Abstract
The primary goals of stroke rehabilitation are to encourage and foster functional improvement and neurological recovery. Organised stroke care, processes of care, early timing of rehabilitation and high intensity of rehabilitation therapies are important factors which have been identified as promoting better overall outcomes for individuals with stroke. This chapter examines the evidence for those elements which have been proven to be important in the effectiveness of stroke rehabilitation.
Key Points

- Evidence suggests that the improvement in disability seen in stroke rehabilitation cannot be explained on the basis of natural recovery of the neurological impairment alone.

- Thus far, the evidence for the association between stroke type and long-term functional outcomes is conflicting and limited. Age and education level may play an important role in mediating functional recovery; however, more studies are needed to confirm this effect.

- The term 'stroke unit' is broad and describes hierarchal service organisation in stroke care along a continuum from more organised to less organised care.

- Individuals with stroke are more likely to survive, return home and regain independence if they received organised inpatient stroke unit care. Furthermore, patients treated on a stroke unit may have fewer medical complications.

- Many elements contribute to the success of stroke rehabilitation unit. Although improved outcomes have been reported among trials evaluating stroke units, no causal mechanism(s) has been identified and verified.

- It is unclear whether care pathways improve stroke rehabilitation outcomes. Furthermore, more research is needed to determine if care pathways reduce hospital costs or decrease length of hospital stay. Compliance with stroke rehabilitation guidelines however, may help improve outcomes.

- Early admission to stroke rehabilitation may be associated with improved functional outcomes; however, more research is needed to confirm these findings.

- Very early mobilization following stroke is complex; shorter, more frequent out-of-bed sessions improves outcomes while more prolonged periods of early mobilization results in worse.

- Greater intensities of physiotherapy and occupational therapy may result in improved functional outcome; the amount of increased therapy needed to result in an improved outcome is an additional 17 hours over 10 weeks.

- More intensive language therapy may be more beneficial at treating aphasia compared to less intensive therapy; however the evidence is limited and uncertain.

- Greater functional improvements made on interdisciplinary stroke rehabilitation units are maintained over the long-term.
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Abstract

Key Points

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6.1 Functional Improvements and Neurological Recovery

Spontaneous neurological recovery, as demonstrated by an improvement in impairment, is an important part of the recovery seen after a stroke. For instance, within 6 months post stroke, upper limb impairment resolves by fixed proportion. Fixed proportion states that 70% of each patient’s maximum possible neurological improvement in their motor impairment occurs regardless of the initial impairment (as measured by the Fugl-Meyer score or 3D-kinematics) but only for those with a relatively intact corticospinal (motor) tract function (Prabakaran et al. 2008). This holds true for patients across all ages and countries with different rehabilitation services (Byblow et al. 2015). Irreversible structural damage to the corticospinal tract severely limits motor recovery of the upper extremity.

Some authors have suggested that the majority of functional recovery after stroke is simply related to spontaneous natural recovery from neurological impairment (Dobkin 1989; Lind 1982). Proportional resolution of upper extremity impairment appears to be minimally affected by rehabilitation therapy. 3D kinematics in subacute and chronic stroke survivors have shown that motor recovery associated with rehabilitation is driven more by adaptive (or compensatory) learning strategies. The fact that specialized stroke rehabilitation units and greater intensities of rehabilitation (see later discussion) are associated with improved functional outcomes indicates that neurological recovery alone cannot account for the degree of functional improvements seen in stroke rehabilitation. Most clinical tests used in research (Action Reaction Arm Test (ARAT) or walking speed (6 minute walk test) only assess the patient’s ability to accomplish a certain task or function; they do not measure impairment. It appears that rehabilitation promotes largely and likely entirely, adaptive or compensatory motor recovery.

In terms of the expected time course of recovery following stroke, Yagura et al. (2003) suggested that functional recovery is thought to reach 80% of maximum by three months, 95%, by six months and 100% by 12 months.

In their assessment of the relationship between impairment and disability after a stroke, Roth et al. (1998) concluded that, “although stroke-related impairment and disability are significantly correlated with each other, reduced impairment level alone does not fully explain the reduced disability that occurs during rehabilitation. Even patients without substantial impairment reduction demonstrate disability reduction during rehabilitation, suggesting that rehabilitation has an independent role in improving function beyond that explained by neurological recovery alone.” Kwakkel et al. (2006) using a modified form of regression analysis estimated that time alone could explain between 16% and 42% of the observed improvement in many parameters of recovery during the first 6 to 10 weeks post stroke. However, the authors speculated that the effects of time on recovery were likely overestimated given that patients in the study also received therapeutic interventions.

Conclusions Regarding Functional Improvement and Neurological Recovery

Evidence suggests that the improvement in disability seen in stroke rehabilitation cannot be explained on the basis of natural recovery of the neurological impairment alone.

6.2 Hemorrhagic vs. Ischemic Stroke

Approximately 10% of all strokes are the result of intracerebral hemorrhage (ICH) (Kelly et al. 2003; Paolucci et al. 2003). The proportion of patients presenting with hemorrhagic stroke tends to be higher in Eastern European and Asian countries where the prevalence of untreated hypertension may be higher. (Kalra & Langhorne 2007). Although primary ICH has been associated with more severe
neurologic impairment and higher mortality in the acute phase (up to one half of patients with primary ICH die within the first month), it is generally believed that patients with ICH have a better recovery compared to patients with ischemic strokes.

Jørgensen et al. (1995) found that, after controlling for potential confounders stroke type (ischemic vs. hemorrhagic) did not influence mortality, the time course of neurological recovery, neurological outcome or the time course of recovery from disability. The apparent effect of poorer outcome among patients with hemorrhagic stroke was due to initial greater stroke severity. Andersen et al. (Andersen et al. 2009) also reported an initial increased risk of mortality associated with ICH, although the effect was time dependent, disappearing after 3 months. Using data from the Glycine Antagonist in Neuroprotection (GAIN) Americans, Chiu et al. (Chiu et al. 2010) also examined whether the poor long-term prognosis associated with hemorrhagic stroke could be explained by initial stroke severity. They reported that ICH was an independent predictor of poor neurologic outcome, nearly doubling the odds of long-term disability. However, ICH was not associated with higher mortality compared with ischemic stroke after adjusting for initial stroke severity and other baseline characteristics.

Paolucci et al. (2003) matched patients on the basis of initial stroke severity, age, sex and onset to admission time and reported that ICH patients had superior rehabilitation outcomes and demonstrated a higher therapeutic response on ADL. ICH patients had higher Canadian Neurological Scale scores, Rivermead Mobility scores as well as greater efficiencies in scores. Lengths of hospital stays were similar between the groups. The authors attribute the greater gains, relative to patients with ischemic strokes to better neurological recovery associated with resolving brain compression. Kelly et al. (2003) reported similar results. Although patients with ICH admitted to a rehabilitation hospital had significantly lower FIM scores compared to patients with ischemic stroke, there were no differences in discharge FIM scores between the groups. Patients with ICH had higher FIM change scores. The same pattern, whereby patients with ICH had lower admission FIM scores but gained the same number of FIM points was also reported by Katrak et al. (2009). Although initial disability did not significantly predict the amount of recovery during rehabilitation, initial stroke severity was a strong predictor of functional status at discharge. Lipson et al. (2005) also found no significant differences in discharge FIM scores between ICH and ischemic stroke patients; however, there was no difference in the mean FIM scores on admission despite the fact that ICH patients were admitted for rehabilitation significantly later compared with ischemic stroke patients.

Other associations between stroke types and functional recovery were recently investigated by Perna & Temple in an observational study (2015). A total of 284 chronic stroke participants were recruited, with 172 having experienced an ischaemic stroke, and 112 having experienced a hemorrhagic stroke. Results suggest that after 3 months of post-acute stroke rehabilitation, no significant difference between groups was found regarding the change in scores concerning adjustment, cognitive and physical abilities, participation and overall functioning. Over the course of the rehabilitation program, both groups demonstrated functional gains that resulted in improvements from mild-moderate limitations to mild limitations. One reason for the lack of difference between groups may have been the reasonably high level of education held by the participants and the young age of the participants (i.e. ischaemic mean age=56.08yr; hemorrhagic mean age=54.30yr). Furthermore, the authors suggested that the racial diversity of the participants recruited may have diluted the functional differences among the stroke patients. The study also only utilized a single outcome to measure functional status which may have biased the results towards this measure. Nonetheless, these findings suggest that both types of strokes benefit from post-acute rehabilitation.

