6

The Elements of Stroke Rehabilitation

Robert Teasell MD, Norine Foley MSc, Norhayati Hussein MBBS, Joshua Wiener BHSc

Last Updated: March 2018

Dr. Robert Teasell
801 Commissioners Road East, London, Ontario, Canada, N6C 5J1
Phone: 519.685.4000 ● Web: www.ebrsr.com ● Email: Robert.Teasell@sjhc.london.on.ca
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1 Functional Improvements and Neurological Recovery</td>
<td>3</td>
</tr>
<tr>
<td>6.2 Hemorrhagic vs. Ischemic Stroke</td>
<td>4</td>
</tr>
<tr>
<td>6.3 Type of Stroke Units Associated with Improved Outcome</td>
<td>6</td>
</tr>
<tr>
<td>6.5 Impact of Care Pathways and Guidelines</td>
<td>16</td>
</tr>
<tr>
<td>6.6 Timing of Stroke Rehabilitation</td>
<td>21</td>
</tr>
<tr>
<td>6.7 Intensity of Therapy</td>
<td>30</td>
</tr>
<tr>
<td>6.7.1 Intensity of Physical and Occupational Therapy</td>
<td>30</td>
</tr>
<tr>
<td>6.7.1.1 Caregiver Mediation and Intensity of Physical Therapy</td>
<td>40</td>
</tr>
<tr>
<td>6.7.2 Intensity of Language Therapy of Aphasia Post-Stroke</td>
<td>41</td>
</tr>
<tr>
<td>6.8 Durability of Rehabilitation Gains</td>
<td>45</td>
</tr>
<tr>
<td>6.8.1 Previous Reviews</td>
<td>45</td>
</tr>
<tr>
<td>References</td>
<td>48</td>
</tr>
</tbody>
</table>
6.1 Functional Improvements and Neurological Recovery

Table 6.1 Studies on functional improvement and neurological recovery

<table>
<thead>
<tr>
<th>Author, Year Country Pedro Score</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Roth et al.</strong> (1998) USA No Score</td>
<td>A prospective cohort of 402 patients consecutively admitted for rehabilitation within three months of stroke was studied. Impairment was quantified with the National Institutes of Health Stroke Scale (NIHSS) while the Functional Independence Measure (FIM) was used to measure disability, in particular the motor and cognitive subscales of the FIM.</td>
<td>342 patients experienced no substantial reduction while 60 patients had a significant reduction in their impairment level. Both groups experienced significant reductions in disability during rehabilitation, including those patients who did not experience a substantial reduction in impairment.</td>
</tr>
<tr>
<td><strong>Kwakkel et al.</strong> (2006) Netherlands No Score</td>
<td>101 patients with first-ever ischemic strokes were studied during the first 16 weeks post stroke. Progress of time was categorized into 8 bi-weekly time intervals and was used as the independent covariate in a first-order longitudinal regression model. The bi-weekly time change (progress of time) was related to improvement in upper and lower limb motor recovery assessed with Fugl-Meyer (FM) score and Motoricity Index (MI), reduction in visuospatial inattention based on the letter cancellation task, and improvement in walking ability, dexterity, and activities of daily living measured with the Functional Ambulation Categories (FAC), Action Research Arm test, and Barthel Index.</td>
<td>Time explained a significant change of 8.4 (42%) measurement units on the Barthel Index for the first 10 weeks poststroke, 1.1 (22%) measurement units on FAC, and 19% on the Action Research Arm test for the first 6 and 8 weeks poststroke. Approximately 25% (for FM-arm) to 26% (for MI-arm) of the significant change in measurements units was explained by time alone for the upper limb compared with 33% for FM-leg and 39% for MI-leg of the lower limb. Time accounted for a reduction of 16% in the letter cancellation task. Observed associations did not change after controlling for covariates such as age, gender, hemisphere of stroke, type of stroke, or intervention.</td>
</tr>
<tr>
<td><strong>Rabadi et al.</strong> (2008) USA Retrospective No Score TPS≤4wk NStart=668 NEnd=668</td>
<td>Population: Mean age=70.30±12.61yr; Gender: Males=311, Females=357. <strong>Intervention:</strong> To determine whether cognitively impaired patients benefit from admission to an acute rehabilitation unit. The study population was divided into 4 groups using MMSE scores: severe cognitive impairment (≤9 points; N=131), moderate cognitive impairment (10–20 points; N=165), mild cognitive impairment (21–24 points; N=139), and cognitively intact (≥25 points; N=233). <strong>Outcomes:</strong> Change in total FIM instrument score, cognitive FIM subscore, length of stay (LOS), FIM efficiency, and discharge disposition (home vs not-to-home) (primary outcomes).</td>
<td>1. Patients with cognitive impairment had more severe strokes based on the degree of neurologic impairments (motor, visual, sensory), both individually and collectively (p&lt;0.001). 2. There was no significant difference in the change in FIM total score across all 4 groups (p=0.572), however, the change in the FIM cognitive subscore was greatest in patients with severe cognitive impairment (3.06) and least in patients with mild cognitive impairment (1.20) and the cognitively intact group (1.38) (p=0.001). 3. FIM efficiency was higher in the cognitively intact group compared to the other 3 cognitively impaired groups of patients, though not significant (p=0.058). 4. Linear regression analyses showed that age, admission FIM total score, were significant predictors of a change in FIM total score, but not the presence of depression (p=0.46) nor admission MMSE score (p=0.06).</td>
</tr>
</tbody>
</table>
Population: Before period (N=174): Mean age= 60.1 ± 17.9yr; Gender: Males=47%, Females=53%. After period (N=259): Mean age= 57.1±18.2yr; Gender: Males=46%, Females=54%

