rehabilitation as soon as possible?

Answer

1. The earlier the patient can enter into rehabilitation the better.

Discussion

There is a growing literature on the benefits of early admission to rehabilitation. Bernaskie et al. (2004) performed a randomized controlled trial (RCT) using a rat model to establish the effect of timing of rehabilitation post stroke on outcomes. A small focal lesion was inflicted on the rats' brains, which were then exposed to an enriched environment with rehabilitative training for five weeks beginning at days 5, 14 or 30 post stroke induction or to social housing (control). Animals who received enriched training at day five demonstrated a marked improvement in recovery which was accompanied by an increased complexity of dendritic branching in the unaffected areas when compared to those who began rehabilitation at day 30. The differences in cortical reorganization and functional recovery between animals in the social housing group and those who began rehabilitation at day 30 were similar. The authors noted that previous research (Barbay et al. 2001) also demonstrated a time dependent rehabilitation induced map reorganization following ischemic injury. The remaining preserved cortical regions were the most responsive to rehabilitation training earlier rather than later post stroke. Scallert et al. (2003) noted that the brain appears to be "primed" to recover early following stroke and it is at this point rehabilitation therapies will be the most effective.

The results from several studies have suggested that stroke rehabilitation is most effective when initiated early (Feigenson et al. 1977, Hayes and Carroll 1986, Salter et al. 2006). Reviews by Cifu and Stewart (1999) and Ottenbacher and Jannell (1993) reported a positive correlation between early rehabilitation interventions and improved functional outcomes. However, it is not evident whether the relationship is causal. One prospective comparative trial by Paolucci et al. (2000) looked at the outcomes of stroke patients admitted to rehabilitation at differing times following stroke. They found that those stroke patients who received rehabilitation early did better functionally than those whose rehabilitation was delayed.

Case Study (continued)

The patient's wife approaches you, concerned about her husband entering into a rigorous exercise program so soon after his stroke.

Q6. What would you advise entering into a rigorous exercise program soon after his stroke?

Answer

1. The earlier the patient can enter into rehabilitation the better. More intensive therapy tends to result in better outcomes.

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B4. The Efficacy of Stroke Rehabilitation

B4.1 Stroke Rehabilitation Units

B4.1 Stroke Rehabilitation Units

Canadian Stroke Strategy Recommendation 5.2: Provision of Inpatient Stroke Rehabilitation (Lindsay et al. 2008)

All patients with stroke who are admitted to hospital and who require rehabilitation should be treated in a comprehensive or rehabilitation stroke unit by an interdisciplinary team [Evidence Level A] (AU-R).

i. Post–acute stroke care should be delivered in a setting in which rehabilitation care is formally coordinated and organized [Evidence Level A] (ASA).

ii. All patients should be referred to a specialist rehabilitation team on a geographically defined unit as soon as possible after admission [Evidence Level A] (RCP). Pediatric acute and rehabilitation stroke care should be provided on a specialized pediatric unit [Evidence Level B] (RCP-P).

iii. Post–acute stroke care should be delivered by a variety of treatment disciplines, experienced in providing post-stroke care, to ensure consistency and reduce the risk of complications [Evidence Level C] (RCP).

iv. The interdisciplinary rehabilitation team may consist of a physician, nurse, physical therapist, occupational therapist, speech–language pathologist, psychologist, recreation therapist, patient and family/caregivers [Evidence Level A] (ASA). For children, this would also include educators and child-life workers. This "core" interdisciplinary team should consist of appropriate levels of these disciplines, as identified by the Stroke Unit Trialists' Collaboration [Evidence Level B] (AHA-P, SIGN 64).

v. The interdisciplinary rehabilitation team should assess patients within 24 to 48 hours of admission and develop a comprehensive individualized rehabilitation plan which reflects the severity of the stroke and the needs and goals of the stroke patient [Evidence Level C] (HSFO, NZ).

vi. Patients with moderate or severe stroke who are rehabilitation ready and have rehabilitation goals should be given an opportunity to participate in inpatient stroke rehabilitation [Evidence Level A] (HSFO).

vii. Stroke unit teams should conduct at least one formal interdisciplinary meeting per week to discuss the progress and problems, rehabilitation goals and discharge arrangements for patients on the unit [Evidence Level B] (SIGN 64). Individualized rehabilitation plans should be regularly updated based on patient status reviews [Evidence Level C].

viii. Clinicians should use standardized, valid assessment tools to evaluate the patient's stroke-related impairments and functional status [Evidence Level B] (ASA, RCP).

ix. Where admission to a stroke rehabilitation unit is not possible, a less optimal solution is inpatient rehabilitation on a mixed rehabilitation unit (i.e., where interdisciplinary care is provided to patients disabled by a range of disorders including stroke) [Evidence Level B] (SIGN 64).

Case Study

A 75 year old gentleman suffered a large left MCA stroke and is transferred to your larger center for assessment and treatment. The neurologist asks you for a rehabilitation opinion. The patient comes from a small town about an hour away. His family resides in your center. The small town has a 10 bed general rehabilitation unit. The other option is a 20 bed stroke rehabilitation unit in your center. The patient's wife lives with him while one of the daughters lives in the city where your center is located and visits regularly.

Q1. You are asked by the neurologist and the family as to where this gentleman should go for his stroke rehabilitation. What would you recommend?

Answers

1. The evidence suggests that he should be rehabilitated in a specialized stroke rehabilitation center (CSS Guideline Recommendation 5.2).
2. However, although mixed rehabilitation units are less than ideal for stroke patients, there are some advantages to having rehabilitation conducted closer to home (i.e., family and friends providing support, discharge planning)

Case Studies

You are asked to do a review of a number of stroke rehabilitation units.

Case A

The manager tells you that they have a specialized stroke rehabilitation unit which consists of a team of stroke rehabilitation therapists assessing and treating stroke patients who are interspersed on the general medical unit. The team meets weekly to coordinate and manage the stroke patients.

Case B

The manager tells you that they have a specialized stroke rehabilitation unit which consists of 12 beds, placed together with a dedicated stroke rehabilitation team of nurses and therapists attached largely to that unit. The therapists tend to rotate to different

services but when they spend their 3 months on the stroke rehabilitation unit they see only stroke rehabilitation patients.

Case C
The manager tells you they have a specialized stroke rehabilitation unit with geographically defined beds and dedicated stroke rehabilitation therapists. When you review their hospital data you notice they rehabilitated 15 stroke rehabilitation patients last year.

Q2. Which one of these is a stroke rehabilitation unit?

- **Case A**
- **Case B**
- **Case C**
- **Case B and C**
- **None of the Above**

Answers
1. A stroke rehabilitation unit must have dedicated stroke rehabilitation beds localized to a geographic single location and have specialized stroke clinicians managing those patients.
2. Case A is not a stroke rehabilitation unit. The patients are scattered throughout the general medical ward and there is no geographic centralization of the stroke rehabilitation beds (CSS Guideline Recommendation 5.2). Research shows that traveling stroke rehabilitation teams like this are not efficacious.
3. Case B is not a stroke rehabilitation unit. Patients are localized in a single geographic location in dedicated stroke rehabilitation beds but do not have dedicated therapy staff because therapists are rotated through different services (CSS Guideline Recommendation 5.2).
4. Case C report that they are a stroke rehabilitation unit but with only 15 stroke rehabilitation patients per annum it is hard to see how they can have dedicated beds and dedicated staff who spend the majority of their time treating stroke rehabilitation patients.
5. The correct answer is '***None of the Above***.'

Discussion

Stroke Rehabilitation Units
Stroke rehabilitation units are characterized by an interdisciplinary team working cohesively and closely to provide a comprehensive rehabilitation program for each patient. They are inevitably found in rehabilitation centres or acute care hospitals and consist of dedicated beds in a single geographic area of the hospital. There are dedicated nurses and therapists on these units who are specialized or at least experienced in the care of stroke rehabilitation patients by virtue of the fact that the majority of their time is spent in treating these individuals. Weekly team conferences are held to establish or revise rehabilitation goals and plans, assess patient

progress, identify barriers or complications and to develop a plan for discharge or transfer to another type of rehabilitation program. These programs may vary in terms of the types of therapies offered as well as their intensity and duration. Brandstater and Basmajian (1987) and Roth et al. (1998) have identified the common features of comprehensive stroke rehabilitation programs which are shown in Table B.1.

Table B.1 Common Elements of Comprehensive Stroke Rehabilitation Programs (Brandstater and Basmajian 1987 and Roth et al. 1998)

1. Commitment to continuity of care from the acute phase of the stroke through long-term follow-up.
2. Use of an interdisciplinary team of professionals experienced in and dedicated to the care of the patient with stroke.
3. Careful attention to the prevention, recognition, and treatment of comorbid illnesses and intercurrent medical complications.
4. Early initiation of goal-directed treatment that takes maximal advantage of the patient's abilities and minimises disabilities.
5. Systematic assessment of the patient's progress during rehabilitation, with adjustment of treatment to maximise benefits.
6. Emphasis on patient and family/caregivers education.
7. Attention to psychological and social issues affecting both the patient and family/caregiver.
8. Early and comprehensive discharge planning aimed at a smooth transition to the community, and at continuity of care to promote social reintegration and resumption of roles in the home, family, recreational, and vocational domains.

The most recent clinical practice guidelines (Duncan et al. 2005) endorsed by the American Heart Association recommend that stroke rehabilitation care should be provided by a multidisciplinary team and delivered in a setting which is formally coordinated and organized. The authors also acknowledged the need for a flexible approach and were unable to identify a universally applicable “best practice” approach applicable to all stroke patients. The authors noted the heterogeneity of the literature on which their recommendations were based, the inability to identify the nature of the intervention(s) under study and the inability to elucidate the distinctively unique aspects of care which enabled superior outcomes when compared to standard care.

The Canadian Stroke Strategy Guidelines’ Recommendation 5.2 deals with the issue of Stroke Rehabilitation Units. Those guidelines note the need for stroke rehabilitation to be formally coordinated and organized, to have a specialized stroke rehabilitation team on a geographically localized unit, for the team to be interdisciplinary and experienced in stroke rehabilitation care, with standardized assessments and at least weekly interdisciplinary team meetings.

Q3. Describe the evidence for stroke rehabilitation units.

Answers

1. Stroke Unit Trialists Collaboration (2001, 2007) have systematically reviewed all randomized trials that have compared inpatient specialized interdisciplinary stroke rehabilitation units with conventional care (typically provided on a general medical ward).

2. Specialized interdisciplinary stroke rehabilitation units are associated with improved functional outcomes, reduced mortality, shorter lengths of hospital stay and reduced need for institutionalization *in moderate to severe stroke patients.*

Discussion

The Stroke Unit Trialists' Collaboration (2001) systematically reviewed all randomized trials that compared inpatient stroke units (including dedicated stroke units and mixed assessment/rehabilitation units) with conventional care (typically provided on a general medical ward). The distinctive features of the organized stroke units identified by the investigators included:

1. Coordinated multidisciplinary team care
2. Staff with special interest in stroke
3. Routine involvement of caregivers
4. Continued education and training programs

A total of 23 clinical trials were reviewed. Primary outcome measures included death, dependency and the requirement for institutionalized care. Stroke unit care was associated with a significant reduction in death (OR 0.82, 95% CI 0.71-0.94, p=0.005) at a median of one-year follow-up. Stroke unit care was associated with a significant reduction in the combined outcomes of both death or institutional care (OR 0.78, 95% CI 0.67-0.91,p=0.001) and death or dependency (OR 0.78, 95% CI 0.68-0.89, p=0.0003). The number needed to treat to prevent death was 33, to prevent one patient from being unable to return home was 20 and to prevent one patient from failing to achieve independence was 20. There was a modest reduction in length of hospital stay of 6 days associated with stroke unit care. The benefits of specialized stroke care were not related to age or sex; however, patients with moderate or severe strokes benefited more, relative to patients recovering from a mild stroke.

The Stroke Unit Trialists' Collaboration (2007) systematically reviewed all randomized trials that compared organized inpatient stroke units (including dedicated stroke units and mixed assessment/rehabilitation units) with less-organized conventional care (typically provided in a general medical ward). The distinctive features of the organized stroke units identified by the trialists in interviews included 1) coordinated multidisciplinary team care; 2) staff with special interest in stroke; 3) routine involvement of carers and; 4) continued education and training programs. A total of 31 clinical trials were reviewed. Primary outcome measures included death, dependency and the requirement for institutionalized care. Stroke unit care was associated with a significant reduction in death (OR 0.86, 95% CI 0.76-0.98,p=0.02) at a median of one-year follow-up. Stroke unit care was also associated with a reduction in the combined outcomes of both death or institutional care (OR 0.82, 95% CI 0.73- 0.92, p=0.0006) and death or dependency (OR 0.82, 95% CI 0.73-0.92, p=0.001). The number needed to treat to prevent one death was 33, to prevent one patient from being unable to return home was 20 and to prevent one patient from failing to achieve independence was 20. There was a modest reduction of length of hospital stay, of four days associated with stroke unit care. The benefits of specialized stroke care were not related to age, sex or stroke severity.

Seenan et al. (2007) included only non-randomized trials, which more closely approximate usual clinical practice, to see if the benefits associated with stroke units described previously in RCTs held up. The meta-analysis included data from 18 studies, some of which were

unpublished comparing stroke unit care with an alternative intervention (conventional care on a general medical or neurology ward or mobile stroke team). The odds of death and poor outcome were reduced for patients receiving stroke unit care (OR: 0.79, 95% CI 0.73 to 0.86, and OR: 0.87, 95% CI 0.80 to 0.95, respectively).

Foley et al. (2007) in a recent systematic review, identified 12 RCTs which compared the effectiveness of stroke rehabilitation units to an alternative form of care, usually a general medical ward or a Neurology ward (Foley et al. 2007). Patients included in the review were admitted to either a subacute unit, after receiving their initial care on an acute stroke unit, or were admitted to combined acute/subacute stroke rehabilitation unit immediately following their stroke. Compared to the alternative form of care, the results from pooled analyses indicated a clear benefit of specialized care; the odds of death, the combined outcome of death and dependency and the need for institutionalization were all significantly reduced. Length of hospital stay was also significantly reduced. (Table B2). When combined meta-analyses of stroke rehabilitation units are performed there is improvement for the outcomes of combined death/dependency, functional outcomes, mortality, need for institutionalization and length of hospital stay.

Pooled Analyses for Stroke Rehabilitation Unit Outcomes (Foley et al. 2007)

Outcome	**Result from Pooled Analyses: OR (95% CI) or Weighted Mean Difference (95% CI)***
Death	0.79 (0.65, 0.98)
Death and dependency	0.59 (0.49, 0.71)
Need for institutionalization	0.69 (0.54, 0.87)
Length of stay	-16.4 (-31.2, -1.6)*

There is only one RCT that compared a subacute stroke rehabilitation unit to *ad hoc* care (essentially none or limited rehabilitation) provided in the community (Ronning and Guldvog 1998). The other RCTs did not capture the true benefit of stroke rehabilitation as they compared specialized stroke rehabilitation care to care provided on a General Medical or Neurology ward where stroke patients would still receive therapy. In the RCT of Ronning and Guldvog (1998), 251 stroke patients, after an average acute stay of 10 days, randomized stroke patients to the rehabilitation unit or the control group who were discharged to the community. Those admitted to the rehabilitation unit had an average length of stay of 27.8 days. For those admitted to Community Care, 40% went to a nursing home, 30% went to outpatient therapy and 30% received no formal rehabilitation treatment. At 7-month follow-up, the number of stroke patients who were dependent (Barthel Index <75) or dead was 23% in the stroke rehabilitation group and 38% in the *ad hoc* community group (p=.01), a 39% reduction in bad outcomes with stroke rehabilitation. More impressive was the impact on individuals with moderate to severe strokes, (defined as admission Barthel Index scores of <50). Within this subset (n=114), at 7-month follow-up, the number of stroke patients who were dependent (Barthel Index <75) or dead was 32% in the stroke rehabilitation group and 62% in the community ad hoc group (p=.002), a 48% reduction in poor outcomes. Moreover, the Barthel Index score at 7 months was 90 in the stroke rehabilitation group and 73 in the community *ad hoc* group (p=.005). This study, the only one to compare a stroke rehabilitation unit to a no treatment control, demonstrated nearly a 50% reduction in poor outcomes, a truly remarkable impact.

In summary, specialized interdisciplinary stroke rehabilitation units are associated with improved functional outcomes, reduced mortality, shorter lengths of hospital stay and reduced need for institutionalization in moderate to severe stroke patients. Given the demonstrated benefit of this

treatment it is now regarded as the standard of stroke care. Stroke patients are complex and have specialized needs. Intervention requires specialized training for stroke rehabilitation clinicians in keeping with best evidence. In interdisciplinary rehabilitation, the emphasis is on working as a team, bringing together individuals with different skills to deal with the complex needs of the stroke patient.