Conclusions Regarding Hemorrhagic versus Ischemic Stroke
Thus far, the evidence for the association between stroke type and long-term functional outcomes is conflicting and limited. Age and education level may play an important role in mediating functional recovery however, more studies are needed to confirm this effect.

6.3 Elements of a Stroke Unit Associated with Improved Outcome

6.3.1 What Form of Stroke Unit is Best?
Specialized stroke rehabilitation units are associated with better outcomes, compared with mixed rehabilitation wards, general medicine, and mobile stroke teams:

The Stroke Unit Trialists’ Collaboration (SUTC) systematic review (2013) has described the hierarchical service organization in stroke care, moving along a continuum from more organised to less organised care:

1. Stroke ward:
Wards where a multidisciplinary team including specialist nursing staff based in a discrete ward cares exclusively for stroke patients. This category included the following subdivisions:

a) Acute stroke units
These units accept patients acutely but discharge early (usually within seven days). These units are further subcategorised into:

i) ‘intensive’ model of care with continuous monitoring, high nurse staffing levels and the potential for life support

ii) ‘semi-intensive’ with continuous monitoring high nurse staffing but no life support facilities

iii) ‘non-intensive’ with no high nurse staffing or life support facilities

b) Rehabilitation stroke units
Patients are accepted after a period of usually of five to seven days or more, and focus on rehabilitation.

c) Comprehensive (ie combined acute and rehabilitation)
These are stroke units that accept patients acutely but also provide rehabilitation for at least several weeks if necessary.

Both the rehabilitation unit and comprehensive unit models offer prolonged periods of rehabilitation.

2. Mixed rehabilitation ward: where a multidisciplinary team including specialist nursing staff in a ward provides a generic rehabilitation service but not exclusively caring for stroke patients.

3. Mobile stroke team: where a peripatetic multidisciplinary team (excluding specialist nursing staff) provides care in a variety of settings.

4. General medical ward: where care is provided in an acute medical or neurology ward without routine multidisciplinary input
The SUTC (2013) reported that more-organised care was consistently associated with improved outcomes, with decreased mortality, institutionalised care and dependency. Based on 21 trials, stroke unit care showed reductions in the odds of death recorded at final (median one year) follow-up (OR 0.87, 95% CI 0.69 to 0.94; P = 0.005), the odds of death or institutionalised care (OR 0.78, 95% CI 0.68 to 0.89; P = 0.0003) and the odds of death or dependency (OR 0.79, 95% CI 0.68 to 0.90; P = 0.0007) compared to care provided on a general medical ward.

Outcomes were independent of patient age, sex, initial stroke severity or stroke type, and appeared to be better in stroke units based in a discrete ward. There was no indication that organised stroke unit care resulted in a longer hospital stay.

Subgroup analyses in the SUTC (2013) indicate that the observed benefits of organised stroke unit care are not limited to any one models of stroke unit organisation that were examined. Comprehensive units and mixed assessment/ rehabilitation units, tended to be more effective than care in a general medical ward. There were also trends towards better outcomes within the dedicated stroke rehabilitation ward setting as opposed to the mixed rehabilitation ward, and within the acute (semi-intensive) ward as opposed to the comprehensive ward.

Foley et al (2007) compared three models of stroke care (acute, rehabilitation and comprehensive units) and found that all models stroke units were associated with significant reductions in mortality, combined death and dependency and length of stay. However not every model was associated with equal benefit (See Table 6.3.1.1)

<table>
<thead>
<tr>
<th>Models of stroke care</th>
<th>Mortality OR (95% CI)</th>
<th>Death/dependency OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute stroke care</td>
<td>0.80 (0.61-1.03)</td>
<td>0.70 (0.56-0.86)</td>
</tr>
<tr>
<td>Combined acute and rehabilitation</td>
<td>0.71 (0.54-0.94)</td>
<td>0.50 (0.39-0.65)</td>
</tr>
<tr>
<td>Post acute rehabilitation</td>
<td>0.60 (0.44-0.81)</td>
<td>0.63 (0.48-0.83)</td>
</tr>
<tr>
<td>Overall</td>
<td>0.71 (0.60-0.83)</td>
<td>0.62 (0.53-0.71)</td>
</tr>
</tbody>
</table>

Further analyses in the SUTC (2013) indicate that the observed benefits of organised stroke unit care are not limited to any of the subgroup of patients. Apparent benefits were seen in people of both sexes, aged under and over 75 years, with ischemic or hemorrhagic stroke and across a range of stroke severities.

Similarly, Langhorne et al (2013) noted that there whilst stroke unit care reduced death or dependency (RR 0.81; 95% CI:0.47–0.92; P=0.0009; I²=60%) there were no difference in benefits for stroke patients with intracerebral hemorrhage (RR, 0.79; 95% CI, 0.61–1.00) when compared to patients with ischemic stroke (RR, 0.82; 95% CI, 0.70–0.97; Pinteraction=0.77). Table 6.3.1.2 evaluates the differences between various rehabilitation models.

Table 6.3.1.2. Summary of studies evaluating different models of rehabilitation

<table>
<thead>
<tr>
<th>Study Type, PEDro Score</th>
<th>Sample Size</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fjaertoft et al. (2003)</td>
<td>RCT (8)</td>
<td>E: Stroke unit care with early supported discharge</td>
<td>• Modified Rankin Score (+)</td>
</tr>
<tr>
<td></td>
<td>NStart=320</td>
<td>C: Ordinary stroke unit services</td>
<td>• Barthel Index (-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Patients at home, institutionalized, deceased (-)</td>
</tr>
<tr>
<td>Study</td>
<td>Design</td>
<td>N_Start</td>
<td>N_End</td>
</tr>
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<td>-------------------------------</td>
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<tr>
<td>Chan et al. (2014)</td>
<td>RCT (7)</td>
<td>41</td>
<td>41</td>
</tr>
<tr>
<td>Claesson et al. (2000)</td>
<td>RCT (6)</td>
<td>249</td>
<td>249</td>
</tr>
<tr>
<td>Claesson et al. (2003)</td>
<td>RCT (6)</td>
<td>249</td>
<td>216</td>
</tr>
<tr>
<td>Sulter et al. (2003)</td>
<td>RCT (6)</td>
<td>54</td>
<td>54</td>
</tr>
<tr>
<td>Donnelly et al. (2004)</td>
<td>RCT (6)</td>
<td>113</td>
<td>97</td>
</tr>
<tr>
<td>Garraway et al. (1980)</td>
<td>RCT (5)</td>
<td>311</td>
<td></td>
</tr>
<tr>
<td>Smith et al. (1981)</td>
<td>RCT (5)</td>
<td>133</td>
<td></td>
</tr>
<tr>
<td>Sivenius et al. (1985)</td>
<td>RCT (5)</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>Kalra et al. (1994)</td>
<td>RCT (5)</td>
<td>146</td>
<td></td>
</tr>
<tr>
<td>Jorgenen et al. (1999)</td>
<td>Prospective</td>
<td>1241</td>
<td>1241</td>
</tr>
<tr>
<td>West et al. (2013)</td>
<td>Prospective</td>
<td>232</td>
<td>232</td>
</tr>
<tr>
<td>Di Carlo et al. (2011)</td>
<td>Retrospective</td>
<td>355</td>
<td></td>
</tr>
</tbody>
</table>

6. The Elements of Stroke Rehabilitation

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Both Fjaertoft et al. (2003) and Sulter et al. (2003) compared a conventional stroke unit to an extended stroke unit service or a stroke care monitoring unit respectively. Neither study reported a significant difference between groups concerning ADL performance according to the Barthel Index. However, independence as measured by the Modified Rankin Scale was found to be significant higher among those who received extended stroke unit care compared to conventional stroke care by Fjaertoft et al. (2003) but this was not replicated by Sulter et al. (2003). Although Fjaertoft et al. (2003) are unsure as to why the extended stroke unit service was efficacious in improving independence, they propose that inclusion soon after stroke onset, a sample population with greater functional impairment, and a large participant pool may have contributed. Conversely, Sulter et al. (2003) reported a significantly lower mortality rate among patients who received care in a stroke care monitoring unit compared to a conventional stroke unit while Fjaertoft et al. (2003) reported no differences. Monitoring patients for potential complications may have allowed for greater prevention and therefore fewer cases of mortality.