Intervention: To examine whether a full-time neurointensivist (NI) impacted outcomes of patients with more severe strokes and this was compared with data before and after the period at which an NI was appointed for care delivery.

Outcomes: Mortality; Expected length of stay (LOS).

1. The adjusted outcomes for mortality and LOS for each stroke group in the NICU or hospital was not significantly different between the two periods. It ranged between 24% in the hospital LOS for ICH and 137% in the NICU LOS for IS.

2. There was a statistically significantly shorter stay in both the NICU LOS and hospital LOS by 92% and 70%, respectively, during the after period: (Cox proportional hazard ratios, 95% CI were 2.37, 1.4–4.1 and 1.8, 1.04–3 for IS, 1.98, 1.3–3 and 1.2, 0.8–1.9 for ICH, and 1.6, 1.1–2.3 and 1.4, 1.01–2 for SAH, respectively) or for all strokes (1.92, 1.52–2.43 and 1.7, 1.28–2.25) for the first 12d of admission.

6.2 Hemorrhagic vs. Ischemic Stroke

Table 6.2 Functional outcomes of patients with hemorrhagic vs. ischaemic strokes

<table>
<thead>
<tr>
<th>Author, Year Country Pedro Score</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Jørgensen et al. (1995)</strong> Denmark No Score</td>
<td>1,000 unselected patients with acute stroke of a verified type in the Copenhagen Stoke Study were included. Logistic regression was used to examine the influence of stroke type on outcome, adjusting for age, sex, initial stroke severity, comorbidity and recurrent stroke during hospital stay. Neurological deficits and functional disabilities were evaluated weekly from the time of acute admission throughout the rehabilitation period.</td>
<td>Eighty-eight (9%) of the sample had intracerebral hemorrhage. The relative frequency of intracerebral hemorrhage rose exponentially with increasing stroke severity. In multivariate analyses, stroke type had no influence on mortality, neurological outcome, functional outcome, or the time course of recovery. Initial stroke severity was the all-important prognostic factor. The relative importance of hypertension and blood pressure on admission was not greater for intracerebral hemorrhage than for infarction.</td>
</tr>
<tr>
<td><strong>Kelly et al. (2003)</strong> USA No Score</td>
<td>Data from 1064 patients (871 with cerebral infarction, 193 with ICH) admitted for inpatient rehabilitation was examined. FIM admission, discharge and change scores were compared between stroke types.</td>
<td>Total admission FIM score were higher in patients with infarction compared with ICH (59 vs. 51, P=.0001). There was no difference in total discharge FIM score between groups (82.3 ischemic vs. 79.1 ICH, p=0.200). Patients with ICH gained more FIM points during rehabilitation (28 vs. 23.3; P=.002). The ICH patients with the most severely disabling strokes had significantly greater recovery than cerebral infarction patients with stroke of similar severity.</td>
</tr>
<tr>
<td><strong>Paolucci et al. (2003)</strong> Italy No Score</td>
<td>A case-control study of 270 inpatients admitted for inpatient rehabilitation. Patients with sequela of first stroke were matched for stroke severity, basal disability, age (within 1 year), sex, and onset admission interval (within 3 days). The 2 groups' length of stay, Barthel Index (BI), Rivermead Mobility Index (RMI) and Canadian Neurological Scale (CNS) scores were compared, as well as efficiency (gain in score/LOS) of BI and RMI.</td>
<td>Compared with ischemic patients, hemorrhagic patients had significantly higher CNS (7.3 vs. 6.7) and RMI scores (6.6 vs. 5.4) at discharge and higher BI (50 vs. 40) and RMI (38 vs. 29) efficiency scores. Hemorrhagic patients showed a probability of a high therapeutic response on the BI that was approximately 2.5 times greater than that of ischemic patients.</td>
</tr>
<tr>
<td>Authors</td>
<td>Year</td>
<td>Country</td>
</tr>
<tr>
<td>---------------------</td>
<td>------</td>
<td>---------</td>
</tr>
<tr>
<td>Andersen et al.</td>
<td>2009</td>
<td>Denmark</td>
</tr>
<tr>
<td>Katrak et al.</td>
<td>2009</td>
<td>Australia</td>
</tr>
<tr>
<td>Chiu et al.</td>
<td>2010</td>
<td>USA</td>
</tr>
<tr>
<td>Perna &amp; Temple.</td>
<td>2015</td>
<td>USA</td>
</tr>
</tbody>
</table>
# 6.3 Type of Stroke Units Associated with Improved Outcome