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Key Study: Efficacy of Interdisciplinary Stroke Rehabilitation

Garraway WM, Akhar AJ, Prescott RJ, Hockey L. Management of acute stroke in the elderly: preliminary results of a controlled trial. *BMJ 1980;280:1040-1043(a).*

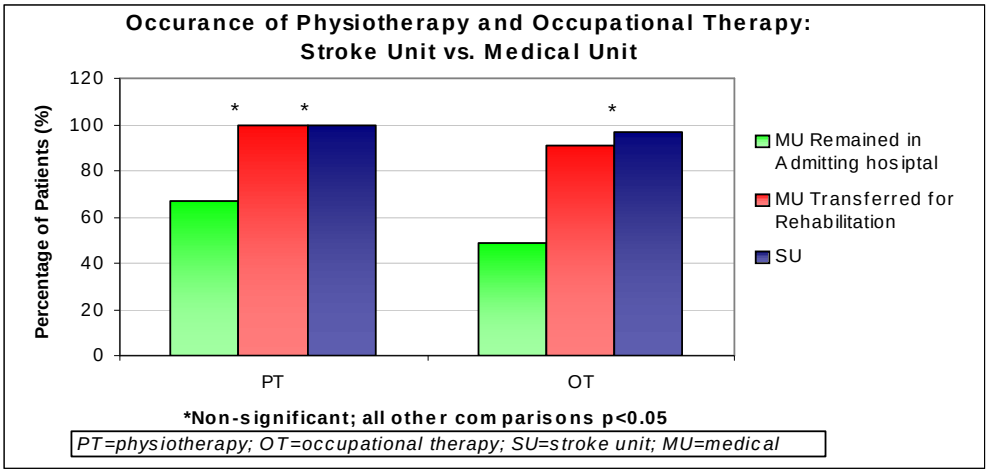
Garraway WM, Akhtar AJ, Hockey L, Prescott RJ. Management of acute stroke in the elderly: follow-up of a controlled trial. *BMJ 1980;281:827-829(b).*

Smith ME, Garraway WM, Smith DL, Akhtar AJ. Therapy impact on functional outcome in a controlled trial of stroke rehabilitation. *Arch Phys Med Rehabil 1982;63:21-24.*

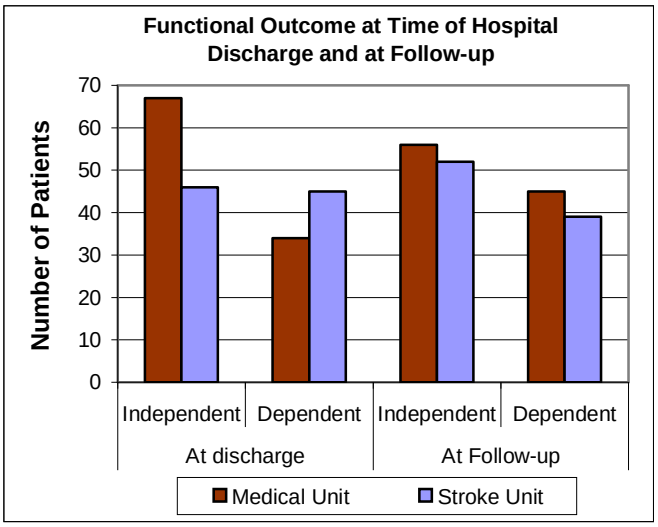
Author / Year Country PEDro score	Methods	Outcome
Garraway et al. 1980 (a) and Smith et al. 1982 UK 5 (RCT)	311 consecutive patients with moderate to severe strokes, admitted within 7 days of onset of symptoms were randomized to receive treatment on either a stroke unit or one of 12 medical units on call for emergency admissions.	A greater proportion of stroke unit patients were classified as independent when compared to medical unit patients, 50% vs. 32% at 60 days. When comparing only survivors, the proportion of independent patients rose to 62%. A greater proportion of stroke unit patients were referred for physical and occupational therapy. There were shorter delays between admission and start of therapy.
Garraway et al. 1980 (b) UK 5 (RCT)	Follow up study of 192 stroke patients from “a” study.	At one year, there were no longer significant differences in the proportion of patients who were classified as independent. 55% of stroke unit patients and 52% of medical ward patients were assessed as independent.

Garraway et al. 1980 (a)

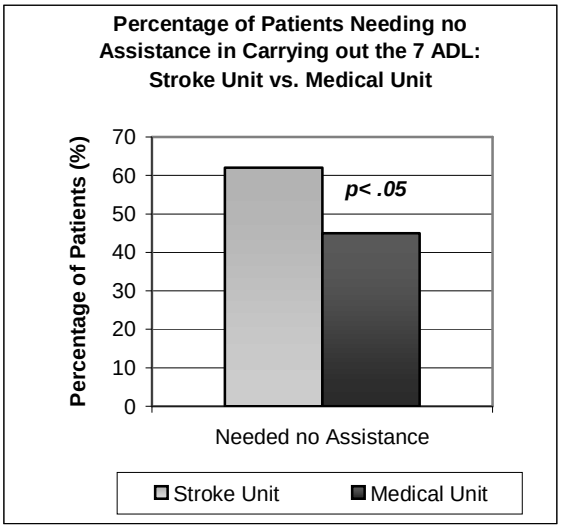
Patient Outcomes at the End of an Acute Phase of Rehabilitation



Garraway et al. 1980 (b)



Smith et al. 1982



Importance: This was the first study to demonstrate the benefit of stroke units over standard medical care.

Relevant SREBR Conclusions: There is strong evidence that combined (acute and rehabilitation) stroke units are associated with reduction of combined death/dependency, the need for institutionalization and length of hospital stay as well as improved functional outcome.

Related References:

Indredavik B, Slordahl SA, Bakke F, Rokseth R, Haheim LL. Stroke unit care improves long-term survival and function. Cardiology Review 1999;16:24-27(a).

Key Study: Efficacy of Interdisciplinary Stroke Rehabilitation

Indredavik B, Bakke F, Solberg R, Rokseth R, Haaheim LL, Holme I. Benefit of a stroke unit: a randomized controlled trial. *Stroke 1991;22:1026-1031*.

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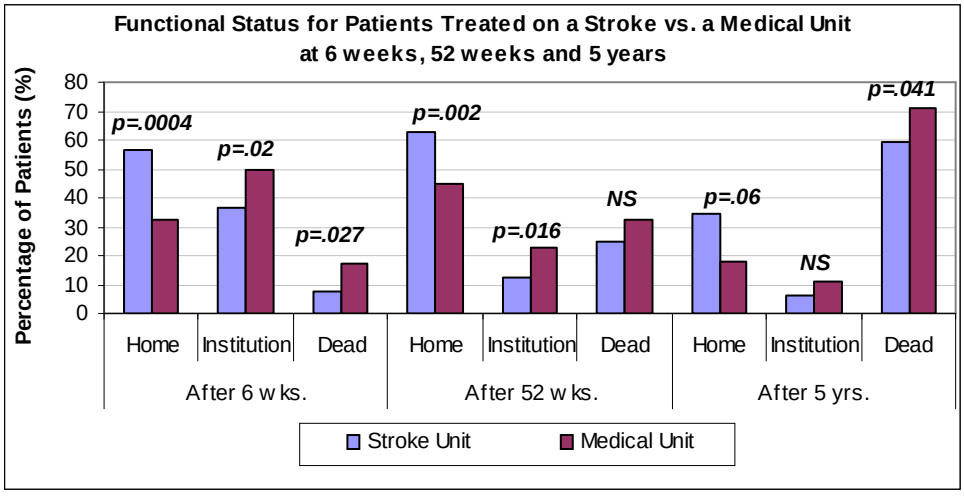
Author / Year Country PEDro score	Methods	Outcome
Indredavik et al. 1991 Norway 7 (Single-blind RCT)	220 acute (within 7 days) stroke patients randomized to either a combined acute/rehabilitation stroke unit or a general medical unit	Patients who were treated on the combined stroke unit were more likely to have been discharged home, were less likely to have been institutionalized and were more likely to have higher Barthel Index scores at both 6 weeks and 1 year. The 6-week mortality rate was lower for patients treated on the combined stroke unit.
Indredavik et al. 1997 Norway 7 (RCT)	5-year follow-up study of 220 stroke patients examining long-term survival and functional state of stroke initially randomized to either a combined acute/rehabilitation stroke unit or a general medical unit.	5 years following stroke, a greater proportion of patients originally treated on the stroke unit were alive, residing at home with higher Barthel Index scores when compared to patients treated on the general medical unit.
Indredavik et al. 1999 (a) Norway 7 (RCT)	220 unselected hospitalized stroke patients randomized to receive care on either a stroke unit or a general medical ward. 10-year follow-up study of Indredavik et al. 1991.	At 10-years post stroke, a greater proportion of patients initially treated on the stroke unit were alive (25 vs. 13%), residing in their homes (20 vs 8%) and had Barthel Index scores ∃60 (20 vs 8%) compared to patients treated on a general medical ward.

Indredavik et al. 1997,1991



Importance: This study showed the benefits of stroke units could be determined by 6 weeks and continued through for 10 years after the study.

Relevant SREBR Conclusions: There is strong evidence that combined (acute and rehabilitation) stroke units are associated with a reduction of combined death/dependency and the need for institutionalization and length of hospital stay as well as improved functional outcome.

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Garraway WM, Akhtar AJ, Hockey L, Prescott RJ. Management of acute stroke in the elderly: follow-up of a controlled trial. BMJ 1980;281:827-829(b).

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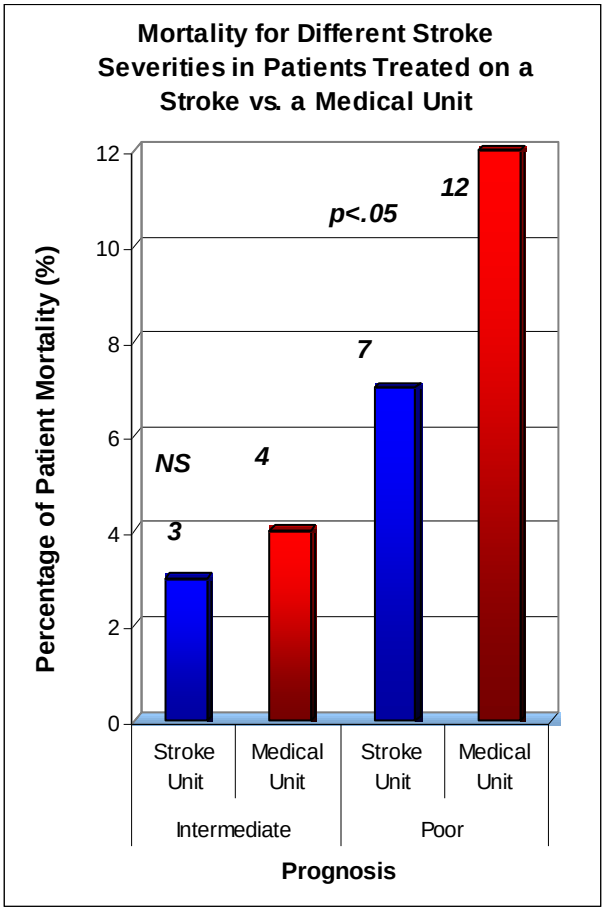
Sivenius J, Pyorala K, Heinonen OP, Salonen JT, Riekkinen P. The significance of intensity of rehabilitation of stroke--a controlled trial. Stroke 1985;16:928-931.

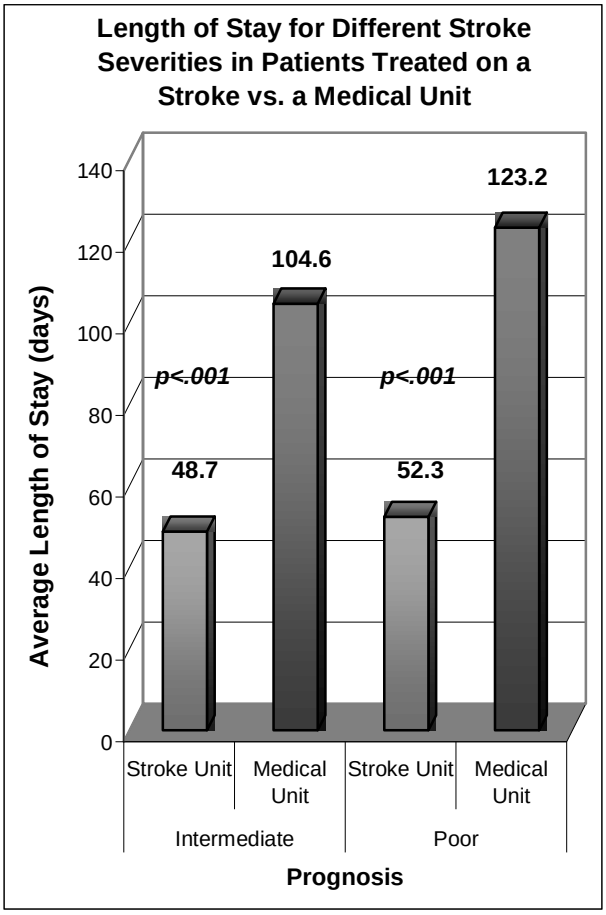
Smith ME, Garraway WM, Smith DL, Akhtar AJ. Therapy impact on functional outcome in a controlled trial of stroke rehabilitation. Arch Phys Med Rehabil 1982;63:21-24.

Key Study: Efficacy of Interdisciplinary Stroke Rehabilitation

Kalra L, Dale P, Crome P. Improving stroke rehabilitation. A controlled study. ***Stroke 1993;24:1462-1467.***

Author / Year Country PEDro score	Methods	Outcome
Kalra et al. 1993 UK 5 (RCT)	245 stroke patients randomized at 2 weeks post stroke to a rehabilitation unit or a general medical unit after stratification by stroke severity.	Patients with a poor prognosis treated on a general medical ward had higher mortality rates and longer hospital stays. Patients in the stroke rehab unit with stroke of intermediate severity had better discharge Barthel Index scores and shorter hospital stays.





Importance: This RCT showed that patients in subacute stroke units had better outcomes with regard to mortality, average length of stay and discharge Barthel Index scores.

Relevant SREBR Conclusions: Based on the results from meta-analyses, there is strong evidence that specialized, interdisciplinary rehabilitation provided in the subacute phase is associated with reductions in mortality, and the combined outcome of death or dependency, but is not associated with a reduced need for institutionalization or length of hospital stay, compared to conventional care on a general medical ward. There is strong evidence that for the subset of more severe stroke patients, specialized stroke rehabilitation reduces mortality, but does not

result in improved functional outcomes, nor does it reduce the need for institutionalization, compared to conventional care. There is strong evidence that for the subset of patients with moderately severe stroke, specialized rehabilitation improves functional outcomes but does not reduce mortality, compared to conventional care. There is strong evidence that for the subset of patients with mild stroke, specialized rehabilitation does not improve functional outcome or reduce mortality, compared to conventional care.

Related References

Drummond AE, Pearson B, Lincoln NB, Berman P. Ten year follow-up of a randomised controlled trial of care in a stroke rehabilitation unit. BMJ 2005;331:491-492.

Juby LC, Lincoln NB, Berman P. The effect of a stroke rehabilitation unit on functional and psychological outcome: a randomised controlled trial. Cerebrovasc Dis 1996;6:106-110.

Kalra L, Eade J. Role of stroke rehabilitation units in managing severe disability after stroke. Stroke 1995;26:2031-2034.

Lincoln NB, Husbands S, Trescoli C, Drummond AE, Gladman JR, Berman P. Five year follow up of a randomised controlled trial of a stroke rehabilitation unit. BMJ 2000;320:549.

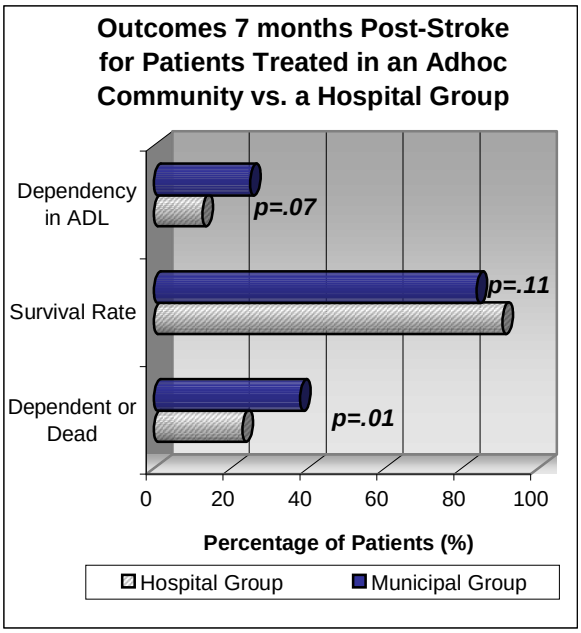
Ronning OM, Guldvog B. Outcome of subacute stroke rehabilitation: a randomized controlled trial. Stroke 1998;29:779-784(b).

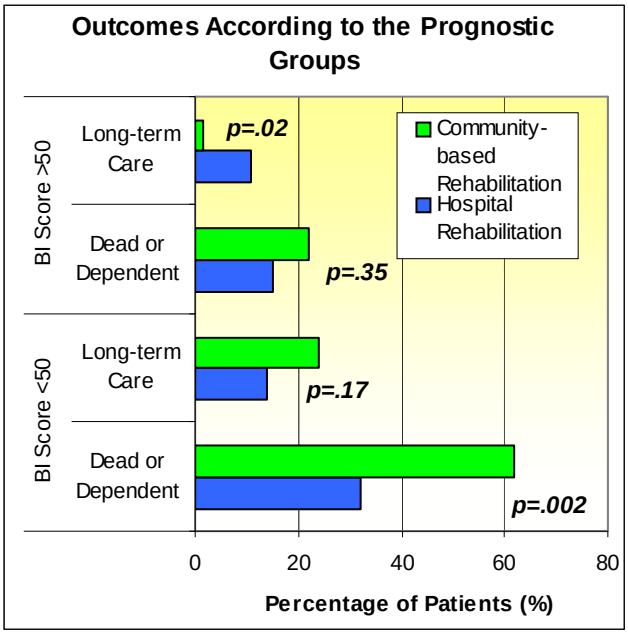
Stevens RS, Ambler NR, Warren MD. A randomized controlled trial of a stroke rehabilitation ward. Age Ageing 1984;13:65-75.