In comparing two differing models of care (acute care followed by rehabilitation vs acute-rehabilitation combined), Chan et al. (2014) did not report any significant differences on the FIM. Despite this, the authors highlight that as a proof-of-concept, this study revealed that an early comprehensive approach can provide effective and efficient care within one location. Although length of stay did not differ significantly between groups, patients in the comprehensive group experienced a mean of 5.28 days less in total which increased to 7.7 days for moderate stroke patients. In terms of FIM efficiency (FIM ÷ LOS) was found to be significantly higher in the comprehensive group. These findings suggest that early rehabilitation may prove to be more efficacious in achieving functional improvements and earlier discharge home (Chan et al. 2014). Future research is required to evaluate the cost of such a model.

Donnelly et al. (2004) did not report any significant differences in ADL performance, gait, or quality of life between community and hospital rehabilitation approaches at 1-year follow-up. The cost of the community program was non-significantly less, and as the program had limited staff, the authors suggest that increased capacity could lead to faster response times, higher savings in bed days, and lower care costs overall. At 1-year follow-up from their initial study, Claesson et al. (2003) revealed no significant long-term differences in re-admission rates, length of stay, and discharge destination between patients treated in a stroke unit or a general hospital ward. The authors suggest that management of cardiovascular diseases and risk factors has improved, and that knowledge of stroke care is improved in general with the development of stroke units. Further, a trend has been observed in previous research suggesting that stroke has become less severe within the Swedish population and so Claesson et al. (2003) suggest that this may have been reflected in their results.
6.4 What Elements of Care are Associated with Improved Outcomes?

Why specialized stroke unit care improves patient outcomes remains unclear. It is likely that the processes of care and the structures that support these processes contribute to their success; however, the issue is complex. In the case of stroke rehabilitation, the unit of study is broad and involves the examination of complex care delivery systems. Furthermore, comparisons of studies, which appear to provide similar interventions, can be quite different. Several features associated with organised stroke unit care have been identified to contribute to the better outcomes:

- Co-ordinated multidisciplinary staff
- Regularly scheduled meetings
- Routine involvement of carers
- Staff specialization
- Standardized and early assessments
- Better diagnostic procedures
- Early mobilization
- Prevention of complications
- Better application of "best-evidence"
- Attention to secondary prevention measures

Evans et al. (2001) suggested specific components of acute stroke care that might be associated with decreased mortality and dependence, including: thrombolysis, physiological homeostasis, anticoagulation among patients with atrial fibrillation, early aspirin use and early mobilization. Processes of care were evaluated between a dedicated stroke unit, which included both acute and rehabilitative services and less organized stroke team, located on a general medical ward. Within the first seven days of admission, patients on the stroke unit were more closely monitored neurologically. A greater percentage of patients received oxygen therapy, nasogastric feeding and measures to prevent aspiration.

Within the first four weeks of stroke, a greater percentage of stroke unit patients received a formal bedside swallowing assessment, a social work and occupational therapy assessment within 7 days, written evidence of rehabilitation goals and discharge/rehabilitation plans (Evans et al. 2001) (See Table 6.4.1). Although both groups were comprehensively assessed and investigated, greater attention was paid to evaluations of consciousness, swallowing and communication among patients treated on the stroke unit. Medical complications were more common among patients admitted to the general medical ward and appeared to be the factor most strongly associated with improved outcome among patients receiving care on the stroke unit. However, to what extent this factor and other unidentified factors contributed to the better outcome is unknown.

Table 6.4.1 Differences in the Processes of Care Between a Stroke Unit and a Stroke Team (A. Evans et al. 2001).

<table>
<thead>
<tr>
<th>Process of Care</th>
<th>Odds Ratio (95% CI) Associated with the Benefit of Stroke Unit Care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formal swallowing assessment with 72 hours</td>
<td>3.3 (2.0-5.4)</td>
</tr>
<tr>
<td>Occupational therapy assessment with 72 hours</td>
<td>2.4 (1.4-4.0)</td>
</tr>
<tr>
<td>Social work assessment within 72 hours</td>
<td>2.8 (1.1-6.9)</td>
</tr>
<tr>
<td>Attention to secondary prevention</td>
<td>2.0 (1.2-3.3)</td>
</tr>
<tr>
<td>Assessment of caregiver skill needs</td>
<td>11.3 (6.6-19.2)</td>
</tr>
<tr>
<td>Written rehabilitation goals</td>
<td>2.5 (1.3-4.8)</td>
</tr>
</tbody>
</table>
Indredavik et al. (1999) also found aggressive medical management including the use of intravenous saline solutions, oxygen therapy, heparin and Paracetamol to reduce fever was more frequent among patients managed on a stroke unit, compared to treatment received by patients on a general medical ward. Early mobilization was the most significant factor associated with discharge home at six weeks, although it remains unclear whether the benefit resulted from a decrease in medical complications such as deep vein thrombosis and pneumonia, or was due to positive psychological benefits. There were no differences in either the total mean hours of both occupational and physical therapy the groups received, which further highlights the intangible elements of a stroke unit that could account for the better outcomes.

In a retrospective study, Ang et al. (2003) reported that patients treated within the integrated stroke unit had a shorter LOS and better functional outcome. The authors speculated that the main reasons for the improved outcome was due to seamless nature of care since patients did not have to be physically transferred to a different facility or wait have to wait for a bed to become available, before intensive rehabilitation therapies could begin. However, the report contained insufficient detail of the interventions provided within the two groups to assess the differences in care processes, which may have been responsible for the observed differences.

Strasser et al. (2008) investigated the role of education within existing interdisciplinary rehabilitation units. A multiphase, staff training program compared training and information provision delivered over six-month period with information provision only. The group that received additional training discharged patients with a significantly greater gain in mean motor FIM score (+13.6). The authors speculated that “the intervention taught the necessary skills and provided a useful conceptual model to positively impact on team dynamics”.

Commenting on the changes in stroke care at an Auckland Hospital between 1996 (prior to the establishment of a stroke unit) and 2001, following the establishment of a mobile stroke team, Barber et al. (2004) reported that while there were changes in the processes of stroke care since the implementation of the new stroke services, that there had been no corresponding decrease in mortality (14% in 2001 vs. 17% in 1996). However, greater proportions of patients were treated with aspirin within 24 hours of admission, and were discharged on anticoagulation therapy. Only 24% of patients were kept nil by mouth for 24 hours, compared to 46% in 1996.

Rudd et al. (2005), using data from the 2001-2002 National Stroke Audit (including England, Wales and Northern Ireland) evaluated the organization, processes of care and outcomes for stroke. The authors found that better processes of care, were more frequently associated with stroke unit care and decreased the risk of death considerably. The risk of death for patients who received care on a stroke unit was estimated to be 75% that of the risk for those receiving treatment on a non-stroke unit.

While all of the above mentioned studies have focused on identifying the individual contributions of a variety of therapies or interventions, associated with a good outcome, Wade (2001) warns against the risk of committing a “type III error” (falsely rejecting the experimental hypothesis of the interactive effects of complex interventions are not considered), by pursuing such a course. He suggests that attempting to deconstruct the elements of specialized stroke rehabilitation therapies, in an effort to establish which isolated component(s) are effective may be flawed, by failing to recognise the interdisciplinary and complementary nature of the stroke rehabilitation. Ballinger et al. (1999) concluded that the types and duration of therapies provided by 13 physical and occupational therapists
at four rehabilitation facilities treating stroke patients were heterogeneous and varied between institutions and individuals.

It can be difficult to realize the same benefits associated with processes of care from clinical trials when they are translated into usual practice. As Kalra & Langhorne (2007) noted, “most stroke units evolve in response to local patients’ needs, priorities and service arrangements, which may not be replicated in other settings”.

One of the elements of stoke unit care that has been associated with improved outcome is the prevention of complications. Complications are known to be common following acute stroke. Indredavik et al. (2008) followed 489 acute stroke patients who were admitted to a comprehensive stroke unit and subsequently enrolled in an early supported discharge service. Despite the benefit of the best model of care, medical complications were still common. During the first seven days following stroke, 64% of patients experienced at least one complication. The most common complications were pain, elevated temperature, stroke progression and urinary tract infections. Increasing stroke severity, advancing age and female gender were the strongest predictors of complications.

Sorbello et al. (2009) also reported a high frequency of medical complications during the acute period following stroke, with or without early mobilization. 82% of patients experienced at least one complication, the most common being falls and urinary tract infections. These findings suggest that some complications experienced following stroke are difficult or impossible to prevent. Furthermore, it suggests that complications may not impact on stroke outcome as much as previously believed. In contrast to this finding, Govan et al. (2007), using a subset of data from the SUTC, found that patients receiving specialized stroke care had a lower incidence of chest infections, other infections and pressure sores. The prevention and treatment of complications was believed to be a contributing factor in improved outcomes.