Table 6.3.1 Studies evaluating models of stroke care

<table>
<thead>
<tr>
<th>Author, Year Study Type, PEDro Score Sample Size</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Garraway et al.</strong> (1980b) UK RCT PEDro=5 N=311</td>
<td>311 consecutive patients with moderate to severe strokes, admitted within 7 days of onset of symptoms were randomized to receive treatment on either a stroke unit or one of 12 medical units on call for emergency admissions.</td>
<td>1. A greater proportion of stroke unit patients was classified as independent when compared to medical unit patients, 50% vs. 32% at 60 days. When comparing only survivors, the proportion of independent patients rose to 62%. A greater proportion of stroke unit patients was referred to physiotherapy (PT), with shorter delays between admission and the start of PT.</td>
</tr>
<tr>
<td><strong>Garraway et al.</strong> (1980a) UK RCT PEDro=4 N=192</td>
<td>Follow-up study of 192 stroke patients from “1980a” study.</td>
<td>1. At one year, there were no longer significant differences in the proportion of patients that was classified as independent. 55% of stroke unit patients and 52% of medical ward patients were assessed as independent. No p-values or statistics were provided.</td>
</tr>
<tr>
<td><strong>Kalra et al.</strong> (1994) UK RCT PEDro=5</td>
<td>Analysis of 146 middle-band stroke patients taken from a sample of 245 stroke patients randomized at 2 weeks post stroke to a rehabilitation unit or a general medical unit after stratification by stroke severity. (Analysis of 1993 RCT).</td>
<td>1. The median Barthel Index (BI) scores of patients managed on the stroke unit were significantly higher when compared to patients on the medical unit (15 vs. 12). The rate of improvement in BI scores was faster for patients on the stroke unit and these patients had significantly shorter LOS (6 vs. 20 weeks). Significant gains were achieved at a faster rate without additional physiotherapy or occupational therapy in total.</td>
</tr>
<tr>
<td><strong>Jorgensen et al.</strong> (1999) Denmark PCT No Score TPS=NA NStart=1241 NEnd=1241</td>
<td>Population: Patients treated in general wards (GW: N=305): Mean age=74.9±10.1yr; Gender: Males=139, Females=196. Patients treated in stroke units (SU: N=936): Mean age=74.4±11.2yr; Gender: Males=428, Females=508.</td>
<td>1. The mortality rate was significantly greater in the patients treated in the GW compared to those treated in the SU at all time points (30d: 23% vs. 17%, p=0.03; during hospital stay: 29% vs. 23%, p=0.01; 6m: 35% vs 28%, p=0.01; 1yr: 39% vs. 32%, p=0.01; 5yr: 71% s. 64%, p=0.02). 2. The relative risk of death at the different time points after a stroke if treated on a SU were found to be significant (30d: RR 0.45, 95% CI (0.28,0.71), p&lt;0.001; in hospital stay: RR 0.50, 95% CI (0.34,0.74), p&lt;0.001; 6m: RR 0.57, 95% CI (0.39,0.82), p=0.002; 1yr: RR 0.59, 95% CI (0.42,0.84), p=0.003; 5yr: RR 0.60, 95% CI (0.42,0.85), p=0.003).</td>
</tr>
<tr>
<td><strong>Claesson et al.</strong> (2000) Sweden</td>
<td>Population: Stroke Unit (SU; N=166): Mean Age=80.1yr; Gender: Male=56, Female=110. General Ward (GW; N=83): Mean Age=79.7yr;</td>
<td>1. The mean total cost per patient in the SU was $25,373 compared to $28,657 for patients in the GW (p&gt;0.05).</td>
</tr>
</tbody>
</table>
RCT  
PEDro=6  
TPS<7d  
NStart=249  
NEnd=249