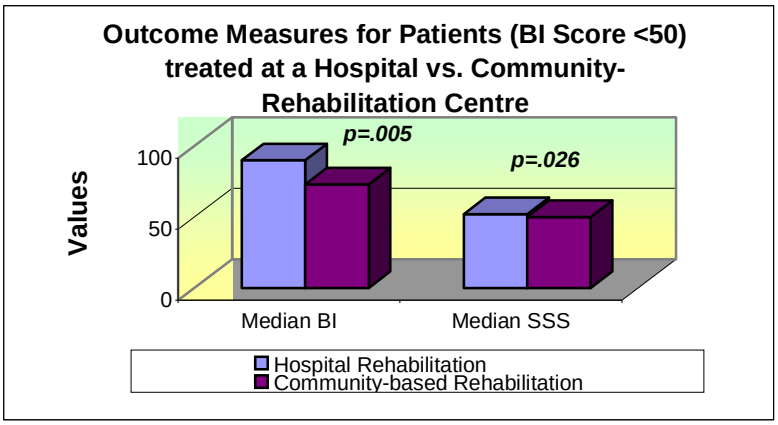
Key Study: Efficacy of Interdisciplinary Stroke Rehabilitation

Ronning OM, Guldvog B. Outcome of subacute stroke rehabilitation: a controlled trial. ***Stroke 1998;29:779-784(b).***

Author / Year Country PEDro score	Methods	Outcome
Ronning and Guldvog 1998 (b) Norway 6 (Quasi RCT)	251 stroke patients randomized to sub-acute rehabilitation in a hospital-based stroke rehabilitation program or to a community-based program (nursing home 40%, outpatient rehabilitation 30% and no rehabilitation 30%) and followed for 7 months.	Greater proportion of community-based rehab patients dependent or dead compared to hospital rehabilitation patients. No difference in survival at 7 months. Patients with moderate or severe stroke, treated in a hospital-based program, had higher median Barthel Index scores at 7 months (90 vs. 73) and lesser combined dependency and death (23 vs. 38%).







Importance: This RCT is the only study that compared organized stroke rehabilitation care to ad hoc treatment in the community, the closest thing to a non-treatment control. The benefits of

stroke rehabilitation for more severe strokes was quite dramatic with a 48% reduction in death and dependency in the treatment group.

Relevant SREBR Conclusions: There is strong evidence that interdisciplinary specialized subacute stroke rehabilitation results in overall reduced mortality and combined death or dependency but not the need for institutionalization or length of hospital stay.

Related References

Drummond AE, Pearson B, Lincoln NB, Berman P. Ten year follow-up of a randomised controlled trial of care in a stroke rehabilitation unit. BMJ 2005;331:491-492.

Juby LC, Lincoln NB, Berman P. The effect of a stroke rehabilitation unit on functional and psychological outcome: a randomised controlled trial. Cerebrovasc Dis 1996;6:106-110.

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Lincoln NB, Husbands S, Trescoli C, Drummond AE, Gladman JR, Berman P. Five year follow up of a randomised controlled trial of a stroke rehabilitation unit. BMJ 2000;320:549.

Peacook PB, Riley CP, Lampton TD, Raffel SS, Walker JS. The Birmingham Stroke, Epidemiology and Rehabilitation Study. In: Stewart GT, ed. Trends in Epidemiology. Thomas, Springfield IL.

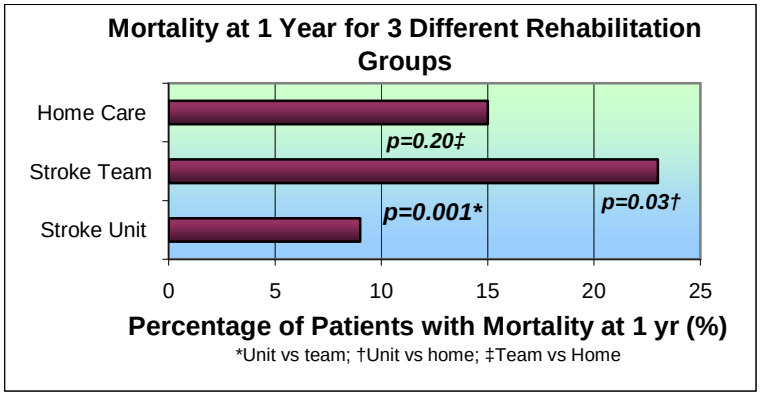
Stevens RS, Ambler NR, Warren MD. A randomized controlled trial of a stroke rehabilitation ward. Age Ageing 1984;13:65-75.

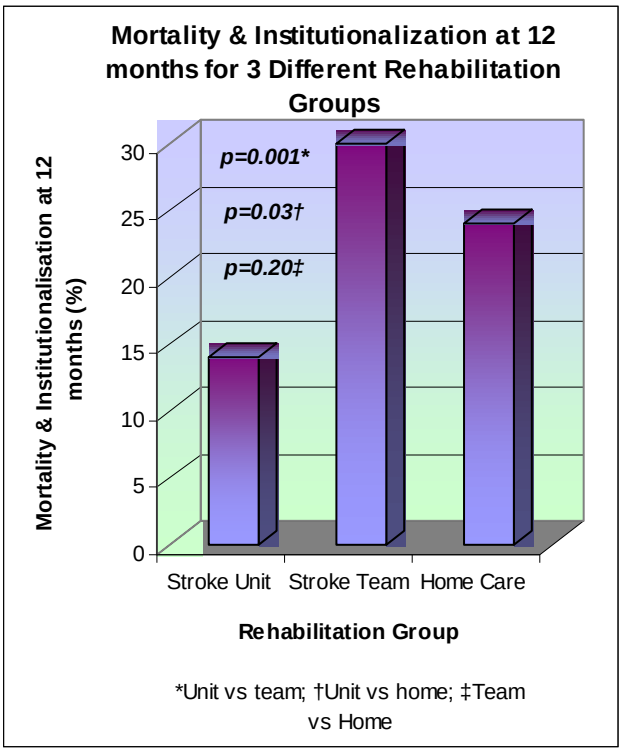
Key Study: Efficacy of Interdisciplinary Stroke Rehabilitation

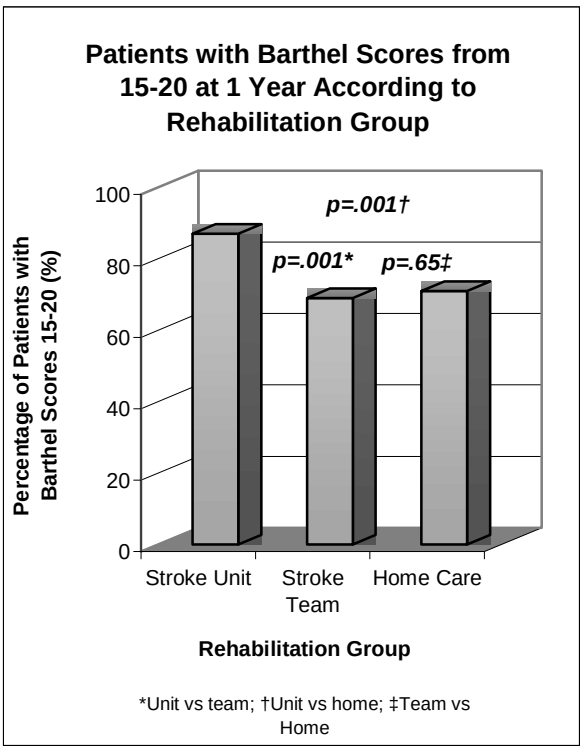
Kalra L, Evans A, Perez I, Knapp M, Donaldson N, Swift CG. Alternative strategies for stroke care: a prospective randomised controlled trial. *Lancet 2000;356:894-899.*

Kalra L, Evans A, Perez I, Knapp M, Swift C, Donaldson N. A randomised controlled comparison of alternative strategies in stroke care. *Health Technol Assess 2005;9:1-94.*

Author / Year Country PEDro score	Methods	Outcome
Kalra et al. 2000 UK 8 (RCT)	457 patients suffering from an acute, moderately disabling stroke were randomized to a stroke unit (n=152), a stroke team (n=152) or home care (n=153). Care was provided for a maximum of 3 months. The main outcome measure was death or need for institutionalization at one year.	The odds of dying or being institutionalized at 1 yr were 3.2 times greater for stroke-team and 1.8 times greater for home care patients when compared to stroke unit patients. Barthel Index scores were better for stroke unit patients than for stroke team and home care. Modified Rankin scores were better for stroke unit patients than for stroke team, and home care patients.
Kalra et al. 2005 UK 8 (RCT)	Additional outcomes from Kalra et al. 2000 study.	Mortality and institutionalization was significantly lower among patients managed on the stroke unit compared to the other two forms of management (13.8% compared to 30.2% for stroke team and 23.6% for home care). Although the median Barthel Index and Frenchay Activity Index scores were not significantly different between the groups although patients managed on the stroke unit achieved greater change scores. Stroke units were more cost-effective than home care or stroke teams.







Importance: This RCT compared stroke unit, mobile stroke team or home care treatments. Stroke unit care was superior to home care or mobile stroke team care in terms of combined death or institutionalisation, functional change scores and cost-effectiveness.

Relevant SREBR Conclusions: There is strong evidence that mobile stroke teams do not reduce mortality, combined death or dependency, the need for institutionalization or the length of hospital stay and do not convey the same benefits as inpatient stroke rehabilitation.

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Evans A, Harraf F, Donaldson N, Kalra L. Randomized controlled study of stroke unit care versus stroke team care in different stroke subtypes. Stroke 2002;33:449-455

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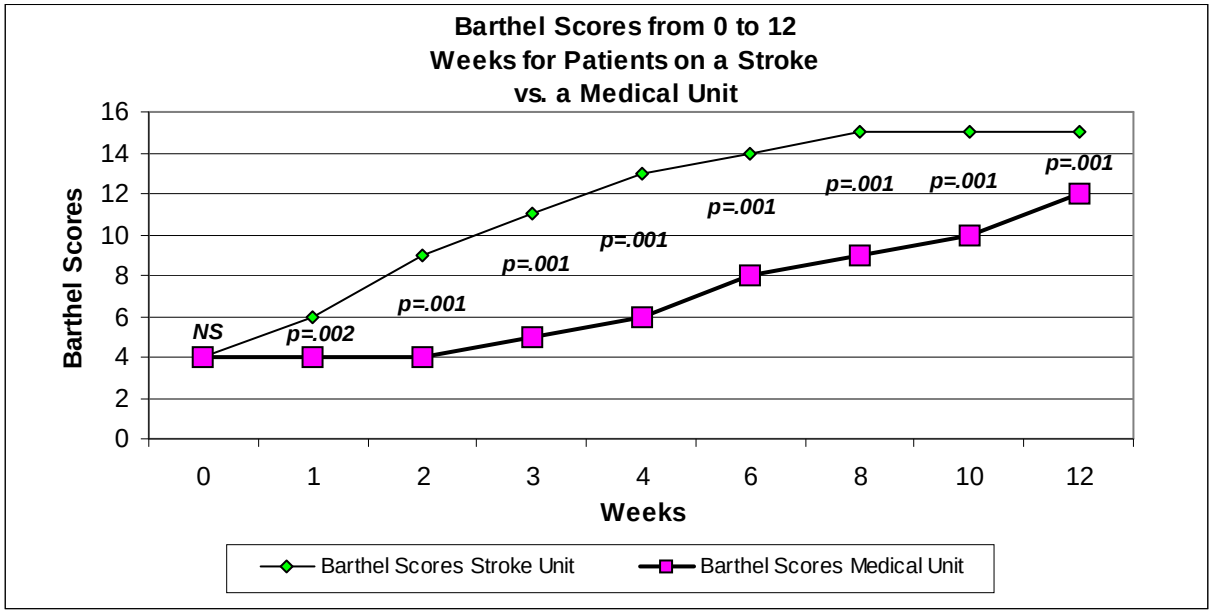
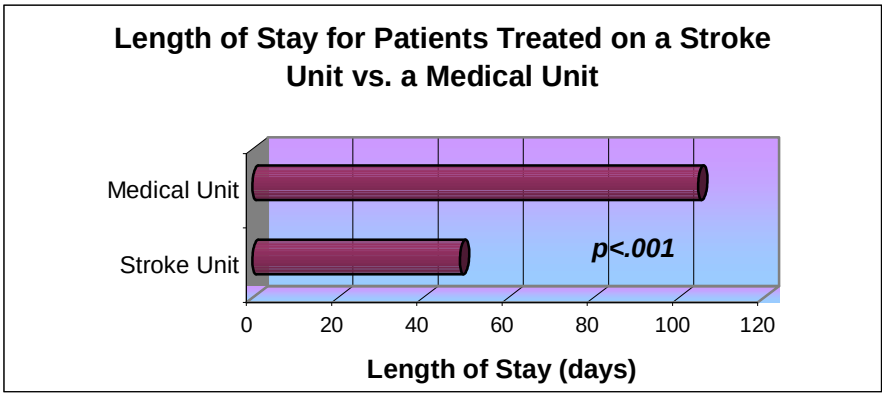
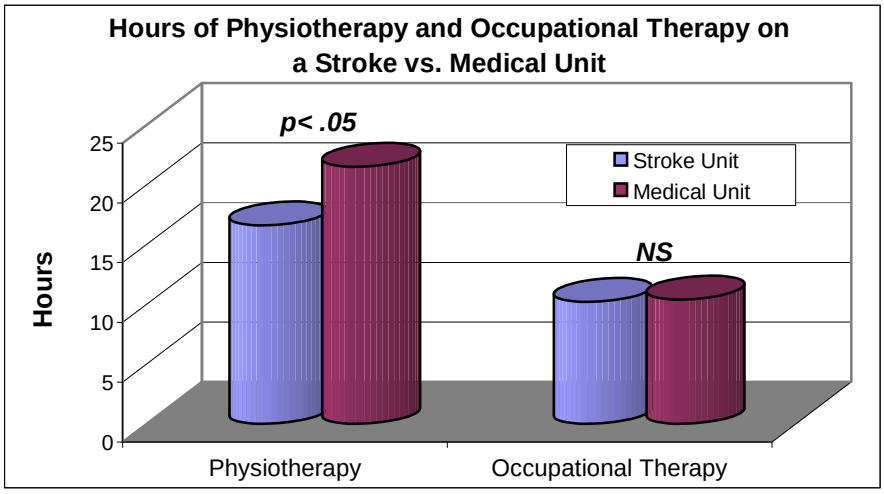
Key Study: Efficacy of Interdisciplinary Stroke Rehabilitation

Kalra L. The influence of stroke unit rehabilitation on functional recovery from stroke. ***Stroke 1994;25:821-825.***

Author / Year Country PEDro score	Methods	Outcome
Kalra et al. 1994(a) UK 5 (RCT)	Analysis of 146 middle-band stroke patients taken from a sample of 245 stroke patients randomized at 2 weeks post stroke to a rehabilitation unit or a general medical unit after stratification by stroke severity. (Analysis of 1993 RCT).	The median Barthel Index (BI) scores of patients managed on the stroke unit were significantly higher when compared to patients on the medical unit (15 vs 12). The rate of improvement in BI scores was faster for patients on the stroke unit and these patients had significantly shorter LOS (6 vs 20 weeks). Significant gains were achieved at a faster rate without additional physiotherapy or occupational therapy in total.







Importance: This study demonstrates that middle-band stroke patients do better in a specialized stroke rehabilitation unit when compared to a general medicine unit in terms of functional outcomes and length of hospital stay. This despite the fact that both groups received the same amount of overall therapy. The stroke unit care was more specialized and intensive ("front-loading"). The result was significant improvements in function with shorter lengths of stay; hence, better health outcomes were obtained at a lesser cost.

Relevant SREBR Conclusion: There is moderate evidence, based on the results from a single study that the same therapies delivered more intensively over a shorter period of time results in faster recovery and earlier discharge from hospital

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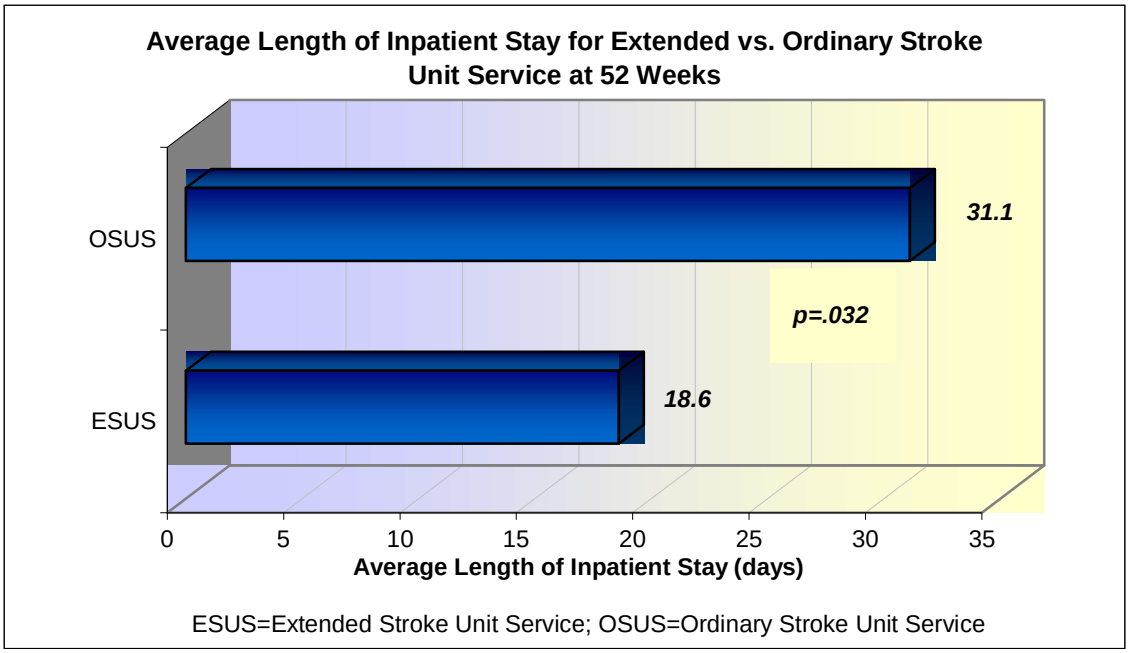
Key Study: Efficacy of Interdisciplinary Stroke Rehabilitation

Indredavik B, Fjaertoft H, Ekeberg G, Loge AD, Morch B. Benefit of an extended stroke unit service with early supported discharge: A randomized controlled trial. Stroke 2000;31(12):2989-2994.