Kinoshita et al. (2015) revealed a significant association between patients who received early rehabilitation from a board-certified physiatrist (BCP) and FIM effectiveness ([discharge FIM – admission FIM]/[maximum FIM – admission FIM]). A significant association was also reported with FIM Motor subscale effectiveness. Further, a logistic regression revealed that receiving care from a BCP was also a significant predictor for patients to be discharged home. A subgroup analysis showed that the involvement of a BCP was a significant factors for FIM effectiveness in patients with an admission FIM score of ≥53. Although the study did not specifically look at the reasons as to why rehabilitation lead by a BCP would be efficacious, Kinoshita et al. (2015) note that the duration of daily exercise was longer and regular meetings were significantly more frequent compared to patients who did received rehabilitation from non-BCP specialists. The authors also speculate that BCPs may have been better able to coordinate a multidisciplinary rehabilitation team. However, as there was no data after discharge from hospital it is unclear whether these gains were maintained in the long-term.

While it is tempting to try to reduce the gains that patients achieve while on stroke rehabilitation units to the sum of their parts, Whyte and Hart (2003) identified some factors which contribute to the difficulties encountered in attempting to unveil the effective elements of stroke rehabilitation:

- The broad range of treatments provided, as well as the poor definitions of treatments often described in published reports, means that reproducibility and dissemination of proven therapies may be difficult.
The intensities of treatments provided and the composition of therapy can vary across studies, even when evaluating similar therapies.

The importance of patient participation, motivation and engagement is difficult to capture and can influence the result, again, when other factors may be constant between studies.

Variations between individual therapists can occur as therapists respond to the responses and cues from patients they are treating. This effect can also result in subtle differences between like therapies and affect the study result.

The therapist effect which refers to “non-specific treatment effects brought about by the therapists’ personality, verbal communication skill or degree of warmth and empathy.”

**Conclusions Regarding the Components of Stroke Units Which Contributes to Improved Outcomes**

The term 'stroke unit' is broad and describes hierarchal service organisation in stroke care along a continuum from more organised to less organised care.

**The element of care** is broad and describes hierarchal service organisation in stroke care along a continuum from more organised to less organised care.

Individuals with stroke are more likely to survive, return home and regain independence if they received organised inpatient stroke unit care. Furthermore, patients treated on a stroke unit may have fewer medical complications.

Many elements contribute to the success of stroke rehabilitation unit. Although improved outcomes have been reported among trials evaluating stroke units, no causal mechanism(s) has been identified and verified.

**6.5 Impact of Care Pathways and Guidelines**

Integrated Care Pathways (ICP) has 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 national guidelines to a local setting. In some centres, ICPs have been developed to reduce lengths of hospital stay in an effort to reduce costs. ICPs can also be 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 and 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. See Table 6.5.1 for a summary of studies evaluating the impact of care pathways on stroke outcomes.
Table 6.5.1 Summary of Studies Evaluating the Impact of Care Pathways

<table>
<thead>
<tr>
<th>Author, Year Study Type, PEDro Score Sample Size</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
</table>
| **Middleton et al. (2011)** RCT (8) N=19       | E: Care in an acute stroke unit following standard treatment protocols C: Care in an acute stroke unit following an abridged version of the guidelines | • Death/dependence (90d) (+)  
• SF-36: physical component (+), mental component (-)  
• Barthel Index (-)  
• 30d Mortality (-) |
| **Sulch et al. (2000; 2002)** RCT (6) N=152    | E: Integrated Care pathway (based on evidence based practice) C: conventional multidisciplinary care | • Quality of life (6mo) (+)  
• Mortality rate (-)  
• Frequency of institutionalization (-)  
• LOS (-) |
| **Panella et al. (2012)** RCT (6) N=14 hospitals | E: Clinical pathway C: Usual care pathway | • Risk of mortality at 7d (+)  
• 30d Mortality (-)  
• LOS (-)  
• Dependency levels (-)  
• Readmission/institutionalization (-) |
| **Falconer et al. (1993)** RCT (5) N=212       | E: Critical Path Method of care C: Usual care method (Multidisciplinary rehab team) | • Motor function (-)  
• Cognitive function (-)  
• LOS (-) |
| **Hamrin et al. (1990)** RCT (4) N=280         | E: Managed according to Systematized care procedures C: Managed according to conventional care | • Functional outcomes (-) |
| **Brusco et al. (2015)** PCT NStart=996 NEnd=996 | E: Monday-Saturday rehab C: Monday-Friday rehab | • FIM (6mo) (+), (12mo) (-)  
• Quality of life (12mo) (-) |

An updated Cochrane review (Kwan & Sandercock 2009) which included 3 randomized and 12 non-randomized trials, reported no significant difference between care pathway and control groups in terms of death or alter the eventual discharge destination. In fact, patients managed with a care pathway were more likely to be dependent at discharge (P =0.04); less likely to suffer a urinary tract infection [(OR 0.51, 95% (CI) 0.34 to 0.79), less likely to be readmitted (OR 0.11, 95% CI 0.03 to 0.39); and more likely to have neuroimaging (OR 2.42, 95% CI 1.12 to 5.25). Evidence from randomised trials suggested that patients’ satisfaction and quality of life were significantly lower in the care pathway group (P = 0.02 and P < 0.005 respectively).

This finding was confirmed by Hoeing et al. (2002) who found the structure of care (systematic organization, staffing expertise and technological sophistication) was not 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.

In contrast, a more recent cluster-randomized controlled trial (Panella et al. 2012) reported that an evidence-based care pathway that was developed with the input from a multidisciplinary team resulted in a reduction in the odds of 7-day mortality, and increased the odds of return to pre-stroke function. Another cluster randomized controlled trial (Middleton et al. 2011) demonstrated that patients who
were allocated to a stroke unit with standardized evidence-based nursing protocols designed to improve the management of dysphagia, hyperglycemia and fever had better outcomes compared to patients who were randomized to a stroke unit without similar protocol.

Sulch et al. (2002; 2000) 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).

Although intuitively care pathways should improve the quality of stroke care, the evidence does not support this conclusion. 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 patient satisfaction and quality of life.

In contrast, there appears to be strong evidence that adherence to clinical guidelines, which involves application of evidence-based practices at an individual patient level, does improve outcomes. Despite this observation, rehabilitation guidelines are as

It is important to understand however, that the quality of the guideline

**Conclusions Regarding the Impact of Care Pathways**

*There is conflicting evidence as to whether stroke care pathway improve rehabilitation outcomes.*

It is unclear whether care pathways improve stroke rehabilitation outcomes. Furthermore, more research is needed to determine if care pathways reduce hospital costs or decrease length of hospital stay. Compliance with stroke rehabilitation guidelines however, may help improve outcomes.

6.6 Timing of Stroke Rehabilitation

**6.6.1 Early Admission to Rehabilitation**

Animal studies suggest that there is a time window when the brain is “primed” for maximal response to rehabilitation therapies, such that any delays are detrimental to recovery (Biernaskie et al. 2004). The brain appears to be “primed” to “recover” early in post stroke period. The results of several studies (Feigenson et al. 1977; Hayes & Carroll 1986; Wertz 1990) have suggested stroke rehabilitation should be initiated soon after stroke to achieve optimal results. 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. 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. 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.

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).

This review summarized the results of several studies that have attempted to discern the effects of early admission on rehabilitation outcomes (See table 6.6.1).