Fjaertoft H, Indredavik B, Lydersen S. Stroke unit care combined with early supported discharge: long-term follow-up of a randomized controlled trial. Stroke 2003;34(11):2687-91.

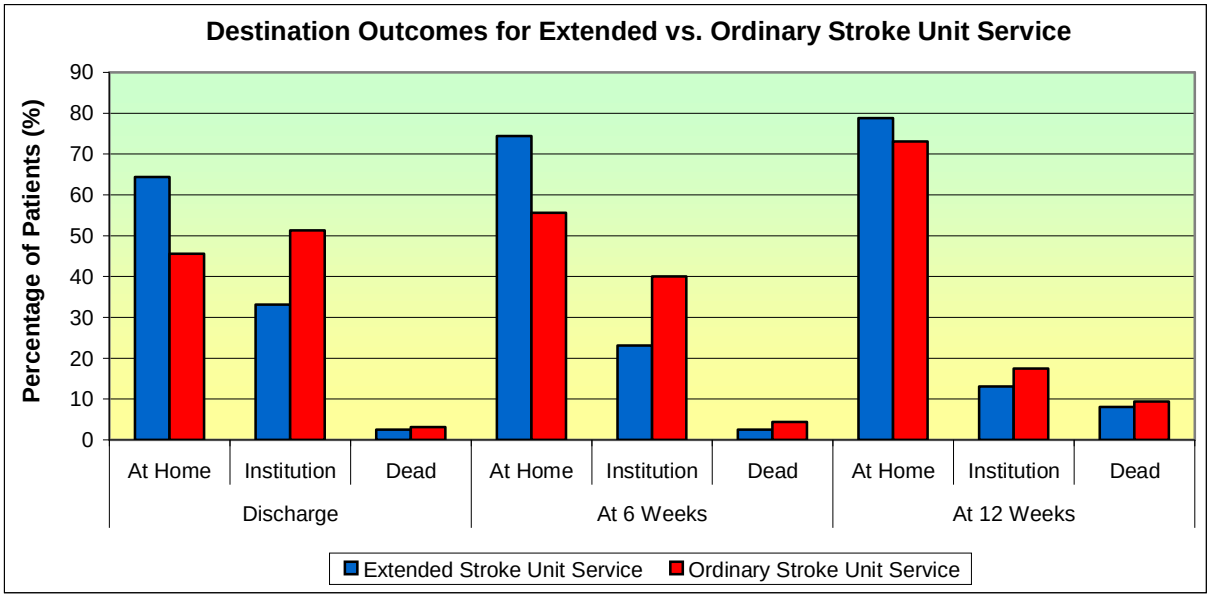
Author / Year Country PEDro score	Methods	Outcome
Indredavik et al. 2000 Norway 7 (RCT)	320 stroke patients were randomized to receive care on an enhanced stroke unit service (ESUS) with an early supported discharge component or an ordinary stroke service (OSUS).	A greater proportion of patients treated in the extended stroke unit was independent (using Rankin scores #2 and BI scores ≤ 95) and had been discharged home (64 vs. 46%). Shorter LOS for patients treated on the extended stroke service (19 vs. 31 days).
Fjaertoft et al. 2003 Norway 7 (RCT)	52 week follow-up to 2000 study	A greater proportion of ESUS patients was independent, defined as a modified Rankin Scale score of ≤2, (56.3% vs. 45.0%, p=0.045). There were non-significant improvements in independence, defined as a Barthel Index score of ≥ 95, favouring ESUS patients (52.5% vs. 46.3%, p=0.264).

Fjaertoft et al. 2003



ESUS=Extended Stroke Unit Service; OSUS=Ordinary Stroke Unit Service

Indredavik et al. 2000



Importance: This study was important because it showed that stroke unit care combined with early supported discharge appears to improve long term clinical outcome when compared with ordinary stroke unit care.

Relevant SREBR Conclusions: There is strong evidence that stroke patients with mild to moderate disability, discharged early from an acute hospital unit, can be rehabilitated in the community by an interdisciplinary stroke rehabilitation team and attain similar functional outcomes when compared to patients receiving in-patient rehabilitation.

B4.2 Combined Acute and Subacute Stroke Rehabilitation Units

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Case Study

You are again asked to do a review of a stroke rehabilitation unit. In this case, the stroke rehabilitation unit has been combined with the acute stroke unit so that patients are admitted to the acute stroke unit and remain on that same unit from their initial admission to the hospital with their acute stroke to their community discharge once their stroke rehabilitation is over. As a combined acute-subacute stroke unit they have interdisciplinary and dedicated nursing and therapy staffing and have 20 dedicated beds all geographically localized together.

Q1. Describe the evidence for combined acute and subacute stroke rehabilitation units.

Answers

1. Based on the results from meta-analyses, there is strong evidence that combined acute and rehabilitation stroke units are associated with a reduction in odds of combined death/dependency, the need for institutionalization and length of hospital stay, improved functional outcomes but are not associated with reductions in mortality alone.
2. Combined acute-subacute stroke rehabilitation models are considered an acceptable alternative to the specialized subacute stroke rehabilitation unit.

Discussion

Six RCTs evaluating combined acute/rehabilitation stroke units have been identified. All of these combined units admitted patients acutely and offered both acute and rehabilitative care. Each one of the trials assessed care provided on a Combined Stroke Unit (SU) or Neurology Ward to care provided on a General Medical Ward (GMW) (Garraway et al. 1980, Indredavik et al. 1991, Fagerberg et al. 2000, Ma et al. 2004, Sivenius et al. 1985, Kaste et al. 1995). Of the six trials, four included a dedicated stroke unit as the intervention and a general medical unit as the control condition Garraway et al. 1980, Indredavik et al. 1991, Fagerberg et al. 2000, Ma et al. 2004). Sivenius et al. (1985) and Kaste et al. (1995) offered specialized care on a neurology ward, which included patients with diagnoses other than stroke.

Among the six studies, which evaluated combined stroke unit care compared to medical/Neurological ward treatment, mortality was lower in a single trial (Indredavik et al. 1991. However, while Indredavik et al. (1991, 1997, 1999) reported reduced mortality at six weeks, five and ten years, there was no statistically significant difference at the one-year point. Mortality was not assessed in the trial authored by Ma et al. (2004).

The majority of the studies reported improvements in functional outcome, mainly assessed by a wide variety of ADL instruments. Five out of six studies reported significant improvements in

patients who received care on a specialized stroke/Neurology ward. The mean Barthel Index score and the proportion of patients classified as independent in ADL at one-year follow-up were greater among patients receiving care on the Neurology (mixed) ward (Kaste et al. 1995). Sivenius et al. (1985) noted greater gains in a 27-point ADL score among patients receiving more intensive rehabilitation at 3 months. The gains persisted at 6 and 12 months, although they were non-statistically significant. Only Kaste et al. (1995) failed to report a beneficial effect of specialized treatment. The large proportion of patients included in this trial who had suffered from a mild stroke (45%) may have diluted the impact of the treatment, as patients with more disabling strokes are the group most likely to benefit.

The results were conflicting with respect to reductions in LOS. Three studies reported significantly shorter LOS associated with comprehensive stroke units (Garraway et al. 1980, Indredavik et al. 1991, Kaste et al. 1995). Two studies reported no differences in LOS between groups (Sivenius et al. 1985, Fagerberg et al. 2000) and one study did not assess this outcome.

The results were also conflicting for the proportion of patients requiring institutionalization following rehabilitation. Indredavik et al. (1991) reported that the proportion of patients requiring institutionalization was lower in patients who had received care on a specialized unit, while Fagerberg et al. (2000) found no difference in LOS between treatment groups. The outcome was not assessed in the remaining studies.

The reason for the conflicting results of the outcomes of LOS and institutionalization was unclear, although it may be explained, in part on the basis of differences in the processes of care between the individual institutions, variations in the characteristics of the patients included or the timing or sensitivity of the functional outcome measures used.

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B5. Elements of Stroke Rehabilitation Care

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Recommendation 5.3 Components of Inpatient Stroke Rehabilitation (Lindsay et al. 2008)

All patients with stroke should begin rehabilitation therapy as early as possible once medical stability is reached [Evidence Level A] (ASA).

i. Patients should receive the intensity and duration of clinically relevant therapy defined in their individualized rehabilitation plan and appropriate to their needs and tolerance levels [Evidence Level A] (HSFO, RCP).

ii. Stroke patients should receive, through an individualized treatment plan, a minimum of 1 hour of direct therapy by the interprofessional stroke team for each relevant core therapy, for a minimum of 5 days per week based on individual need and tolerance [Evidence Level A] (EBRSR), with duration of therapy being dependent on stroke severity [Evidence Level C] (EBRSR).

iii. The team should promote the practice of skills gained in therapy into the patient's daily routine in a consistent manner [Evidence Level A] (RCP).

iv. Therapy should include repetitive and intense use of novel tasks that challenge the patient to acquire necessary motor skills to use the involved limb during functional tasks and activities [Evidence Level A] (SCORE).

v. Stroke unit teams should conduct at least one formal interdisciplinary meeting per week at which patient problems are identified, rehabilitation goals set, progress monitored and support after discharge planned [Evidence Level B] (SIGN 64).

vi. The care management plan should include a predischarge needs assessment to ensure a smooth transition from rehabilitation back to the community. Elements of discharge planning should include a home visit by a health care professional, ideally before discharge, to assess home environment and suitability for safe discharge, determine equipment needs and home modifications, and begin caregiver training for how the patient will manage activities of daily living and instrumental activities of daily living in their environment [Evidence Level C].

Reference

Lindsay P, Bayley M, Hellings C, Hill M, Woodbury E, Phillips S. Canadian best practice recommendations for stroke care (updated 2008). CMAJ 2008; 179 (12): S1.

B5.1 Impact of Care Pathways and Guidelines

B5.1 Impact of Care Pathways and Guidelines

Case Study

A new stroke rehabilitation program is being initiated in your center. The centerpiece of the new program will be a 15 bed stroke rehabilitation unit. The new coordinator of this program wants you to assist with setting up an integrated care pathway, "to ensure that patients are managed according to best evidence."

Q1. Describe the evidence supporting integrated care pathways for stroke rehabilitation.

Answers

1. Care pathways do not appear to improve stroke rehabilitation outcomes or reduce costs.
2. Compliance with stroke rehabilitation guidelines does improve outcomes.
3. Systems of stroke rehabilitation care systematic organization, staffing expertise and technological sophistication are less important than the processes of care (timing, intensity, task-specificity) in determining outcomes of stroke rehabilitation.

Discussion

Integrated Care Pathways (ICP) have been recently introduced in an attempt to improve the quality and consistency of stroke rehabilitation care. They have been seen as a means to translate the recommendations from various guidelines and recommendations to a local setting. They are very prescriptive in their approach and represent a tendency toward micromanagement; however, they do ensure certain things get done and contain an element of accountability which is often missing on stroke rehabilitation units. In some centres they have been developed to reduce lengths of hospital stay in an effort to reduce costs. ICPs are also referred to as "care mapping" (Falconer et al. 1993).

The definition of a care pathway may vary from one institution to another, although there are several common elements which include: being patient focused, the management is evidence-based, is multidisciplinary, documents in detail the clinical process and is constructed in a manner that facilitates an audit of outcomes (Edwards et al. 2004). However, the development and successful implementation of an ICP is time consuming and expensive and raises concerns over their associated opportunity costs. Sulch et al. (2000) described the development of an integrated care pathway as "an organized, goal-defined and time management plan that has the potential of facilitating timely interdisciplinary coordination, improving discharge planning and reducing length of hospital stay." Other, less formal systems may include checklists of processes of care (Cadilhac et al. 2004). Kwan et al. (2007) suggested that the development of care pathways might be more appropriate for acute stroke management where they have the greatest potential to alter the highly complex processes of care, rather than in the rehabilitative phase of stroke when well coordinated service is usually provided by an interdisciplinary team.

Although intuitively care pathways should improve the quality of stroke care, the evidence does not support this conclusion. It may be that care pathways simply reinforce rather than change practice. It may also suggest that imposing a blueprint of care, rather than individualizing treatment, does not improve outcomes. Therefore, although organized interdisciplinary stroke rehabilitation units have been shown to improve outcomes, care pathways do not appear to be a contributing component to their success. There is evidence that the use of care pathways may actually be associated with poorer patients satisfaction and quality of life.

A recently updated Cochrane review (Kwan and Sandercock 2004) reporting the results of 3 randomized and 12 non-randomized trials, suggested that care pathways did not help to decrease the risk or death or alter eventual discharge definition, over and above that of conventional care. In fact, patients managed with a care pathway were more likely to be dependent at discharge although less likely to suffer a urinary tract infection, and were less likely to be readmitted to hospital and were more likely to have neuroimaging. Patient satisfaction and quality of life were significantly lower in the care pathway group. The authors noted, "*there is currently insufficient supporting evidence to justify routine implementation of care pathways for…stroke rehabilitation*." This finding was confirmed by Hoenig et al. (2002) who found the structure of care (systematic organization, staffing expertise and technological sophistication) was not necessarily associated with better functional outcomes whereas interestingly, compliance with AHCPR post stroke rehabilitation guidelines improved those same outcomes. The apparent paradox may signify the importance of using evidence or guidelines to assist rehabilitation clinicians in individualizing the rehabilitation of stroke patients as opposed to a "one size fits all" approach.

Sulch et al. (2000, 2002) randomized 152 stroke patients to a rehabilitation program of integrated care pathways (ICP), characterized as an organized, goal-defined and time managed plan with the potential to improve discharge planning and reduce length of hospital stay, or to a conventional multidisciplinary team (MDT) program of conventional rehabilitation. Patients receiving MDT care improved significantly faster between weeks 4 and 12 (median change in Barthel Index 6 vs. 2, $p<0.01$) and had higher Quality of Life scores, assessed by the EuroQol Visual Analogue Scale (EQ-VAS) at 6 months (72 vs. 63, $p<0.005$).

Forster and Young (2002) noted that, "*...a balance needs to be struck between testing out a specific treatment approach and evaluating it in an overly isolated fashion. In clinical practice it is often diversity of approach that is effective; the clinician using trial and error to determine a strategy which appears helpful to the individual patient.*" Wade (2001) warned of the dangers of excessively deconstructing the "black box" of rehabilitation.

In conclusion, based on the results from three RCTs, there is strong evidence to suggest that care pathways do not improve stroke rehabilitation outcomes. There is moderate evidence that care pathways do not reduce hospital costs or decrease length of hospital stays. There is limited evidence that compliance with stroke rehabilitation guidelines and adherence to processes of care result in improved outcomes.