**Table 6.6.1 Summary of Studies Evaluating Timing of Stroke Rehabilitation**

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Type, PEDro Score</th>
<th>Sample Size</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bernhardt et al. (2008)</td>
<td>RCT (8)</td>
<td>NStart=71, NEnd=71</td>
<td>E: Very Early Mobilization, C: Standard Care</td>
<td>Mobilization (+), Good outcomes (3 &amp; 6mo) (-), (12mo) (+), Mortality (-), Serious adverse events (3mo) (-), Non-serious adverse events (-), Total number of falls (-), Deterioration (-), Excessive fatigue (-), Modified Rankin Score (-), Number of severity of complications (-)</td>
</tr>
<tr>
<td>Sorbello et al. (2009)</td>
<td>RCT (8)</td>
<td>NStart=71, NEnd=71</td>
<td>E: Very Early Mobilization, C: Standard Care</td>
<td>Mobilization (+), Good outcomes (3 &amp; 6mo) (-), (12mo) (+), Mortality (-), Serious adverse events (3mo) (-), Non-serious adverse events (-), Total number of falls (-), Deterioration (-), Excessive fatigue (-), Modified Rankin Score (-), Number of severity of complications (-)</td>
</tr>
<tr>
<td>Langhorne et al. (2010)</td>
<td>RCT (7)</td>
<td>N=32</td>
<td>E1: Early Mobilization (EM) (within 24hr), E2: Automated physiological monitoring (AM), E3: Combined EM + AM, C: standard stroke unit care</td>
<td>Medical complications E1 vs. C (within 5d of stroke) (+), (3mo) (-)</td>
</tr>
<tr>
<td>Cumming et al. (2011)</td>
<td>RCT (7)</td>
<td>N=32</td>
<td>E: Very Early Mobilization, C: Standard Care</td>
<td>Walking sooner (+), Barthel Index (3mo) (+), (12mo) (-), Rivermead Motor Assessment Scale: (3mo &amp; 12mo) (+)</td>
</tr>
<tr>
<td>Diserens et al. (2012)</td>
<td>RCT (7)</td>
<td>N=32</td>
<td>E: Early mobilization (after 52hr), C: Mobilization (after 7d)</td>
<td>Severe complications (+), Minor complications (-), Blood Flow (-)</td>
</tr>
<tr>
<td>Sundseth et al. (2012)</td>
<td>RCT (7)</td>
<td>N=65</td>
<td>E: Very Early Mobilization (within 24hr), C: Control mobilization (between 24hr and 48hr)</td>
<td>Poor outcome (-), Mortality (-), Dependency (-)</td>
</tr>
<tr>
<td>Bai et al. (2014)</td>
<td>RCT (6)</td>
<td>NStart=165, NEnd=154</td>
<td>E: Standardized 3-stage rehabilitation (began therapy within 24hr of admission), C: Standard hospital ward/Internal</td>
<td>Modified Ashworth Scale: fingers plantar flexors (3mos) (+); elbows, fingers, plantar flexors (6mos) (+)</td>
</tr>
</tbody>
</table>
Although there is a strong correlation between early admission to stroke rehabilitation and improved functional outcomes, demonstrated in both individual studies and based on the results of meta-analysis, this relationship may not be one of cause and effect. Patients with severe strokes (and higher levels of impairment) are also more likely to experience medical complications, or be too impaired to participate in rehabilitation that may delay their admission to a stroke rehabilitation unit. In contrast, mild to moderate stroke patients with fewer medical complicating factors are more likely to be admitted sooner than later to a stroke rehab unit. The results from the individual studies are difficult to compare owing to the variations in the cohorts. The studies authored by Paolucci et al. (2000) and Gagnon et al. (2006) were similar with respect to their categorization of time from stroke onset, although the results were conflicting. Patients in the early onset cohort showed a greater rate of recovery in one study (Paolucci et al. 2000), but not in the other (Gagnon et al. 2006).

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.

Overall, there is a clinical association between early admission to rehabilitation and better functional outcomes (Paolucci et al. 2000; Salter et al. 2006; Bai et al. 2012). The effects of training after stroke are generally greater when started early after stroke, perhaps because of a “sensitive period” of enhanced neuroplasticity.

### 6.6.2 Very Early Admission to Rehabilitation

Given that early admission to stroke rehabilitation appears to result in better outcomes, the AVERT trial was a large randomized controlled trial examining the benefit of very early mobilization of stroke patients initiated within the first 24 hours of the stroke. The AVERT trial initially produced 3 publications examining the early findings of the study (Bernhardt et al. 2008; Sorbello et al. 2009; Cumming et al. 2011). In the first presentation of results, there were no reported differences between the early mobilization and conventional groups in death or the number and severity of complications at 3 months. The authors attributed the lack of statistically significant between study groups to a small sample size. In the second publication, (Sorbello et al. 2009), there was no reported difference between groups in the
frequency of medical complications between groups. Finally, in a last publication, Cumming et al. (Cumming et al. 2011), reported that patients randomized to the early group were able to walk 50 meters unassisted, sooner were discharged from hospital slightly earlier (median 6 vs. 7 days) and a greater percentage were discharged home (32% vs. 24%).

Additional results from AVERT phase II showed that the early mobilization protocol resulted in delivery of more and earlier therapy (van Wijk et al. 2012). Schedule (hours to first mobilization, dose per day, frequency and session duration) and nature (percentage out-of-bed activity) of therapy differed significantly between the VEM and standard care (SC) groups. Mobilization was earlier, happened on average 3 times per day in those receiving VEM, with the higher median proportion of out-of-bed activity in VEM session (85.5%) compared to median 42.5% in the standard care (van Wijk et al. 2012). In addition to VEM being effective in improving mobility and independence, economic evaluation suggested that VEM is potentially cost effective (Tay-Teo et al. 2008). Patients receiving VEM incurred significantly less costs at 3 months compared to standard care; and the difference in mean per patient total cost persisted at the 12-month assessment (Tay-Teo et al. 2008).

The benefit of early mobilization was also investigated in an observer-blinded, pilot randomised controlled trial studying the key aspects of early stroke unit care. In the Very Early Rehabilitation or Intensive Telemetry After Stroke [VERITAS], early mobilization and intensive monitoring was incorporated within a 2x2 factorial study design (Langhorne et al. 2010). The early mobilization intervention arm utilized protocol based on the AVERT trial with respect to the timing, nature, and frequency of the intervention (Langhorne et al. 2010). Degree of mobilization activity, defined as the mean time spent upright per working day, was 61 (SD, 54) minutes in the early mobilization group compared with 42 (SD, 57) minutes with standard care. By Day 5, 74% of patients in the early mobilization group were independent in walking, compared to 44% of patients with standard care. There was also a trend to more patients on the early mobilization protocol being independent at 3 months (Langhorne et al. 2010). Although there was no difference in good outcome at 3 months (defined as modified Rankin Scale score of 0-2) between groups, the odds of medical complications were lower among subjects in the early mobilization group (OR 0.1, 95% CI: 0.001 to 0.9, p=0.04), after adjusting for age and severity of stroke.

Pooling of individual patients’ data from some of the initial AVERT research and VERITAS showed that time to first mobilization from symptom onset was significantly shorter among VEM patients (median, 21 hours; IQR: 15.8-27.8 hours) compared with standard care patients (median, 31 hours; IQR: 23.0-41.2 hours) (Craig et al. 2010). VEM patients had significantly greater odds of independence at 3 months compared with standard care patients (adjusted OR, 3.11; 95%CI 1.03-9.33) (Craig et al. 2010).

Diserens et al. (2012) also investigated whether early mobilization was safe and effective in preventing serious complications. While patients in the early group had a lower occurrence of severe complications the sample size was small and there were loses in the standard care group. Comparisons with other studies of early mobilization are difficult to make since the criteria used to define “early” were different. In contrast, Sundseth et al. (2012) provided very clear criteria for defining VEM. A large number of drop-outs, particularly in the VEM group, resulted in a non-significant trend towards a reduction in poor outcome for VEM patients.

The impact of timing to rehabilitation on overall functional outcome was not limited to patients transferred from acute care to rehabilitation. Early initiation of rehabilitation predicted better functional outcome on patients with severe strokes in a stroke intensive care unit with a multidisciplinary stroke care team (Hu et al. 2010). After adjusting for stroke severity and age, patients who started earlier
rehabilitation had higher Barthel Index scores at discharge. Commencing rehabilitation one day earlier in the stroke ICU resulted in an increase of the Barthel Index score by 0.65 points (Hu et al. 2010).

There is increasing evidence that early mobilization, however it is defined, is not associated with negative effects and may be better for patients compared with delayed mobilization.

With all the evidence seemingly supporting very early rehabilitation, the results of the AVERT trial came as a surprise. This 56 site international RCT was conducted over 8 years. 2104 patients less than 24 hours post stroke were randomly assigned to standard care (SC) (n=1050) or SC + Very Early Mobilization (VEM) (n=1054) until discharge or 14 days, whichever came first. The VEM group started earlier (18.5 hours versus 22.4 hours post stroke), received more out of bed sessions (6.5 vs. 3.0) and received more therapy (31 minutes/day; total of 201 minutes versus 10 minutes/day; total 70 minutes). More patients in the standard care (SC) group (n=525) than VEM (n=480) (p=.001) had a favourable outcome (modified Rankin Scale (0-2) at 3 months post stroke) (The AVERT Trial Collaboration Group 2015). Later analysis by Bernhardt et al. (2016) found an improved odds of favourable outcome with increased daily frequency of out-of-bed sessions. Overall, shorter more frequent early mobilization improved the chance of regaining independence; higher doses of long-term mobilization worsened outcome (Bernhardt et al. 2016).

**Conclusion Regarding the Timing of Stroke Rehabilitation**

**There is level 1a evidence that earlier admission to rehabilitation results in improved overall functional outcomes.**

**There is level 1a evidence that very early mobilization (VEM) post stroke (within the first 24 hours) results in improved outcomes when there are more frequent short in duration out-of-bed sessions and that VEM results in poorer outcomes when early mobilization session are more prolonged.**

**Early admission to stroke rehabilitation is associated with improved functional outcomes, however more research is needed to confirm these findings.**

**Very early mobilization following stroke is complex; shorter, more frequent out-of-bed sessions improves outcomes while more prolonged periods of early mobilization results in worse outcomes.**

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### 6.7 Intensity of Therapy

#### 6.7.1 Intensity of Physical and Occupational Therapy

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”.

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Overall greater intensity of therapy practice results in better outcomes. Research with animals that have shown the benefit of increased intensity of therapies have involved thousands of repetitions. Lang et al. (2007) found that in monitoring occupational therapists involved in inpatient stroke rehabilitation noted that task-specific, functional upper extremity movements occurred in about half the upper extremity rehabilitation sessions; the average number of upper extremity repetitions was only 32, a fraction of the thousands of repetitions seen in animal research. Van Peppen et al. (2004) noted additional therapy time of 17 hours over 10 weeks was necessary to see the positive effects from the increased intensity of therapy. This was affirmed by Verbeek et al. (2014). The Canadian Stroke Guidelines recommend that stroke rehabilitation patients should receive a minimum of three hours of direct task-specific therapy, five days per week delivered by an interprofessional team. A number of innovative approaches have been initiated in an attempt to increase intensity including group therapy (Renner et al. 2016), non-immersive virtual reality (gaming) and altering the therapy skill mix, taking advantage of less expensive alternatives to increase the overall intensity of therapy.

Definition of Intensity
The definition of intensity or 'dosage' has been an unresolved issue in studies investigating the dose-response relationship in rehabilitation therapies (Kwakkel 2006). Restrictions in measuring energy expenditure as a measure of activity intensity have resulted in estimates of therapy intensity in rehabilitation, measures such as the number of repetitions (frequency), the overall time spent in therapy or frequency of treatment sessions (Kwakkel 2006).

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.

The American Congress of Rehabilitation Medicine Stroke Movement Interventions Subcommittee have recommended operational definitions for concepts that are common in stroke motor rehabilitation (Page et al. 2012). The recommendations focused on those terms regarded as often mislabelled, terms such as intensity and dosing (duration and frequency). The recommended definition for intensity is "the amount of physical or mental work put forth by the client during a particular movement or series of movements, exercise or activity during a defined period of time" (Page et al. 2012). Duration is defined as "length of time during which a single session is administered" and frequency is defined as "how often during a fixed period the regimen is administered" (Page et al. 2012). In addition, the delivery method and window of therapy have been identified as areas for further refinement (Page et al. 2012).

Amount of Time Spent in Rehabilitation Therapies
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. (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 units, patients spent 72% of their time in non-therapeutic activities.

Even more discouraging are the results from A Very Early Rehabilitation Trial (AVERT) (Bernhardt et al. 2007; Bernhardt et al. 2004) 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 comparison between Australian patients and those in Norway (Bernhardt, Chitravas, et al. 2008) revealed that patients admitted to acute stroke units in Trondheim 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.

**Randomized Controlled Studies Examining Intensity of Therapies**

Many trials have evaluated the efficacy of increased intensity of therapy and the relationship to improved functional outcomes. The results are presented in Table 6.7.1.1.

**Table 6.7.1.1 Summary of Studies Evaluating the Intensity of Physiotherapy and Occupational Therapy Post-Stroke**

<table>
<thead>
<tr>
<th>Author/Year</th>
<th>PEDro Score</th>
<th>Sample Size</th>
<th>Intervention</th>
<th>Outcome</th>
</tr>
</thead>
</table>
| Langhammer et al. (2007) | 2           | N=75        | E: Intensive outpatient physical therapy  C: standard care                     | • Motor Assessment Scale (-)  
• Barthel Index (-)  
• Nottingham Health Profile (-)  
• Berg Balance scale (-) |
| Langhammer et al. (2008) | 2           |             |                                                                            |                                                                         |
| Langhammer et al. (2009) | 2           |             |                                                                            |                                                                         |
| Askim et al. (2010) | 2           | N=62        | E: 3 sessions of physiotherapy and structured home exercise program + standard treatment  C: Standard treatment | • Berg Balance scale (-)  
• Motor Assessment Scale (-)  
• Barthel Index (-) |
| Partridge et al. (2000) | 2           | N=114       | E: Physiotherapy for 60min/d  C: Physiotherapy 30 min/d                     | • Walking independence (+)  
• BI (4wks) (+), (6mos) (-) |
| Logan et al. (1997) | 2           | N=101       | E1: Arm training  E2: leg training  C: control                            | • Barthel Index (26 & 52wks) (-)  
• Walking ability (26 & 52wks) (-)  
• Dexterity (ARA) (26wks) (+), (52wks) (-) |
| Di Lauro et al. (2003) | 2           |             | E: Intensive rehabilitative treatment  C: Ordinary rehabilitative treatment  | • Barthel Index (-)  
• NIH (-) |
| Pohl et al. (2007) | 2           | N=155       | E: Gait trainer + PT  C:PT                                                    | • Profiles of Recovery (6wks & 6mos) (-) |
| Kwakkel et al. (1999) | 2           | N=101       | E1: Arm training  E2: leg training  C: control                            | • Barthel Index (26 & 52wks) (-)  
• Walking ability (26 & 52wks) (-)  
• Dexterity (ARA) (26wks) (+), (52wks) (-) |
| Kwakkel et al. (2002) | 2           |             |                                                                            |                                                                         |
| Logan et al. (1997) | 2           | N=111       | E: Enhanced physiotherapy  C: Usual care                               | • Barthel Index (3 & 6mo) (-)  
• Nottingham Extended ADL (3mo) (+), (6mo) (-) |
| Di Lauro et al. (2003) | 2           |             | E: Intensive rehabilitative treatment  C: Ordinary rehabilitative treatment  | • Barthel Index (-)  
• NIH (-) |
<table>
<thead>
<tr>
<th>Reference</th>
<th>Study Design</th>
<th>N</th>
<th>Group 1 (E)</th>
<th>Group 2 (C)</th>
<th>Outcome Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAPS (2004)</td>
<td>RCT (7)</td>
<td>70</td>
<td>E: Twice regular Physiotherapy</td>
<td>C: Physiotherapy</td>
<td>Mobility measures (-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rivermead Mobility Index (-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Walking speed (-)</td>
</tr>
<tr>
<td>Parry et al. (1999)</td>
<td>RCT (7)</td>
<td>282</td>
<td>E: 10 hours of additional</td>
<td>C: Regular amounts of</td>
<td>Barthe Index (6mo) (-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>physiotherapy over 5 weeks</td>
<td>physiotherapy</td>
<td>Rivermead Motor Assessment Arm score (6mo) (-)</td>
</tr>
<tr>
<td>Slade et al. (2002)</td>
<td>RCT (7)</td>
<td>141</td>
<td>E: 67% increase in the amount</td>
<td>C: Regular amount of</td>
<td>Length of stay (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>of routine inpatient</td>
<td>physio/occupational therapy</td>
<td>Barthe Index (-)</td>
</tr>
<tr>
<td>Sunderland et al. (1992)</td>
<td>RCT (6*)</td>
<td>132</td>
<td>E: Enhanced upper extremity</td>
<td>C: Conventional therapy</td>
<td>Extended Motricity Index (6mo) (+)</td>
</tr>
<tr>
<td>Sunderland et al. (1994)</td>
<td>RCT (6)</td>
<td>282</td>
<td>therapy</td>
<td></td>
<td>Motor Club Assessment (1yr) (-)</td>
</tr>
<tr>
<td>Richards et al. (1993)</td>
<td>RCT (6)</td>
<td>27</td>
<td>E: Early, intensive inpatient</td>
<td>C: Conventional routine therapy</td>
<td>Gait velocity (6wks) (+), (3 &amp; 6mos) (-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>rehabilitation</td>
<td>(not intense)</td>
<td></td>
</tr>
<tr>
<td>Werner &amp; Kessler (1996)</td>
<td>RCT (6)</td>
<td>48</td>
<td>E: Intensive 12 weeks of</td>
<td>C: No treatment control</td>
<td>Change in FIM (0-3mos) (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>outpatient rehabilitation</td>
<td></td>
<td>Change in FIM (3-9mos) (-)</td>
</tr>
<tr>
<td>Feys et al. (1998)</td>
<td>RCT (6)</td>
<td>100</td>
<td>E: Upper limb therapy +</td>
<td>C: Upper limb therapy</td>
<td>Brunnstrom-Fugl-Meyer test (6wks) (-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>sensorimotor stimulation for 6</td>
<td></td>
<td>Brunnstrom-Fugl-Meyer test (3 &amp; 6mos) (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>weeks</td>
<td></td>
<td>Barthe Index (-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Action Research Arm test (-)</td>
</tr>
<tr>
<td>Pohl et al. (2002)</td>
<td>RCT (6)</td>
<td>60</td>
<td>E1: Structured speed-dependent</td>
<td></td>
<td>Walking speed, cadence, stride length and FAC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>treadmill training</td>
<td></td>
<td>(4wks) (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>E2: Limited progressive</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>treadmill training</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C: Conventional gait training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Park et al. (2011)</td>
<td>RCT (6)</td>
<td>25</td>
<td>E: Routine physical therapy +</td>
<td>C: Community-based ambulation</td>
<td>10-m walk test (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>community-based ambulation</td>
<td>therapy</td>
<td>Community walk test (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cauraugh et al. (2011)</td>
<td>RCT (6)</td>
<td>18</td>
<td>E: 16 Treatment protocols</td>
<td>C: 1 Treatment protocol</td>
<td>Box and block test (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>treadmill training (BWSTT)</td>
<td></td>
<td>(+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>E2: Variable speed BWSTT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C: Slow speed BWSTT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smith et al. (1981)</td>
<td>RCT (5)</td>
<td>133</td>
<td>E: intensive therapy</td>
<td>C: conventional therapy</td>
<td>ADL Index (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C2: No therapy.</td>
<td></td>
</tr>
<tr>
<td>Sivenius et al. (1985)</td>
<td>RCT (5)</td>
<td>95</td>
<td>E: intensive physiotherapy</td>
<td></td>
<td>Motor Function 4-Point Scale (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>program on a stroke unit</td>
<td></td>
<td>ADL 4-Point Scale (3mos) (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C: control group receiving</td>
<td></td>
<td>ADL 4-Point Scale (6 &amp; 12mos) (-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>conventional physiotherapy on a</td>
<td></td>
<td>Length of Stay (-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>general medical unit</td>
<td></td>
<td>Recurrence of stroke (-)</td>
</tr>
<tr>
<td>Ruff et al. (1999)</td>
<td>RCT (3)</td>
<td>113</td>
<td>E: received therapy 7 days/wk</td>
<td>C: therapy 6 days/wk</td>
<td>FIM (-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LOS (-)</td>
</tr>
</tbody>
</table>
The nature of specialized stroke rehabilitation services implies a greater intensity of therapy although this fact is not always documented. Several studies have attempted to determine the contribution of therapy intensity in stroke rehabilitation. However, illuminating the effect of greater intensity of therapy on functional outcome is difficult due to the variability of treatments provided, the timing and duration of their delivery and the outcomes that were assessed. Additionally, self-report of actual duration of therapy provided by physical therapists has been shown to be overestimated, compared with video recording (mean time 32 vs. 25 min) (Bagley et al. 2009). Intensity of treatment is also dependent on the ability and the willingness on the part of the patient. The mechanism through which improved outcomes are achieved has not been well described. Fang et al. (2003) suggested that a program of greater intensity physiotherapy simply enabled patients to improve or achieve independence in ADL faster through compensation of the non-paretic limb, rather than necessarily through neurological improvements.