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Key Study: Elements of Stroke Rehabilitation

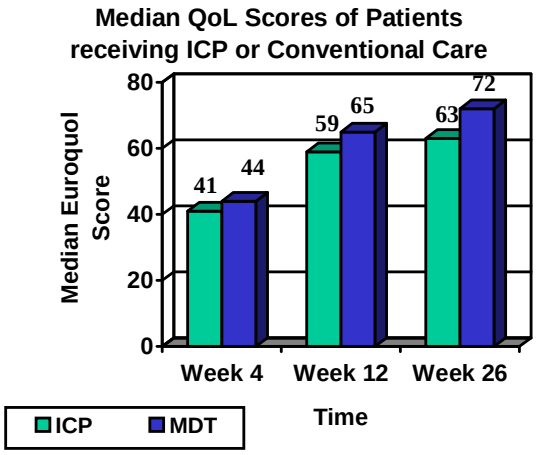
Sulch D, Evans A, Melbourn A, Kalra L. Does an integrated care pathway improve processes of care in stroke rehabilitation? A randomized controlled trial. *Age Ageing 2002; 31(3):175-179.*

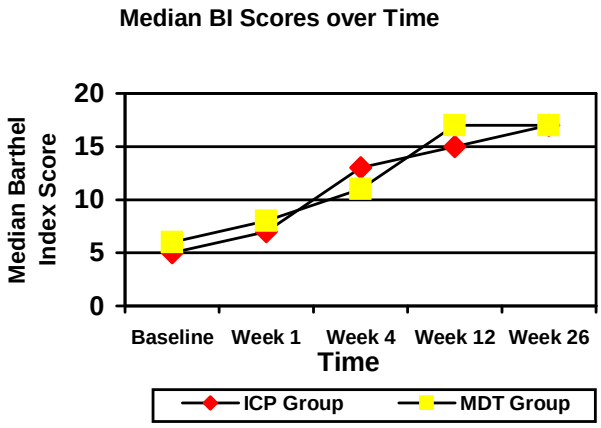
Sulch D, Kalra L. Integrated care pathways in stroke management. *Age Ageing 2000;29:349-352.*

Sulch D, Melbourn A, Perez I, Kalra L. Integrated care pathways and quality of life on a stroke rehabilitation unit. *Stroke 2002;33(6):1600-4.*

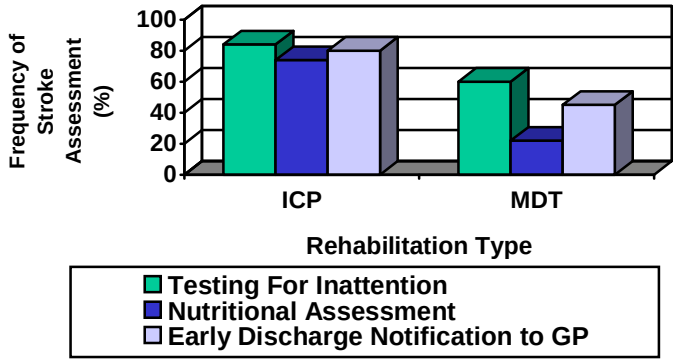
Author / Year Country PEDro score	Methods	Outcome
Sulch et al. 2000 UK 6 (RCT)	152 patients were randomized to be managed by an Integrated Care Pathway (ICP) based on evidence of best practice, professional standards and existing infrastructure for facilitating inter-disciplinary coordination, improving discharge planning and reducing length of hospital stay or were to be managed by conventional multi-disciplinary care (control). (see Figure)	There were no differences in mortality rates, frequency of institutionalization or LOS between the two groups. Conventional multidisciplinary care resulted in higher BI scores between 4 and 12 weeks and higher Quality of Life scores at 12 weeks and 6 months, compared to the ICP group patients.
Sulch et al. 2002 UK 6 (RCT)	Additional analyses from Sulch et al. 2000. Quality of life was assessed using the EuroQoL Visual Analogue Scale (EQ-VAS) at 6 mos.	Patients receiving conventional multidisciplinary therapy had significantly higher QoL scores at 6 mos compared to patients in Integrated Care Pathway group (median 72 vs. 63, $p<0.005$).
Sulch et al. 2002 UK 6 (RCT)	Additional analyses from Sulch et al. 2000, investigating the frequency of stroke specific assessments associated with either ICP or multidisciplinary care.	Increased frequency of stroke-related assessments with ICP, including testing for inattention (84% vs. 60%, $p=0.015$) and nutritional assessments (89% vs. 70%, $p=0.024$). Early discharge notifications to general practitioners were also higher among patients in the ICP group.

Sulch et al. (2000, 2002) Integrated Care Pathways





Frequency of Assessments



Importance: This RCT demonstrated that care pathways did not improve stroke rehabilitation outcomes suggesting the importance of individualized therapies within an evidence-based content.

Relevant SREBR Conclusion: There is strong evidence that care pathways do not improve stroke rehabilitation outcomes.

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B5.2 Timing of Stroke Rehabilitation

B5.2 Timing of Stroke Rehabilitation

Case Studies

Case Study A

You are asked to see a 53 year old patient in acute care who has had a moderately large Rt MCA infarct 5 days previously. He has a left hemiplegia and evidence ofsome left sided neglect. He is alert and the MMSE is 28/30 and his MOCA is 30/30. He has no history of previous medical problems and his acute neurological investigations are complete. You determine that he is rehabilitation ready. It is the Wednesday before a long weekend and the coordinator is reluctant to admit the Thursday or Friday before the holidays. The neurologist is keen to have the patient discharged out of his acute care unit as the demand for the acute stroke beds is high.

Case Study B

A 75 year old female is admitted with a large subcortical infarct in a left MCA territory 7 days previously. She has a right hemiplegia and a partial expressive aphasia. She is alert, responds to 2-3 step commands. She has severe dysphagia and requires an NG feeding tube. It has been determined she will require a G-J feeding tube but the radiologist is backed up and cannot insert it for a week. It is an unwritten policy on the stroke rehabilitation unit that all tests and procedures be done prior to admission to the stroke rehabilitation unit to avoid the hassle and cost (to the rehabilitation unit) of having the patient transported back to the acute care hospital for the procedure.

Q1. What should be your response?

Answer

1. The evidence supporting early admission to stroke rehabilitation is quite compelling.
2. Every effort should be made to admit the patient to stroke rehabilitation or have comparable therapy and care provided in acute care as soon as possible following the onset of the stroke.

Q2. Describe the evidence for early stroke rehabilitation.

Answers

1. Animal studies have shown that earlier rehabilitation results in improved motor recovery and delayed rehabilitation resulted in worse motor recovery.

2. Clinical comparative data suggests that delays in stroke rehabilitation is associated with worse outcomes even when medical comorbidities and stroke severity are taken into account.
3. Stroke patients who are appropriate candidates should be admitted to a rehabilitation unit or facility as soon as possible.

Discussion

The Earlier the Better: The Importance of Timing

Schallert et al. (2003) has noted that the brain appears to be "primed" to "recover" early on in the post-stroke period. Animal studies have shown that if therapy is delayed for several weeks post-stroke, dendritic arborisation is markedly reduced (Schallert and Jones 1993, Jones and Schallert 1994, Kolb 1995, Kozlowski et al. 1996, Schallert et al. 1997, Johansson 2000). In one animal study, after small strokes were induced in rats, Biernaskie et al. (2004) subjected them to 5 weeks of "rehab" beginning at days 5, 14 and 30 post-stroke. A control group of rats received no rehabilitation and were placed in "social housing." Rats receiving early (day 5) rehab showed marked improvement in neurological recovery. Rats beginning rehabilitation at day 14 showed moderate improvement, while rats receiving the same amount of rehabilitation but not until day 30 showed no greater improvement than the control animals. The same authors examined dendritic morphology in the undamaged animal cortex contralateral to the stroke lesion. Enriched rehabilitation provided very early post stroke (at day 5) resulted in an increased number of dendritic branches and greater complexity of layer V neurons when compared to those rats receiving rehabilitation at day 30 and to those exposed to social housing only. The authors concluded that the post-stroke brain was more responsive to rehabilitation early post-stroke, and that responsiveness declined linearly with time, such that rehabilitation, which is delayed (beginning at day 30 in rats) is no longer effective. The clinical implications of this finding are apparent; rehabilitation will have the greatest impact during the window when the brain is "primed" for behaviour dependent changes or cortical reorganization.

The results of several clinical studies have also shown an association between earlier admission to rehabilitation and improved outcomes. The results of several studies (Feigenson et al. 1977, Hayes and Carrol 1986, Wertz 1990) have suggested stroke rehabilitation should be initiated soon after stroke to achieve optimal results. In their review, Cifu and Stewart (1999) reported that there were four studies of moderate quality that demonstrated a positive correlation between early onset of rehabilitation interventions following stroke and improved functional outcomes (Table 6.6). These authors noted that "Overall, the available literature demonstrates that early onset of rehabilitation interventions – within 3 to 30 days post stroke – is strongly associated with improved functional outcome". Ottenbacher and Jannell (1993) conducted a meta-analysis including 36 studies with 3,717 stroke survivors, and demonstrated a positive correlation between early intervention of rehabilitation and improved functional outcome. Paolucci et al. (2000) divided 135 stroke patients into three groups based on time of admission to rehab (less than 20 days, 21-40 days and 41-60 days post-stroke onset). The shorter onset group had significantly higher Barthel Index scores than the other two groups at follow-up.

Yagura et al. (2003) examined the differences in ambulation and ADL status between three groups of patients, divided according to the duration of time from onset of symptoms to stroke rehabilitation admission and reported that patients who were admitted within 90 days of their

stroke achieved greater gains in ambulation, upper extremity and ADL function, compared to patients who had been admitted either 91-180 days or >180 days following stroke. However, while patients who were admitted earlier achieved better outcomes, all patients significantly benefited from rehabilitation regardless of their onset to admission time. Shah et al. (1990) found that interval between stroke onset and admission to rehabilitation was a predictor of achievement of rehabilitation potential among 258 patients recovering from first-ever stroke. A shorter onset time was associated with improved functional outcome. Similarly, Salter et al. (2006) found that early admission to rehabilitation was associated with improvements in ADL ability as measured by the FIM instrument, after controlling for the effects of patients' age.

Most recently, Maulden et al. (2005) reported on the findings of the Post-Stroke Rehabilitation Outcomes Project (PSROP), an observational, prospective study, which enrolled 1,291 patients from six inpatients rehabilitation facilities in the US. Increases in the length of time from stroke onset to admission to rehabilitation were associated with lower discharge FIM scores and increased LOS for patients with both moderate and severe strokes. Days from stroke onset to admission was also a significant predictor of discharge total FIM score, discharge motor FIM score, discharge mobility FIM score and rehabilitation LOS in regression analysis. The strongest relationship between early admission to rehabilitation and improved functional outcome was among the most severely impaired patients (case-mix group 108-114). However, a literature review by Diserens et al. (2006) examining the potential benefits of early mobilization concluded that no randomized controlled trial had been conducted to enable a comparison of the effects of early (defined as within the first three days of stroke) vs. delayed (greater than 3 days).

While the strong association between early admission and improved functional outcomes appears to be causal, stroke severity might have confounded the relationship. Patients who had suffered more severe strokes (with higher levels of impairment) were also more likely to have suffered medical complications or have been too impaired initially to be able to actively participate in rehabilitation, while patients with mild to moderate strokes, or those considered to be the best rehabilitation candidates were likely admitted to rehabilitation sooner. The concept of the brain being "primed" to recover during a narrow "window" of opportunity post-stroke indicates the importance of timely access to stroke rehabilitation. Allowing a long waiting list to develop denies a potential rehabilitation candidate access to the appropriate, which may likely compromise their outcome.

In summary there is emerging evidence that the brain is "primed" to recover early post-stroke and that stroke patients should have access to specialized stroke rehabilitation therapies as soon as they are able to participate. The current evidence, although not definitive, strongly suggests that the earlier stroke patients are able to participate in rehabilitation the better they will do overall. This emphasizes the negative impact of allowing a waiting list for stroke rehabilitation to develop, particularly for moderately severe stroke patients. The most recent Clinical Practice Guidelines (Duncan et al. 2005) "recommend that rehabilitation therapy start as early as possible, once medical stability is achieved." One exception to this may be the more severe stroke where the benefits of earlier rehabilitation would not be expected to be as great.

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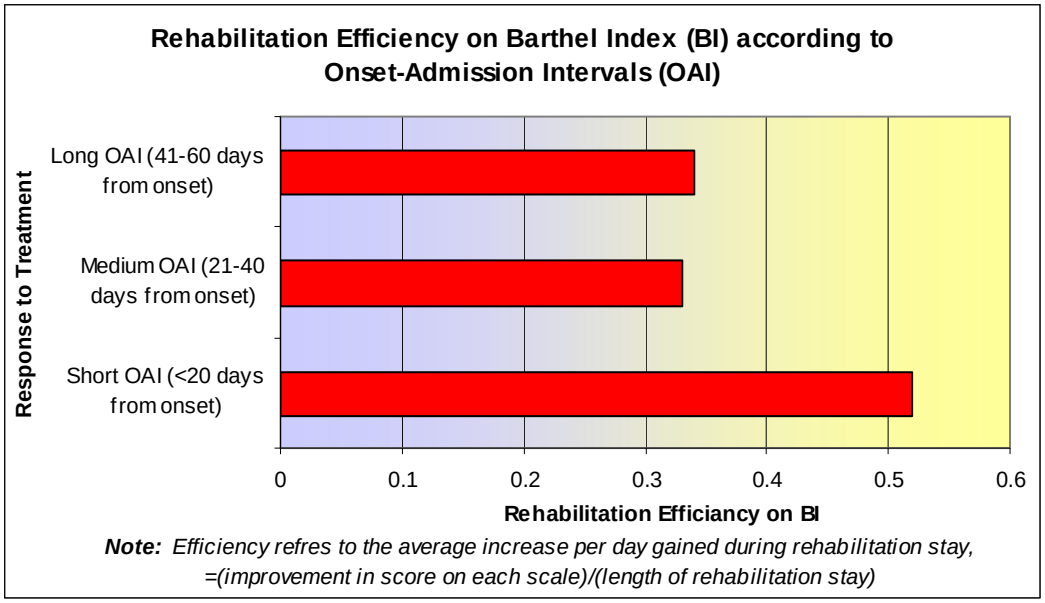
Key Study: Elements of Stroke Rehabilitation

Paolucci S, Antonucci G, Grasso MG, Morelli D, Troisi E, Coiro P, Bragoni M. Early versus delayed inpatient stroke rehabilitation: a matched comparison conducted in Italy. Arch Phys Med Rehabil 2000;81:695-700.

Author / Year Country PEDro score	Methods	Outcome
Paolucci et al. 2000 Italy No Score	A case controlled study of 135 stroke patients who received: 1) rehabilitation within the first 20 days post-stroke (short onset) 2) rehabilitation 21 to 40 days post-stroke (medium onset) and rehabilitation 41 to 60 days (long onset) post-stroke. All patients received the same physical therapy program.	Higher dropout rate was noted in the short onset group. Barthel Index scores in the short onset group showed significantly greater rate of improvement than the other two groups.



Importance: This case-controlled study demonstrated that patients who entered into rehabilitation early (<20 days) showed a significantly greater rate of improvement than those who entered rehabilitation later (>20 days).

Relevant SREBR Conclusion: There is limited evidence that early admission to stroke rehabilitation is associated with improved functional outcomes.

Related Reference

Salter K, Jutai J, Foley N, Bhogal S, Bayona N, Teasell R. Effect of early time to rehabilitation on functional outcome in stroke. J of Rehabilitation Medicine 2006;38(2):113-117.

B5.3 Intensity of Therapy

B5.3 Intensity of Therapy

Case Studies

Case Study A.
A 65 year old female was admitted to the stroke rehabilitation unit after having a moderate sized Lt MCA infarct 9 days previously. She has been on the rehabilitation unit for 4 weeks. Her daughter has noted on several occasions that her mother is often not in therapy, that sessions are often shortened because she is transported to the therapist treatment area late, therapy sessions are often inexplicably cancelled, there is no therapy during patient "education" sessions and "team rounds" and there is no treatment on weekends or holidays. She is concerned that with discharge in another 2 weeks that her mother won't have gotten the therapy she needs and wants to know if the discharge date can be extended.

Case Study B.
A 55 year old male was admitted to the stroke rehabilitation unit after suffering a moderate subcortical infarct which caused paresis of his right arm and an expressive aphasia. His family expressed frustration that he had missed two weeks of speech therapy because the therapist was on holidays and there was no replacement. They would like his length of stay to be extended an additional two weeks to make up the difference.

Case Study C.
An 80 year old female admitted to the stroke rehabilitation unit 10 days after suffering a large Rt MCA infarct is missing half her therapy sessions because she is "tired". Her son, who is very supportive, is concerned that the therapists may be pushing her too hard.

Q1. Should you be concerned?

Answers
1. In each of these cases, the concern is that the intensity of therapy is not sufficient to maximize recovery.
2. Intensity matters. Intensity of therapy is correlated with recovery.
3. When intensity of therapy is low, recovery is slowed or stunted, with an increase in length of hospital stay.

Discussion

In both animal and clinical studies, training and rehabilitation increases cortical representation with subsequent functional recovery, whereas a lack of rehabilitation or training decreases cortical representation and delays recovery. Animals exposed to enriched environments post-stroke have improved functional outcomes when compared with animals exposed to non-enriched environments. The mediating factor appears to be increased activity. In animal studies, it appears that the key factors promoting neurological recovery include increased activity and a complex and stimulating environment. It follows that if training and stimulation, lead to increased cortical reorganization, neurological recovery and functional improvements, then more intensive therapy is likely to result in a greater degree of recovery and improved functional outcomes.

When attempting to determine factors that contribute to the improved functional outcomes that are associated with specialized stroke rehabilitation, the intensity of rehabilitation therapies is often cited as an important element. Do patients who receive therapy for longer periods of time or at a higher level of intensity realize greater benefits compared to patients who receive conventional care? This hypothesis has been investigated extensively although these studies have found that intensity of therapy was only weakly correlated with improved functional outcome. However, Kalra and Langhorne (2007) have noted that "*there is evidence from neuroimaging studies showing that increased intensity of rehabilitation therapies results in greater activation of areas associated with the function towards which this therapy is directed*".

While a universally accepted definition of the term "intensity" does not exist, it is usually defined as number of minutes per day of therapy or the number of hours of consecutive therapy. Studies evaluating the effects of increased intensity of therapy usually provide "more" therapy over a given course of total treatment time compared to the alternative, which receive a lesser amount. This weak association may be explained by differences in the time, duration and composition of therapies provided and/or the characteristics of the stroke patients under study. Page (2003) argues that intensity of therapy has been over-emphasized, and that *"less intense (30-45 min/day) task-specific training regimens with the more affected limb can produce cortical reorganization and correlative, meaningful functional improvements".* Turton & Pomeroy (2002) acknowledge the widely held clinical belief that too much of, or the wrong type of activity early on in the rehabilitation of the upper extremity may produce a worse outcome, increasing spasticity, in particular.

The intensity of the package of rehabilitation therapies offered also needs to be considered. The total amount of time that a patient spends engaged in rehabilitation activities vary considerably, between units, institutions and countries. Lincoln et al. (1996) observed that patients on a stroke rehabilitation unit were engaged in interactive behaviours for only 25% of their time. De Weerdt et al. (2000) used behavioural mapping to quantify the amount of time patients spent in therapeutic activities on two rehabilitation units, one in Belgium and one in Switzerland. Patients were engaged in rehabilitation for a larger percentage of the day than those from Switzerland (45% vs. 27%). De Wit et al. (2005) also observed significant differences in the amount of time patients spent in rehabilitation activities among four European countries (Belgium, UK, Switzerland and Germany) Patients from Germany spent a larger percentage of the day in therapy time (23.4%), while those from the UK spent the least (10.1%). Therapy time ranged from 1 hour per day in the UK to about 3 hours per day in Switzerland. In all of the centres, patients spent 72% of the time in non-therapeutic activities. Even more discouraging are the results from A Very Early Rehabilitation Trial (AVERT) (Bernhardt et al. 2004, 2006) in which a cohort of 58 patients in 5 acute stroke units in Australia were observed. Patients engaged in moderate or high levels of activity for only 12.8% of their therapeutic day. 53% of the

time, patients spent their time in bed and were alone 60% of the time. Although there was a direct relationship between stroke severity and activity, even patients with only mild stroke spent only 11% of their active day walking. Patients' affected upper limbs were observed to be moving only 33% of the time, regardless of whether the patient was with a therapist or alone. A recent comparison between Australian patients and those in Norway (Bernhardt et al. 2008) revealed that patients admitted to acute stroke units in Trondhein spent an average of 21% less time in bed and 10% more time engaged in either sitting out of bed or in standing/walking activities compared with patients in Melbourne hospitals. There were differences between these two systems in terms of staffing ratios, policies and in the rehabilitation programs themselves.

Duncan et al (2005) reviewed all RCTs and meta-analyses published to date examining the effect of intensity on improved functional outcome and concluded that there was weak evidence of a dose-response relationship. The authors suggest that all subsets of patients may not benefit equally and could not recommend specific guidelines about the intensity or duration of rehabilitation therapies.

B5.3.1 Intensity of Physiotherapy and Occupational Therapy

Previous Reviews and Meta-Analyses

The results of a four meta-analyses, suggest that increased intensity of therapy is beneficial. Langhorne et al. (1996) examining the effects of differing intensities of physical therapy showed significant improvements in activities of daily, living (ADL) function and reduction of impairments with higher intensities of treatment. Kwakkel et al. (1997) included 8 RCTs and one non-randomized experiment and found a small but statistically significant intensity-effect on ADL and functional outcome parameters. However, Cifu and Stewart (1999) identified only 3 moderate quality studies and one meta-analysis which examined the intensity of rehabilitation services and functional outcome (see Table 6.9) and reported that the intensity of rehabilitation services was only weakly associated with improved functional outcomes after stroke. Kwakkel et al. (2004) conducting an extension of his previous meta-analysis, evaluated the benefit of augmented physical therapy, including 20 studies which had assessed many interventions: occupational (upper extremity), physiotherapy (lower extremity), leisure therapy, home care and sensorimotor training. After adjusting for differences in treatment intensity contrasts, augmented therapy was associated with statistically significant treatment effects for the outcomes of ADL and walking speed, although not for upper extremity therapy assessed using the Action Research Arm test. A 16-hour increase in therapy time during the first six-months following stroke was associated with a favourable outcome.

Chen et al. (2002) examined the relationship between intensity of therapy and functional gains in a retrospective study of 20 sub acute rehabilitation facilities in the USA. Stroke patients made larger self-care gains if they had lower self-care, higher mobility and cognition function at admission, longer, uninterrupted stays, received more intensive therapies and weren't admitted to a rehabilitation facility initially. Determinants of improvement in mobility included younger age, admission soon after impairment, higher self-care and cognition measures. Although admission function, length of stay and therapy intensity collectively contributed to greater functional gains, length of stay and therapy intensity did not always predict those gains. There was an interdependency between the domains of self-care, mobility and cognition, such that patients with deficits in self-care on admission made the greatest improvements if mobility or cognitively remained intact or relatively intact. Wodchis et al. (2005) studied a large cohort of stroke survivors (n=23,824) admitted to skilled nursing facilities in Ohio, Michigan and Ontario. For patients with an uncertain prognosis on admission the intensity of rehabilitation therapies was

positively associated with an increased likelihood of going home. However, it should be noted that the weekly therapy time would not generally be considered to be intensive (The maximum category was 500+ min/week).

Kwakkel et al. (2004) conducted a meta-analysis to evaluate the benefit of augmented therapies. Twenty studies from a variety of disciplines were included. After adjusting for differences in treatment intensity contrasts, augmented therapy was associated with improvements in components of activities of daily living and walking speed. Benefits associated with upper extremity function assessed with the Action Research Arm test were not evident. A 16-hour increase in therapy time during the first six months following stroke was associated with a favourable outcome.

In the SREBR we reviewed 24 studies that evaluated the efficacy of increased therapy and the relationship to improved functional outcomes were identified. Ten of these were randomized controlled trials in which stroke patients were randomized to receive physical therapies at differing levels of intensity. This review found evidence that greater intensity of physiotherapy and occupational therapy resulted in improved functional outcomes. However, the overall beneficial effect was modest and not maintained over time (Teasell et al. 2008).

Controlling for stroke severity, Bode et al. (2004) found that longer lengths of stay and intensive function-focused occupational therapy predicted greater than expected gains in self-care and cognitive improvement. Sonoda et al. (2004) conducted a trial comparing the results of stroke patients admitted to a conventional stroke rehabilitation program 5 days per week and patients admitted to a Full-time Integrated Treatment (FIT) program 7 days per week. Both groups had similar FIM scores on admission; however, the FIT group had significantly shorter lengths of stay and were discharged with higher average FIM scores and nearly double the FIM efficiency scores.

Interdisciplinary specialized stroke rehabilitation is associated with better outcomes compared to conventional multidisciplinary care. Although it is rarely stated, there has been an inherent presumption that specialized stroke rehabilitation provides higher intensities of stroke rehabilitation therapies, although that is not always the case. Kalra et al. (1994) randomized 146 “middle band” stroke patients to a stroke unit or a general medical unit. Patients admitted to the stroke unit received the same amount of physiotherapy and occupational therapy as those admitted to the general medical unit but the stroke unit therapies were delivered more intensively over a shorter period of time. The result was dramatic differences in functional recovery, with the more intensive therapy group improving at a much faster rate, obtaining functional independence scores higher than the other group, and being able to leave the hospital to return home. This has major implications for quality of care, improved outcomes and cost-effectiveness.

In summary, greater intensities of physiotherapy and occupational therapy result in improved functional outcomes.

B5.3.2 Intensity of Aphasia Therapy Post Stroke

The impact of the intensity of aphasia therapy post-stroke has also been studied. The most effective means of treating aphasia post stroke has yet to be determined, and studies investigating the efficacy of speech and language therapy for patients suffering aphasia post stroke have yielded conflicting results. One possible explanation for the observed heterogeneity

of findings across studies is a difference in intensity of therapy. We have noted that the failure to identify a consistent benefit might have been due to the low intensity of speech-language therapy applied in the negative studies while higher intensities of therapy was present in positive studies (Poeck et al. 1989).

Individual Studies of the Intensity of Language Therapy Post-Stroke

The most recent and largest RCT examined by Bakheit et al. (2007) failed to uncover a benefit of intensive aphasia therapy as assessed using the Western Aphasia Battery. The average length of stroke onset was one-month. The authors reported that the majority of patients receiving intensive treatment weren't able to tolerate it. Patients were either too ill or refused therapy and actually had lower WAB scores compared with patients who received less intensive, standard therapy (68.6 vs. 71.4). While this study was considered to be negative, patients who received an average of 1.6 hours of therapy (standard group) per week had significantly higher scores than those who received only .57 hours of therapy (NHS group). Patients in the highest intensity therapy group received an average of 4 hours of therapy per week. Therefore, depending on how" intensive" is defined, this trial could be considered positive.

Bhogal et al. (2003) observed that a significant treatment effect was achieved among studies which provided a mean of 8.8 hours of therapy per week for 11.2 weeks compared to trials that only provided approximately 2 hours per week for 22.9 weeks. On average, positive studies provided a total of 98.4 hours of therapy while negative studies provided a total of 43.6 hours of therapy. Consequently, total length of therapy was significantly inversely correlated with mean change in Porch Index of Communicative Abilities (PICA) scores. The hours of therapy provided in a week was significantly correlated to greater improvement on the PICA and on the Token Test. And finally, total hours of therapy were significantly correlated with greater improvement on the PICA and the Token Test. The authors concluded that intense therapy over a short amount of time could improve outcomes of speech and language therapy for stroke patients with aphasia (Bhogal et al. 2003).

In summary, it is uncertain whether more-Intensive language therapy is better than less-intensive therapy, although for patients who can tolerate it, more intensive therapy appears to result in improved outcomes.

B5.3.3 Weekend Therapy

Q2. What evidence is there for weekend therapy?

Answers

1. Weekend therapy intuitively makes sense because it helps to facilitate more intensive therapy.
2. There is generally support from the research literature that weekend therapy provides improved outcomes and shorter lengths of stay in hospital, although the literature is by no means unanimous.

Discussion

Sonoda et al. (2004) conducted a trial in Japan comparing outcomes for stroke patients admitted to a conventional stroke rehabilitation program 5 days per week and patients admitted to a Full-time Integrated Treatment (FIT) program 7 days per week. The intensity and frequency of treatment varied between the programs: patients in the conventional program received 80 minutes of OT/PT therapy 5 times per week, while patients in the FIT program were provided with 80 minutes of therapy time 7 days per week and were encouraged to remain active outside of the structured sessions. Both groups had similar FIM scores on admission (80.9 for the conventional therapy group vs. 81.9 for the FIT group). At discharge the FIT group had higher FIM scores (97.1 vs. 105.0, $p<0.01$) and FIM efficiency scores (0.19 vs. 0.33). LOS was shorter for the FIT patients (72.9 vs. 81.1 days). Days from onset of the stroke to admission to rehabilitation were 54 days for the conventional group and 50 days for the FIT group. Additional weekend therapy resulted in significant improvements in FIM efficiency as well as a reduction in length of stay.

B5.3.4 Idle and Alone

Q3. On a rehabilitation unit, how much of a patient's time is spent in therapeutic or interactive activities?

Answer

1. Approximately 25% of their time or less.

Discussion

A number of studies have reported that the majority of a stroke patient's time on a stroke rehabilitation unit is spent idle and alone (Bernhardt et al. 2004, Wade et al. 1984, Lincoln et al. 1996, Keith and Cowell 1987). Lincoln et al. (1996) observed that patients on a stroke rehabilitation unit were engaged in interactive behaviours for only 25% of their time. DeWeerdt et al. (2000) used behavioural mapping to quantify the amount of time patients spent in therapeutic activities on two rehabilitation units, one in Belgium and the other in Switzerland. Patient in the rehabilitation unit in Belgium were engaged in rehabilitation for a longer percentage of the day than those in Switzerland (45% vs. 27%). DeWit et al. (2005) also observed significant differences in the amount of time patients spent in rehabilitation activities across four European countries (Belgium, UK, Switzerland and Germany). Patients from Germany spent a large percentage of the day in therapy time (23.4%) while those from the UK spent the least (10.1%). Therapy time ranged from one hour per day in the UK to about 3 hours per day in Switzerland. In all the centers, patients spent 72% of the time in non-therapeutic activities. The amount of time actually spent in therapy in Canadian rehabilitation units is highly variable and often inadequate (*Is there a citation to support this?)*

B5.3.5 The Impact of Therapist' Autonomy and Weak Accountabilities

Q4. What is the impact of allowing therapists the ability to dictate their own therapy schedules?

Answer

1. A increasing body of evidence suggests that allowing therapists to determine their own schedules as opposed to having their therapies regulated results in less direct therapy time with a subsequent worsening of outcomes.

Discussion

There is an emerging realization that the current Canadian practice of allowing therapists on stroke rehabilitation units to determine their own therapy times is not the most efficient way to practice and produces less than optimal outcomes. This may account for why American centers achieve FIM efficiency scores double that of Canadian centers.

In Europe, DeWit et al. (2007) authored the Collaborative Evaluation of Rehabilitation in Stroke Across Europe (CERISE) Trial. This study compared motor and functional recovery after stroke between 4 European Stroke Rehabilitation Centers. Gross motor and functional recovery was better in the Swiss and German than in the United Kingdom centers with the Belgian center somewhere in the middle. This correlated with more direct therapy per day in Swiss and German centers despite similar staffing. Time sampling studies showed average daily direct therapy time of 60 minutes in the U.K., 120 minutes in the Belgian, 140 minutes in the German and 166 minutes in the Swiss centers. As mentioned previously, difference in therapy time was not attributed to differences in patient/staff ratio. The proportion of time spent on direct patient care was highest for the German PT (66.1%) and OT (63.3%) and lowest for U.K. PT (45.9%) and OT (32.9%). Therapists in the U.K. center spent more than half of the time on non-therapeutic activities (administrative tasks, ward rounds, etc.). The key is that in the German and Swiss centers, the rehabilitation programs were strictly timed, while in the U.K. and Belgian centers they were organized on an *ad hoc* basis. No differences were found in the content of physiotherapy and occupational therapy. DeWit et al. (2007) noted that *"More formal management in the German center may have resulted in more therapy time for patients"*

B5.3.6 Benefits of Applying Best Evidence Regarding Rehabilitation Intensity

At present, therapy is not provided on weekends or holidays while fixed costs continue – the amount of therapy patients actually receive on a daily basis is remarkably small. On a well-staffed stroke rehabilitation unit, the core therapies of physiotherapy, occupational therapy and speech language pathology, the sharp end of the spear for stroke rehabilitation units, accounts for less than 20% of the costs of a stroke patient's inpatient rehabilitation stay . Stroke rehabilitation outcomes are very sensitive to the intensity with which these therapies are applied. Most of the costs of a stroke rehabilitation unit can be attributed to nursing, hoteling and administration costs which remain fixed and continue on a daily basis whether the patient is receiving therapy or not. Hence, a relatively small increase in the overall budget of a stroke rehabilitation unit, less than 10%, if directed towards enhancing the intensity of stroke rehabilitation, could increase therapy by 50%, allowing for weekend therapy and an overall increase in therapy intensity. For instance, providing weekend therapies could reduce hospital length of stay by each day weekend therapy is provided. Thus, with a 38-day length of rehabilitation stay there is the potential to reduce length of stay by 10 days with improved functional outcomes. There are also added benefits, e.g. therapy conducted when the family was more available, less depression and boredom, improved morale, a more consistent and continuous training effect (potentially), etc.

Standards need to be set for the amount of direct therapy time each patient receives to ensure that one hour of therapy is spent in face-to-face time with the patient. Rehabilitation therapies are relatively cheap while hospital stays are not. Increasing the intensity of rehabilitation therapies will reduce lengths of hospital stay, which is where the greatest expense lies, and where the greatest cost-savings are to be found (Table 9). Patients often complain about the lack of therapy and stimulation on weekends. Moreover, it would represent a shift toward more patient-driven care rather than the current provider-driven care. Undoubtedly, an increase in therapy intensity would require increased human resources an greater use of therapy aides, recreational therapists, volunteers etc. would have to be considered.

Summary
Although the exact of amount of therapy needed to optimize outcomes has yet to be determined, given the evidence, it seems prudent to provide therapies on a more intensive schedule. The beneficial effect may be greatest if high-intensity therapies are provided in the early stages of rehabilitation. One study has suggested that the addition of weekend treatment contributed to an almost doubling of FIM efficiency scores.

Therapist autonomy, as practiced on stroke rehabilitation units across Ontario, appears to result in less direct patient-therapy time, which in turn results in less efficient care and poorer outcomes. The problem is not necessarily one of therapist autonomy as it is lack of accountabilities for intensity of therapy rendered.

Rehabilitation is essentially a therapy delivery system with everything else, including doctors and nurses, functioning in more of a supportive role. Therefore, the delivery of high intensity, high quality therapy should be the priority of any stroke rehabilitation unit. In reality, the amount of therapy patients get is often inadequate because of a lack of prioritization of therapy on stroke rehabilitation units. Moreover, therapy is relatively inexpensive in comparison to the cost of inpatient care. This suggests the need for a greater priority in the provision of direct patient-therapy time.

B5.3.7 Durability of Rehabilitation Gains

Q5. Describe the durability of rehabilitation gains.

Answers
1. There is evidence that the greater functional improvements made on interdisciplinary stroke rehabilitation units are maintained over the long-term.

Discussion
Functional recovery (the ability to perform activities despite impairment) and improvement in communication may continue for months after neurological recovery is complete (Stineman and Granger 1998). Between 6 months and 3 years post stroke the average level of functional ability is maintained (Dombovy et al. 1987, Borucki et al. 1992). Beyond 3-5 years, slight decreases were noted, most likely related to the effects of increasing age and comorbidity (Stineman and Granger 1998). Therefore. in the absence of a new event, it has long been thought that stroke patients tend to maintain gains made in rehabilitation over the long-term.