Of the studies outlined above, many demonstrated a benefit on at least one testing but failed to demonstrate a difference when compared to conventional treatment at another point in time or among different stroke sub-types. A significant improvement was found on initial assessment however, the benefit disappeared at a later date. The highest quality studies were associated with no benefit when compared to the control condition.

Reviews and Meta-Analyses
The results of three meta-analyses, suggest that increased intensity of therapy is beneficial (See Table 6.7.1.2). 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 reported that the intensity of rehabilitation services was only weakly associated with improved functional outcomes after stroke.

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>• Stern et al. 1970</td>
<td>• Kwakkel et al. 1997</td>
<td></td>
</tr>
<tr>
<td>• Smith et al. 1981</td>
<td>• Richards et al. 1993</td>
<td></td>
</tr>
<tr>
<td>• Peacock et al. 1982</td>
<td>• Nugent et al. 1994</td>
<td></td>
</tr>
<tr>
<td>• Sivenius et al. 1985</td>
<td>• Kramer et al. 1997</td>
<td></td>
</tr>
<tr>
<td>• Sunderland et al. 1992</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Wade et al. 1992</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Richards et al. 1993</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Keith et al. 1995</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Werner 1996</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Kwakkel et al. (2004) conducted an extension of previous meta-analysis and evaluated the benefit of augmented physical therapy which included 20 studies on several 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).

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.

Galvin et al. (2008) examined the effect of increased duration of exercise therapy on functional recovery post stroke. The results of the meta-analysis which included the results from 10 studies demonstrated that increased duration of exercise therapy time had a small but positive effect on activities of daily living as measured by the Barthel Index. The improvements were maintained over a 6-month period.

Cooke et al. (2010) included the results from 9 RCTs representing 7 individual studies examining varying doses of the same exercise-based interventions. The authors meta-analyzed the studies on the basis of individual outcomes (ARAT scores, Motricity Index, handgrip strength, and comfortable walking speed) at the end of treatment and at follow-up. Most of the analyses contained the results from only 2-3 studies. Some small, but statistically significant treatment effects were reported. The authors concluded that there was some, but limited support in favour of greater therapy intensity.

In a recent meta-analysis, Lohse et al (2014) explored the relationship between rehabilitation dosage and motor improvements to discern whether additional therapy is beneficial. The study defined therapy “does” as the amount of time spent during therapy. A total of 34 RCTs were included in the analysis with a population group consisting of 1750 chronic stroke patients. The average therapy duration was virtually the same in both the treatment group and the control group (49.56±68.12 days vs. 49.60±68.10 days), however the time scheduled for therapy averaged to just under an 60 hours (57.41±44.88 hours) for the treatment group while the control group received only 24.08±36.39 hours of therapy. The resultant effect of the meta-analysis revealed an overall benefit favouring more time spent for therapy compared with less. Moreover, the effect of time was found to be a significant predictor of functional improvement.
Conclusions Regarding the Intensity of Physiotherapy and Occupational Therapy

There is level 1a evidence that greater intensities of physiotherapy and occupational therapy results in improved functional outcomes.

There is level 1a evidence that the amount of therapy needed to result in a significant improvement in motor outcomes is 17 hours of physiotherapy and occupational therapy over a 10 week period of time.

Greater intensities of physiotherapy and occupational therapy may result in improved functional outcome however; the amount of increased therapy needed to result in an improved outcome is an additional 17 hours over 10 weeks.

6.7.2 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).

The details of the studies investigating the intensity of aphasia therapy are presented in Table 6.7.2.1.