6.5.1 Previous Reviews

Evans et al. (1995) reviewed 11 studies published between 1980 and 1993 that evaluated rehabilitation treatments, which included an untreated control group (Table 6.9). The outcomes of mortality, discharge location and functional ability were assessed. Three of the papers evaluated the rehabilitation of individuals with disabilities other than stoke. Their analysis revealed that treatment on a rehabilitation unit resulted in greater odds of survival, higher rates of discharge to home, higher rates of remaining at home at 8-12 month follow-up, and higher levels of functional ability at discharge. However, the difference in survival and functional independence had disappeared at the 12-month follow-up period, suggesting that many patients who are discharged from rehabilitation may deteriorate medically, physically, and functionally. Bagg (1998) was of the opinion that this finding accentuated the need to assess the effectiveness of outpatient and home- based therapies after discharge from inpatient rehabilitation programs, as well as the role of maintenance therapy for individuals with stroke requiring long-term institutionalization. This is discussed in greater detail in the last section on Community Reintegration.

Multidisciplinary Rehab vs. Medical Care and Durability of Rehab Gains (Evans et al. 1995)

Applegate et al. 1990*
Garraway et al. 1980a, 1980b
Indredavik et al. 1991
Kalra et al. 1993
Lefton et al. 1983*
Rubenstein et al. 1984*
Sivenius et al. 1985
Smith et al. 1982
Stevens et al. 1984
Strand et al. 1985
Wood-Dauphinee et al. 1984

* *includes non stroke geriatric patients*

Gresham et al. (1995) noted that studies examining long-term outcomes have reached mixed conclusions. Some studies found functional gains were maintained (Indredavik et al. 1991, Smith et al. 1981, Strand et al. 1985) while others did not (Garraway et al. 1980a, 1980b, 1981, Sivenius et al. 1985, Stevens et al. 1984 Sunderland et al. 1992, 1994, Wade et al. 1992).

All of these studies reported improvement in the functional outcome of stroke rehabilitation patients compared to the control group (general medical ward) anywhere between 12 months and 10 years following stroke. The relative benefit attributed to stroke rehabilitation appears to be very robust. However, the absolute gains achieved through stroke rehabilitation appear to be less robust. Stevens et al. (1984) found selective continued improvement from four to 12 months. In contrast, patients in the control group actually declined in function. Indredavik et al. (1997, 1999) reported a decline in scores associated with functional outcome between five and 10 years post stroke, although the Barthel Index scores of patients treated on the stroke unit were higher compared to control group patients. Davidoff et al. (1991) reported a significant improvement in ADL scores between rehabilitation discharge and one year. Leonard et al (1998) found that FIM scores improved for the first year and then plateaued, with a non-significant decline over the next four to five years. Berhardt et al. (2008) demonstrated that early mobilization during the first 2 weeks following stroke was associated with a good outcome at 12 months following stroke.

There is evidence that the greater functional improvements made on interdisciplinary stroke rehabilitation units are maintained over the long-term.

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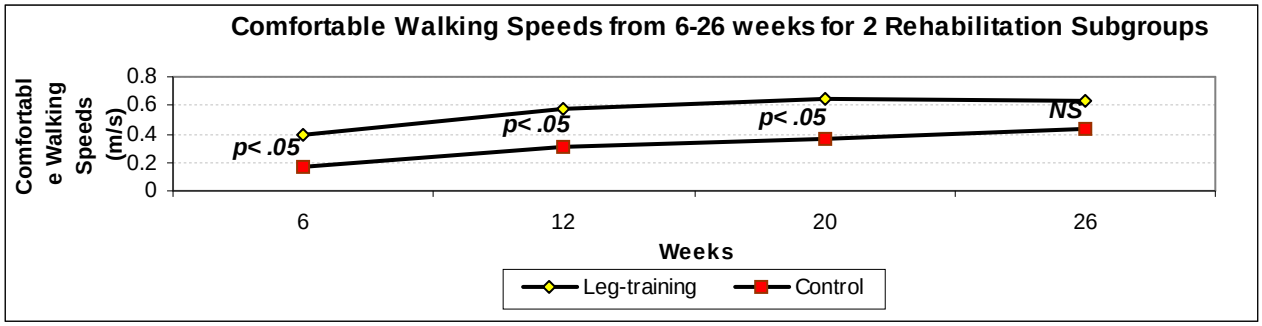
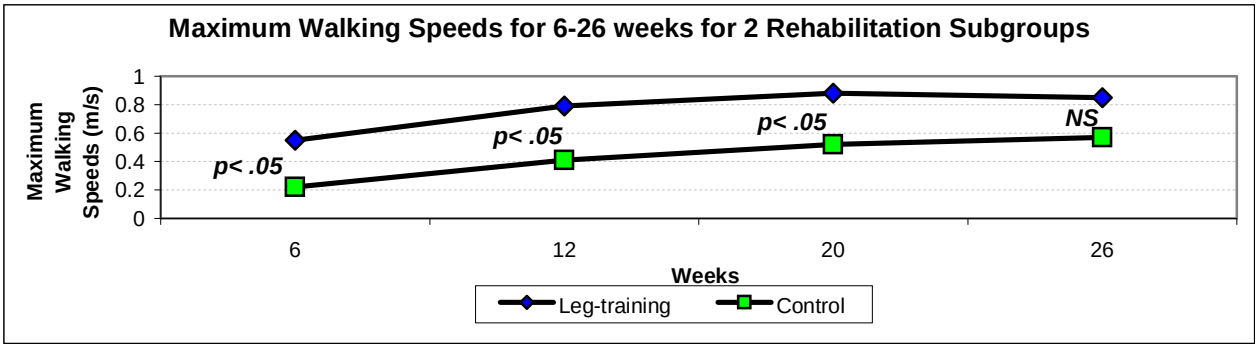
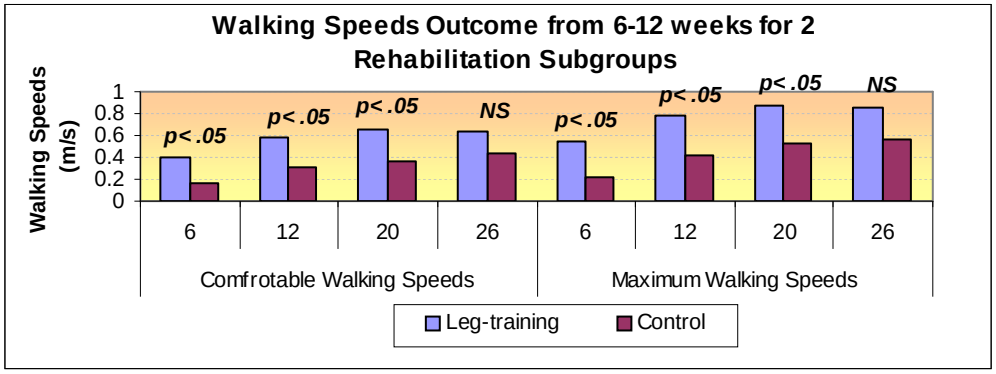
Key Study: Elements of Stroke Rehabilitation

Kwakkel G, Wagenaar RC, Twisk JW, Lankhorst GJ, Koetsier JC. Intensity of leg and arm training after primary middle-cerebral-artery stroke: a randomised trial. *Lancet 1999;354:191-196*.

Author / Year Country PEDro score	Methods	Outcome
Kwakkel et al. 1999 Netherlands 8 (RCT)	101 patients were randomized 14 days following stroke to receive one of 3 therapies: 1) arm training, 2) leg training or 3) basic rehabilitation only. Leg and arm treatments were applied for 30 min 5 days/week x 20 weeks. All patients received basic rehabilitation.	At week 26, significant differences in median Action Research arm (ARA) scores between the three groups were observed. Median Barthel Index and ARA scores of patients in both arm and leg training groups were significantly higher when compared to the control group.







Importance: This RCT showed the benefit of increased physiotherapy on walking speeds post-stroke. This benefit continued for 20 weeks becoming statistically non-significant not until 6 months had passed. Gains were maintained over time.

Relevant SREBR Conclusions: There is strong evidence that greater intensity of physiotherapy and occupational therapy results in improved functional outcomes. However, the overall beneficial effect was modest and the positive effects associated with greater intensities were not maintained over time.

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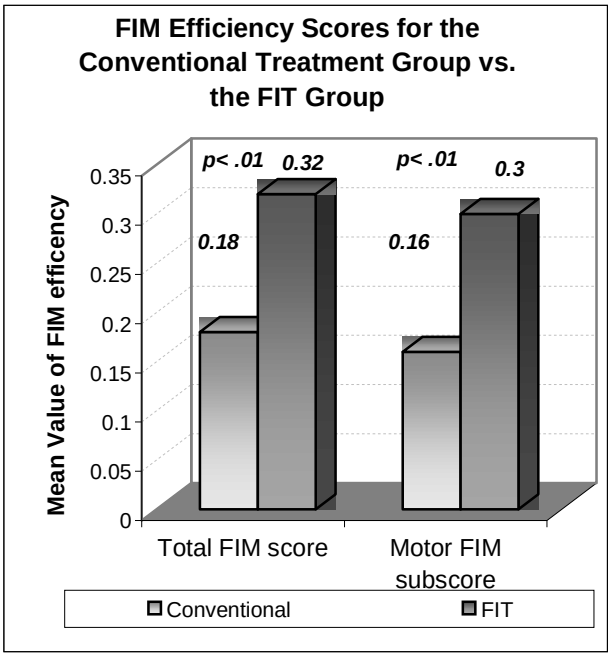
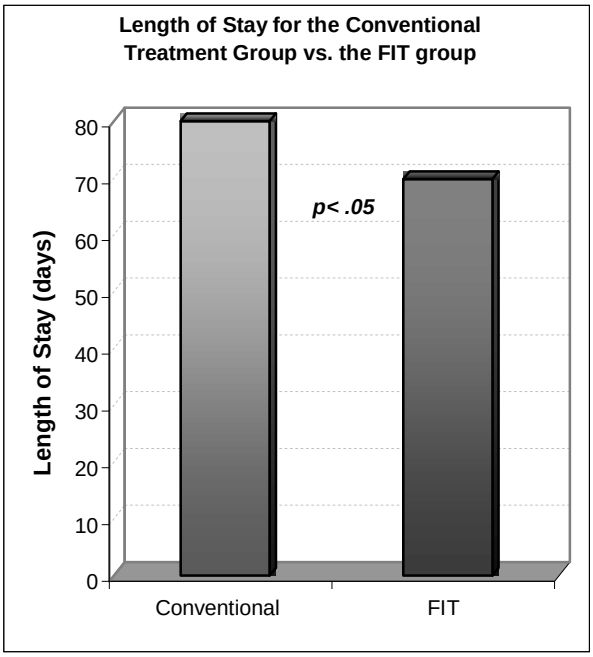
Key Study: Elements of Stroke Rehabilitation

Sonoda S, Saitoh E, Nagai S, Kawakita M, Kanada Y. Full-time integrated treatment program, a new system for stroke rehabilitation in Japan: comparison with conventional rehabilitation. *Am J Phys Med Rehabil. 2004;83(2):88-93*.

Author / Year Country PEDro score	Methods	Outcome
Sonoda et al. 2004 Japan No Score	Historical comparison of 48 stroke patients treated admitted to a conventional stroke rehabilitation program in Dec 1999, compared to 58 patients treated by the Full-time Integrated Treatment (FIT) program. The key difference between the 2 programs was the intensity and frequency of treatment (80 minutes of OT/PT therapy 5x/week vs. same daily total of therapy time, but provided 7x/week, although patients were encouraged to remain active outside of structured sessions).	Admission FIM scores between the 2 groups were similar (80.9, conventional vs. 81.2, FIT), however at discharge the FIT group had higher average FIM scores (97.1 vs. 105.0, p<0.01) and FIM efficiency, (change/LOS) (0.19 vs. 0.33, p<0.01). Hospital stays were also shorter for patients in the FIT group (72.9 vs. 81.1 days). The days of onset of stroke to admission into rehabilitation was 54 days for patients in the conventional group and 50 days for patients in the FIT group.



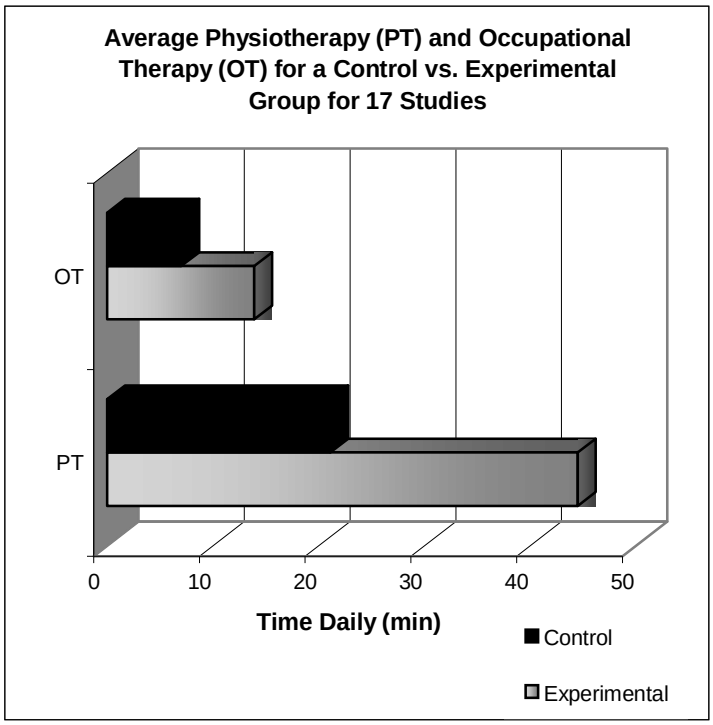


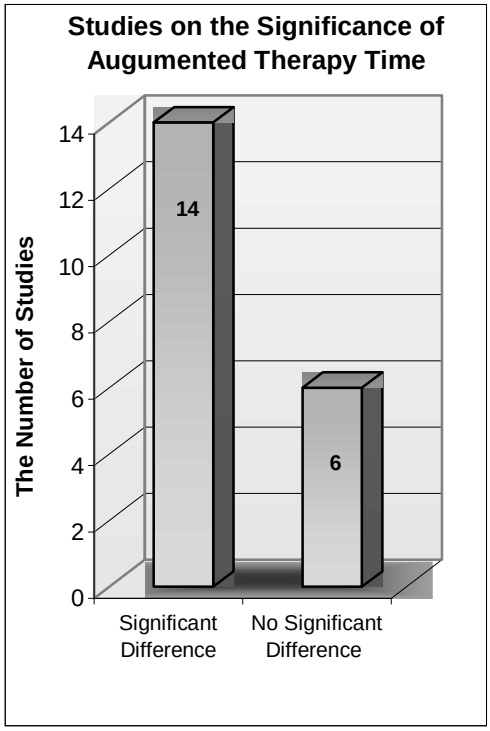
Importance: This comparative study demonstrated that additional weekend therapy results in significant improvements in FIM efficiency as well as a reduction in length of stay.

Key Study: Elements of Stroke Rehabilitation

Kwakkel G, van Peppen R, Wagenaar RC, et al. Effects of augmented exercise therapy time after stroke: a meta-analysis. *Stroke 2004;35:2529-2539.*

Author / Year Country PEDro score	Methods	Outcome
Kwakkel et al. 2004 USA No Score	A systematic review to study the effects of augmented exercise therapy time (AETT) on various stroke outcomes. Searched for candidate articles published between 1966 and 2003. Using a fixed and random effects model, effect sizes were computed for ADL, walking speed and dexterity.	Thirty-one studies met the inclusion criteria, of which 20 were used for analysis, establishing a sample of 2686 stroke patients. At end of intervention, a small heterogeneous summary effect size was established for ADL ($p<.05$). A homogeneous summary effect size ($p<.001$) was established when therapy occurred within the first 6 months after stroke but not thereafter. A significant homogeneous summary effect size was also noted for walking speed ($p=.017$), but not for dexterity.





Importance: This study is an extension of a previous meta-analysis, evaluating the benefit of augmented physical therapy, including 20 studies which had assessed many interventions: occupational (upper extremity), physiotherapy (lower extremity), leisure therapy, home care and sensorimotor training. After adjusting for differences in treatment intensity contrasts, augmented therapy was associated with statistically significant treatment effects for the outcomes of ADL and walking speeds, although not for upper extremity therapy.

Relevant SREBR Conclusions: There is strong evidence that greater intensity of physiotherapy and occupational therapy results in improved functional outcomes. However, the

overall beneficial effect is modest and the positive effects associated with greater intensities were not maintained over time.

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B6. The Importance of Task-Specific Training

B6. The Importance of Task-Specific Training

Q1. Describe the importance of task-specific training.

Answers

1. The best way to relearn a given task is to train specifically for that task.
2. Task-specific therapy allows for the best recovery.
3. NDT or the Bobath restorative approach results in longer lengths of stay and offers no advantage over other therapy.

Discussion

The best way to relearn a given task, if the ability to perform it is lost following a stroke, is to train specifically for that task. In animals, functional reorganization is greater for tasks, which are meaningful to the animal. Repetitive activity alone is not enough to produce increased motor cortical representations (Nudo et al. 2003). Instead, an element of skilled motor learning is required in addition to repetition for cortical reorganization/plasticity to occur. There is growing evidence that the cortex adjacent to the stroke-damaged region is important to recovery but only if stimulated and trained in the lost function (Hallet et al. 2001). Directed, task-specific therapy appears important to maximize recovery of lost function.

Proponents of task-specific training cite that intense training is not always necessary for positive outcomes in stroke patients, but instead suggest that therapy designed to be more task-specific within normal contact time (30 to 45 minutes per session) could be more efficacious (Page 2003). Hesse et al. (2003) notes that, *"Task-specific therapy can enable hemiplegic patients to practice walking repetitively, in contrast to conventional treatment in which tone-inhibiting manoeuvres and gait-preparatory tasks during sitting and standing dominate." (I can't find a ref for this quote)*

Clinically, repetition plays a major role in inducing and maintaining changes within the cortex. However, repetition of a task in the absence of new, meaningful skill learning is unlikely to induce cortical changes of significance. Less intense task-specific training regimens, of 30 to 45 minutes in length, with the more affected limb can produce cortical reorganization and associated meaningful functional improvements. This correlates well with clinical experience and the maxim "use it or lose it".

Several trials have evaluated task-specific therapies focusing on gait restoration. A pilot study by Richards et al. (1993) demonstrated that focused therapy on specific gait activities leads to positive outcome and not the amount of total therapy time. The results from the studies of both Dean et al. (2000) and Salbach et al. (2004) suggest that therapy designed to improve the strength and endurance of the affected lower limb and functional performance demonstrated improvement that was specific to the training. Monger et al. (2002) reported that six patients improved their sit-to-stand performance following a home-based, task-specific exercise program. Task-specific Interventions associated with neglect have been especially promising. Enhanced visual scanning techniques improve visual neglect with subsequent improvement in function (Weinberg et al. 1977, 1979, Paolucci et al. 1996).

In summary, task-specific therapy allows for the best recovery. NDT or the Bobath restorative approach results in longer lengths of stay and offers no advantage over other therapy approaches. Task-specific therapeutic approaches allow for the best recovery with improved FIM scores, improved discharge destination and shorter lengths of stay.

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B7. Outpatient Therapy

B7. Outpatient Therapy

Recommendation 5.4 Outpatient and Community Based Rehabilitation (Lindsay et al. 2008)

After leaving hospital, stroke survivors must have access to specialized stroke care and rehabilitation services appropriate to their needs (acute and/or inpatient rehabilitation) [Evidence Level A] (RCP).

i. Early supported discharge services and transition planning should be provided by a well-resourced, coordinated specialist interdisciplinary team with age-appropriate expertise. These are an acceptable alternative to extended in-hospital rehabilitation and can reduce the length of hospital stay for selected patients [Evidence Level A] (SIGN 64). Patients requiring early supported discharge services should not be referred to generic (nonspecific) community services [Evidence Level A] (RCP).

ii. People who have difficulty in activities of daily living, including self-care, productivity and leisure, should receive occupational therapy or multidisciplinary interventions targeting activities of daily living [Evidence Level A] (AU) [Evidence Level C for pediatrics].

iii. Multifactorial interventions provided in the community, including an individually prescribed exercise program, may be provided for people who are at risk of falling, in order to prevent or reduce the number and severity of falls [Evidence Level A] (AU).

iv. People with difficulties in mobility should be offered an exercise program and monitored throughout the program [Evidence Level B] (MacKay-Lyons and Howlett 2005, Pang et al. 2006).

v. Patients with aphasia should be taught supportive conversation techniques [Evidence Level A] (EBRSR).

vi. Patients with dysphagia should be offered swallowing therapy and opportunity for reassessment as required [Evidence Level A] (Singh and Hamdy 2006).

vii. Children affected by stroke should be offered advice on and treatment aimed at achieving play, self-care, leisure and school-related skills that are developmentally relevant and appropriate in their home, community and school environments [Evidence Level B] (Kirton et al. 2008, RCP-P).

Q1. Describe the importance of outpatient therapy.

Answers
Outpatient therapy allows for earlier discharge of stroke rehabilitation patients into the community. Outpatient stroke rehabilitation is relatively inexpensive:

1. The resources devoted to fund one inpatient stroke rehabilitation bed could fund a full stroke rehabilitation outpatient team (full-time physiotherapist and occupational therapist and half-time speech-language pathologist and social worker) for one year.
2. Patients are often kept in expensive inpatient stroke rehabilitation beds longer than is necessary because of a lack of outpatient therapy.
3. Skills developed in stroke rehabilitation are reinforced and maintained in outpatient therapy.

Discussion

Based on the results from three RCTs, there is strong evidence that additional **hospital-based outpatient therapy** improves short-term functional outcomes when compared to routine care over the short-term. However, the beneficial effects were not maintained over the long-term.

Based on the results from six RCTs, there is strong evidence that additional **home-based therapy** is not associated with improvement in overall functional outcome, as measured by the Barthel Index, when compared to routine care. However, consideration must be given to the low intensity of the interventions provided and the difficulty in detecting small, but clinically important changes in outcome when using the Barthel Index. Based on the results from 3 RCTs, there is conflicting evidence that home-based therapy for chronic stroke survivors is associated with improvements in mobility.

Based on the results from six RCTs, there is conflicting evidence of the superiority of **home-based versus hospital-based outpatient stroke rehabilitation therapy**. Positive outcomes were reported from study groups including both home-based and hospital-based therapy groups. There is limited evidence that hospital-based outpatient rehabilitation services are superior to home-based rehabilitation for frail elderly stroke patients. There is limited evidence that home-based rehabilitation is superior to hospital-based services for younger, severely involved stroke patients.

Outpatient therapy allows for maintenance of gains following stroke rehabilitation and improved community reintegration. Stroke rehabilitation outpatient therapy has been shown to improve outcomes and in particular help to maintain gains made in inpatient stroke rehabilitation. The benefits of outpatient therapy include the fact that the patient is more likely to remain at home through maintenance of gains and are more likely to be discharged home in a timely manner. An outpatient stroke rehabilitation program for severe strokes could significantly improve outcomes with many more patients able to return home and improve FIM scores over time. Outpatient therapy is an essential element of stroke care, yet it is often one of the first casualties of hospital cuts. In Canada, there are inadequate outpatient and community-based rehabilitation services for stroke patients. Unfortunately, this is a shortsighted strategy, which ultimately increases costly inpatient length of stay.

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Key Study: Elements of Stroke Rehabilitation

Gladman JR, Lincoln NB, Barer DH. A randomised controlled trial of domiciliary and hospital-based rehabilitation for stroke patients after discharge from hospital. *J Neurol Neurosurg Psychiatry 1993;56:960-966*.

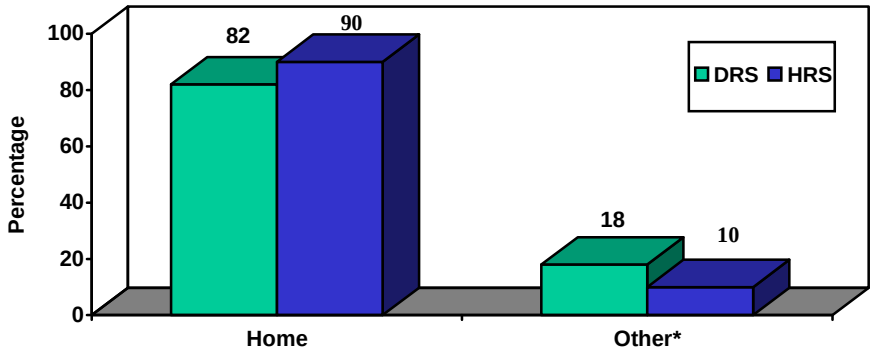
Gladman JR, Lincoln NB. Follow-up of a controlled trial of domiciliary stroke rehabilitation (DOMINO Study). *Age Ageing 1994;23:9-13.*

Author / Year Country PEDro score	Methods	Outcome
Gladman et al. 1993 UK 6 (RCT)	327 stroke patients were randomized to receive domiciliary service for up to 6 months or hospital-based rehabilitation services.	Domiciliary group showed significantly greater performance on Extended ADL household and leisure sub-scores at 6 months.
Gladman and Lincoln. 1994 UK 6 (RCT)	Follow up of 1993 study reporting outcomes between 6-months and one-year after discharge.	Relative risk of death or institutionalization in the domiciliary group was 1.6 after one year.

Gladman et al. 1993 (DOMINO Study Group) and Gladman and Lincoln 1994

At 6 months, there was no difference in the proportion of patients who were residing at home, in hospital, residential care, or who were dead. At one year, 11% of patients in the Domicillary Rehabilitation Services (DRS) group were in an institution compared to 8% in the Hospital Rehabilitation Services (HRS) group. There was a trend towards higher rates of death or institutionalization for the DRS group at one year (27% vs. 19%, p=ns).

Discharge Location of Patients at 6 Months



Other Designation combines:

(%)	DRS	HRS
In Hospital	2	1
Residential / nursing care	6	5
Dead	10	4

Importance: This RCT compared home-based stroke rehabilitation to hospital-based outpatient rehabilitation care. One-year follow-up revealed 3 interesting outcomes based on the site stroke

patients were transferred from. Those from a geriatric ward (elderly and frail) did best with hospital-based outpatient care, which in turn was 26% greater in terms of care. Those from the stroke unit (younger with more extensive CNS involvement) had better household and leisure activity scores at 6 months with home-based therapy, although costs were 2.6 times greater. The 3rd group, those from general medical wards (in between the other two groups described above) showed no difference but costs of hospital-based rehab was only 56% that of home-based rehab care.

Relevant SREBR Conclusions: There is conflicting evidence of the superiority of either home-based or hospital-based stroke rehabilitation. There is limited evidence that hospital-based outpatient rehabilitation services are superior to home-based rehabilitation for frail elderly stroke patients. There is limited evidence that home-based rehabilitation is superior to home-based services for younger more severely involved stroke patients.

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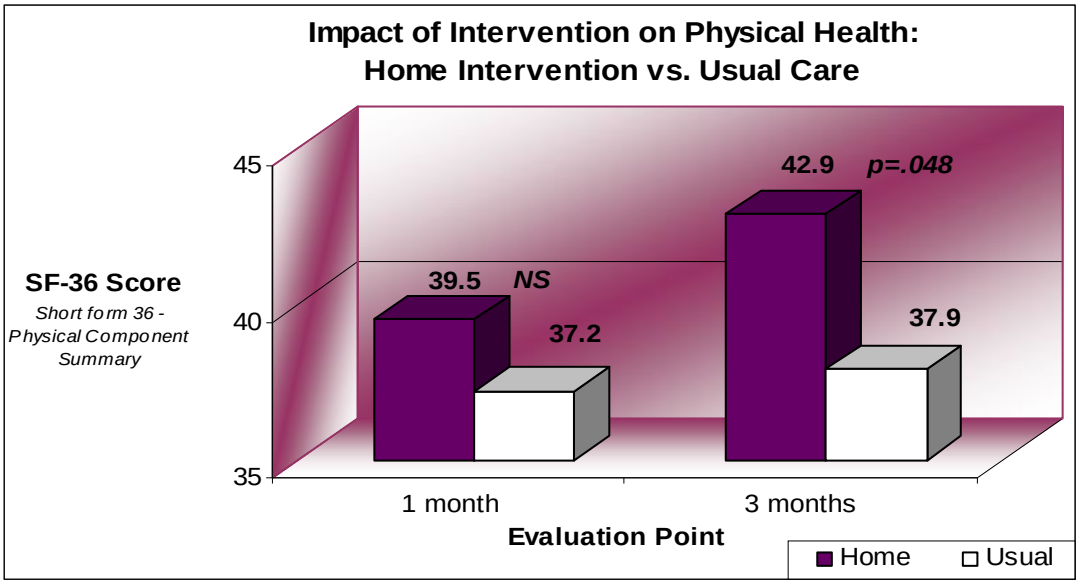
Key Study: Elements of Stroke Rehabilitation

Mayo NE, Wood-Dauphinee S, Cote R, Gayton D, Carlton J, Buttery J, Tamblyn R. There's no place like home: an evaluation of early supported discharge for stroke. *Stroke 2000;31:1016-1023.*

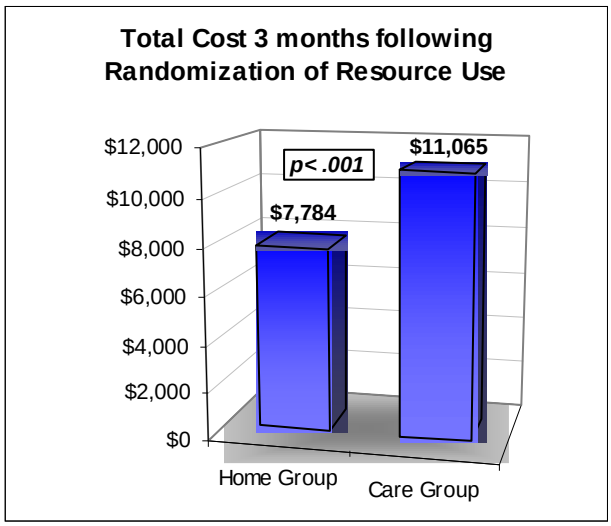
Teng J, Mayo NE, Latimer E, Hanley J, Wood-Dauphinee S, Cote R, Scott S. Costs and caregiver consequences of early supported discharge for stroke patients. Stroke. *2003;34(2):528-36.*

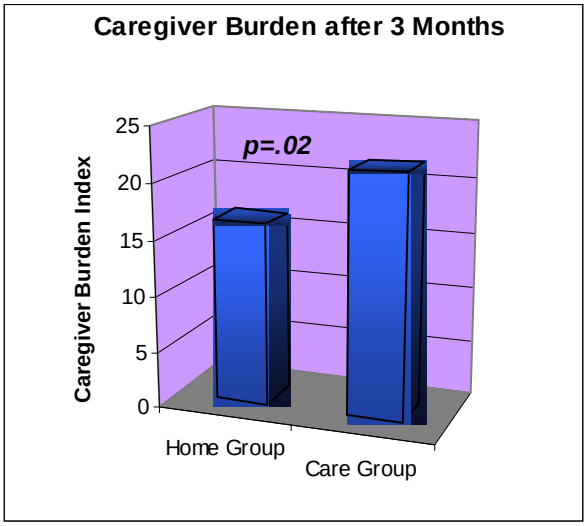
Author / Year Country PEDro score	Methods	Outcome
Mayo et al. 2000 Canada 7 (RCT)	114 of 1542 admitted stroke patients were randomized after discharge to receive either home intervention or usual post stroke care. Eligibility criteria included patients with persistent motor deficits post stroke with caregivers willing and able to provide live-in care over a 4- week period. At 28 days those stroke patients who still needed >1 assist to walk, or those with cognitive impairment or with disabling coexisting conditions were excluded. Barthel scores were approximately 84 on average.	Duration of hospital stay reduced by 2.6 days (9.8 vs. 12.4) in the home treatment group. Barthel score did not change significantly between the two groups. Home therapy group did better on SF-36 physical health component and a community reintegration score vs. usual care.
Teng et al. 2003 Canada 7 (RCT)	Cost and caregiver burden analysis from study by Mayo et al. (2000).	The total costs after 3 mos. associated with the home care group were significantly less compared to the usual care group ($7,784 vs. $11,065 Canadian, p<0.0001). Lower caregiver burden scores were associated with home intervention group.

Mayo et al. 2000



Teng et al. 2003





Importance: This RCT showed that early-supported discharge, the concept of discharging patients to their home early under the care of an interdisciplinary stroke rehab term, can successfully reduce days in hospital without change in functional outcome. In this study it was also found to reduce overall costs.

Relevant SREBR Conclusions: There is strong evidence that stroke patients with mild to moderate disability, discharged early from an acute hospital unit, can be rehabilitated in the community by an interdisciplinary stroke rehabilitation team and attain similar functional outcomes when compared to stroke patients receiving in-patient rehabilitation. However, there is conflicting evidence that the costs associated with early-supported discharge are lower when compared to usual care.

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B8. Classifying Outcomes Post-Stroke

B8. Classifying Outcomes Post-Stroke

Case Study

A 58 year old married woman is admitted to a stroke rehabilitation unit with a large right hemispheric stroke. As a consequence she presents with a left hemiplegia, left neglect and a left homonymous hemianopsia. She had trouble with swallowing and was initially put on a modified diet. She was initiated into a stroke rehabilitation program and continued for 6 weeks. During this time she was unable to ambulate but eventually progressed to the point where she was able to ambulate with one person assist and a quad cane. She required some assistance with her toilet transfers and getting in and out of bed. She was completely dependent for grooming, eating and dressing but by the end of rehabilitation was able to all of the above with set up only with the exception of pulling up her pants which required assistance. She required ongoing assistance with bathing. She was initially incontinent of bladder at night but on rehabilitation became fully continent. At the time of discharge she was able to manage a regular diet. Unfortunately, because of persistent neglect and left homonymous hemianopsia she was unable to drive and was unable to return to work. There were difficulties getting about her own home because it was a split level home with 4 step access and she had trouble getting out of the house because her spouse needed to continue to work.

Q1. Describe the revised World Health Organization Classification of Functioning and Disability.

Answers

1. **Body Function:** A loss of abnormality of body structure or of a physiological or psychological function (formerly referred to as Impairment).
2. **Activity:** The nature and extent of functioning at the level of the person (formerly referred to as Disability).
3. **Participation:** The nature and extent of a person's involvement in life situations (formerly referred to as Handicap).

Q2. Describe the impairments or bodily dysfunctions for this case.

Answer

1. Left hemiplegia.
2. Left neglect.

3. Left homonymous hemianopsia.
4. Dysphagia.

Q3. Describe the disabilities or activity limitations for this case.

Answer

1. Difficulty ambulating.
2. Difficulty with transfers on toilet or in and out of bed.
3. Difficulty with grooming.
4. Difficulty with eating.
5. Difficulty with bathing.

Q4. Describe the handicaps or participation limitations for this case.

Answer

1. Inability to drive.
2. Inability to work.
3. Difficulty accessing her home.
4. Difficulty socializing.

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