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>PEDro Score</th>
<th>N at Randomization</th>
<th>Intensity of Therapy</th>
<th>Impact of Aphasia Therapy vs. Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bakheit et al. (2007)</td>
<td>7</td>
<td>116</td>
<td>36 hrs given over 38 sessions in 12 weeks</td>
<td>-</td>
</tr>
<tr>
<td>Lincoln et al. (1984)</td>
<td>6</td>
<td>327</td>
<td>2, 1-hour sessions per week for 34 weeks</td>
<td>-</td>
</tr>
<tr>
<td>Wertz et al. (1986)</td>
<td>6</td>
<td>121</td>
<td>8 to 10 hours a week for 12 weeks</td>
<td>+</td>
</tr>
<tr>
<td>Hartman (1987)</td>
<td>6</td>
<td>60</td>
<td>2 times a week for 6 months</td>
<td>-</td>
</tr>
<tr>
<td>David et al. (1982)</td>
<td>5</td>
<td>155</td>
<td>30 hours over 15 to 20 weeks</td>
<td>-</td>
</tr>
<tr>
<td>Shewan et al. (1984)</td>
<td>5</td>
<td>100</td>
<td>3, 1-hour session a week for 1 year</td>
<td>+</td>
</tr>
<tr>
<td>Marshall et al. (1989)</td>
<td>5</td>
<td>121</td>
<td>8 to 10 hours a week for 12 weeks</td>
<td>+</td>
</tr>
<tr>
<td>Prins et al. (1989)</td>
<td>5</td>
<td>32</td>
<td>2 sessions a week for 5 months</td>
<td>-</td>
</tr>
<tr>
<td>Meikle et al. (1979)</td>
<td>4</td>
<td>31</td>
<td>Minimum of 3 and maximum of 5 sessions a week for 45 minutes.</td>
<td>-</td>
</tr>
<tr>
<td>Brindley et al. (1989)</td>
<td>4</td>
<td>10</td>
<td>5 hours over 5 days a</td>
<td>+</td>
</tr>
</tbody>
</table>
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 a Cochrane Review by Kelly H et al (2010), intensive speech language therapy (SLT) was compared to conventional SLT by four sub-comparisons. When compared to conventional SLT, the intensive SLT approach was found to result in benefits in participants’ written language skills with some indications of improvements in their receptive language and severity of impairment measures. However, the number of drop-outs from the intensive SLT groups was significantly higher than the conventional SLT group suggesting that such an intensive approach to therapy may not be suitable for all patients.

Cherney et al (2011) performed a systematic review of treatment studies which directly compares conditions of higher and lower intensity treatment for aphasia. Results were described based on International Classification of Functioning, Disability and Health-ICF (WHO 2001). Results at the ICF's language impairment and communication activity/ participation levels tend to be equivocal for both acute and chronic aphasia; with no clear differences between intensive and non-intensive treatment across studies.

Conclusions Regarding the Intensity of Language Therapy

There is conflicting evidence that greater evidence of aphasia therapy results in improved language outcomes.

More intensive language therapy may be more beneficial at treating aphasia compared to less intensive therapy; however the evidence is limited and uncertain.
6.8 Durability of Rehabilitation Gains

Functional recovery (the ability to perform activities despite impairment) and improvement in communication may continue for months after neurological recovery is complete (Stineman & Granger 1998). Between 6 months and 3 years post stroke the average level of functional ability is maintained (Borucki et al. 1992; Dombovy et al. 1987). Beyond 3-5 years, slight decreases were noted, most likely related to the effects of increasing age and comorbidity (Stineman & 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.

6.8.1 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 6.8.1.1). The outcomes of mortality, discharge location and functional ability were assessed. Three of the papers evaluated the rehabilitation of individuals with disabilities other than stroke. 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) stated 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.

Gresham et al. (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. 1980; Garraway et al. 1981; Sivenius et al. 1985; Stevens et al. 1984; Sunderland et al. 1994; Sunderland et al. 1992; Wade et al. 1992)

Five “good” (PEDro > 6) quality studies evaluated the durability of rehabilitation gains. The results are summarized in Table 6.8.1.1 below.

Table 6.8.1.1 Summary of Outcome Measures From RCTs With PEDro ≥ 6 Evaluating the Durability of Rehabilitation Gains

<table>
<thead>
<tr>
<th>Author/Year</th>
<th>PEDro score</th>
<th>Intervention</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bernhardt et al. (2008)</td>
<td></td>
<td>E: Early mobilization</td>
<td>mRS score 0-2 (3mos) (+/-), (6mos) (-), (12mos) (+)</td>
</tr>
</tbody>
</table>

* includes non stroke geriatric patients

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6. The Elements of Stroke Rehabilitation  
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<table>
<thead>
<tr>
<th>Study (Reference)</th>
<th>Intervention</th>
<th>Comparison</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kwakkel et al. (2002)</strong>&lt;br&gt;N=101</td>
<td>E1: Upper extremity&lt;br&gt;E2: Lower extremity therapy&lt;br&gt;C: Control condition</td>
<td>• Dexterity (ARA) (26wks) (+)&lt;br&gt;• Dexterity (ARA) (52wks) (-)&lt;br&gt;• Barthel Index (26 &amp; 52wks) (-)&lt;br&gt;• Walking ability (26 &amp; 52wks) (-)</td>
<td></td>
</tr>
<tr>
<td><strong>Indredavik et al. (1991)</strong>&lt;br&gt;<strong>Indredavik et al. (1997)</strong>&lt;br&gt;<strong>Indredavik et al. (1999)</strong>&lt;br&gt;RCT (7*)&lt;br&gt;N=220</td>
<td>E: Rehabilitation stroke Unit&lt;br&gt;C: General ward</td>
<td>• Barthel Index (6wks, 52wks, 5yrs, &amp; 10yrs) (+)</td>
<td></td>
</tr>
<tr>
<td><strong>Stevens et al. (1984)</strong>&lt;br&gt;RCT (6)&lt;br&gt;N=228</td>
<td>E: Treatment in special ward&lt;br&gt;C: Conventional treatment location</td>
<td>• Independence in dressing (12mos) (+)</td>
<td></td>
</tr>
<tr>
<td><strong>Juby et al. (1996)</strong>&lt;br&gt;<strong>Lincoln et al. (2000)</strong>&lt;br&gt;<strong>Drummond et al. (2005)</strong>*&lt;br&gt;RCT (6)&lt;br&gt;N=315</td>
<td>E: Stroke unit&lt;br&gt;C: Conventional ward</td>
<td>• Nottingham EADL (6mos &amp; 1yr) (+)&lt;br&gt;• General Health Questionnaire (1yr) (+)&lt;br&gt;• BI scores (6mos) (+)&lt;br&gt;• Unfavourable outcomes (death, death/disability, death/institutionalization) (5yrs) (+)&lt;br&gt;• Death (10yrs) (+)</td>
<td></td>
</tr>
</tbody>
</table>

* Considered as a single study. Same patients followed forward in time.<br>† Indicates a positive effect favouring treatment group<br>- Indicates a non-significant difference between the intervention group

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. (1999; 1997) 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.

Bernhardt 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. The program was also found to be cost-effective. Mean total costs over the 12 month study period were AUD $13,559 for the AVERT group and AUD $21,860 for the standard care group (Tay-Teo et al. 2008). A large follow-up study, AVERT III, is planned to examine the effects of additional early mobilization (3x/day for 14 days) following acute stroke.

**Conclusions Regarding the Durability of Rehabilitation Gains**

There is level 1a evidence that relatively greater functional improvements are made by patients rehabilitated on specialized stroke units when compared to general medical units and the effects are maintained over both the short-term and long-term.

There is level 1a evidence that functional outcomes achieved through stroke rehabilitation are maintained and actually improve for up to one year.
There is level 1b evidence that by five years post-stroke functional outcomes plateau and may decline. By ten years, overall functional outcome scores significantly decline although it is unclear to what extent the natural aging process and comorbidity may contribute to these declines.

Greater functional improvements made on interdisciplinary stroke rehabilitation units are maintained over the long-term.
Summary

1. **There is conflicting evidence as to whether stroke care pathway improve rehabilitation outcomes.**

2. **There is level 1a evidence that earlier admission to rehabilitation results in improved overall functional outcomes.**

3. **There is level 1a evidence that very early mobilization (VEM) post stroke (within the first 24 hours) results in improved outcomes when there are more frequent short in duration out-of-bed sessions and that VEM results in poorer outcomes when early mobilization session are more prolonged.**

4. **There is level 1a evidence that greater intensities of physiotherapy and occupational therapy results in improved functional outcomes.**

5. **There is level 1a evidence that the amount of therapy needed to result in a significant improvement in motor outcomes is 17 hours of physiotherapy and occupational therapy over a 10 week period of time.**

6. **There is conflicting evidence that greater evidence of aphasia therapy results in improved language outcomes.**

7. **There is level 1a evidence that relatively greater functional improvements are made by patients rehabilitated on specialized stroke units when compared to general medical units and the effects are maintained over both the short-term and long-term.**

8. **There is level 1a evidence that functional outcomes achieved through stroke rehabilitation are maintained and actually improve for up to one year.**

9. **There is level 1b evidence that by five years post-stroke functional outcomes plateau and may decline. By ten years, overall functional outcome scores significantly decline although it is unclear to what extent the natural aging process and comorbidity may contribute to these declines.
References