Gender: Male=38, Female=45.  
**Intervention**: Patients were randomized to either a SU or a GW. SU patients underwent a standardized examination and systematic observation of deficits and disorders. GW patients received no standardized program for treatment and no extra resources were provided for the management of stroke patients. Assessments were completed at 1yr follow-up.  
**Outcomes**: Mean cost per patient; Number of hospitalizations; Support post-discharge; Number of outpatient rehabilitation days.

Claesson et al.  
(2003)  
Sweden  
RCT  
PEDro=6  
TPS<7d  
NStart=249  
NEnd=216

**Population**: Stroke Unit (N=147): Mean Age=80.0±5.57yr; Gender: Male=47, Female=100.  
General Ward (N=69): Mean Age=79.3±5.39yr; Gender: Male=31, Female=38.  
**Intervention**: Patients were randomized to either a stroke unit or a general ward. Stroke unit patients underwent a standardized examination and systematic observation of deficits and disorders. General ward patients received no standardized program for treatment and no extra resources were provided for the management of stroke patients. Physiotherapy was administered to 26 (15%) and 145 (88%) patients in the general ward and stroke unit respectively (p<0.001). Occupational therapy was administered to 47 (57%) and 148 (90%) patients in the general ward and stroke unit respectively (p<0.001).  
**Outcomes**: Discharge destination: after index stroke, at 1yr post stroke; Readmissions: rate at <90d and 1yr post stroke; length of stay <90d and at 1yr post stroke; total readmissions per patient at 1yr post stroke; Number of hospital or institution free days; Morality at 1yr post stroke.

1. No significant differences in discharge destination post stroke were observed between groups with 187 (86.6%) patients discharged home, 21 (9.7%) discharged to a nursing home, 2 (0.93%) discharged to an elderly care home and 6 (2.8%) discharged to assisted living.  
2. The readmission rate at <90d post stroke was 14% in the stroke unit and 23% in the general ward.  
3. The readmission length at <90d post stroke was 2d in the stroke unit and 4d in the general ward.  
4. At 90d post stroke, 5% of the stroke unit and 15% of the general ward patients were still hospitalized for the index stroke.  
5. No significant differences were observed at 1yr post stroke between groups in the total number of readmissions per patient (stroke unit=44%, general ward=51%) and the length of stay in readmission (stroke unit=10d, general ward=12d).  
6. No significant difference was observed between groups in length of hospital stay at 1yr post stroke (stroke unit=44%, general ward=51%).  
7. No significant difference was observed between groups in the number of hospital or institution free days per patient at 1yr post stroke (stroke unit=265d, general ward=251d).  
8. The proportion of patients living at home at 1yr post stroke was 72% in the stroke unit and
1. A poor outcome was seen in 7 (25.9%) patients in the SCMU group and in 13 (48.1%) in the SU group (p=0.16).
2. Mortality was lower in the SCMU group than in the SU group (1 (3.7%) vs 7 (25.9%); odds ratio, 0.11 (95% CI, 0.02 to 0.96), p<0.05).

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Design</th>
<th>PEDro</th>
<th>TPS</th>
<th>Start</th>
<th>End</th>
<th>Population</th>
<th>Intervention</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulter et al. (2003)</td>
<td>Netherlands</td>
<td>RCT</td>
<td>6</td>
<td>48 hrs</td>
<td>54</td>
<td>54</td>
<td>Stroke Care Monitoring Unit (SCMU): Mean age=68 ±14.7yr; Gender: Males=15, Females=1. Conventional Stroke Unit (CSU): Mean age=67.6±16.0yr; Gender: Males=10, Females=17.</td>
<td>Patients were randomized to either the SCMU or the CSU.</td>
<td>Mortality and poor outcomes defined as modified Rankin scale (mRS) score≥4 or a Barthel Index (BI)&lt;60.</td>
</tr>
<tr>
<td>Fjaertoft et al. (2003)</td>
<td>Norway</td>
<td>RCT</td>
<td>8</td>
<td>7d</td>
<td>320</td>
<td>320</td>
<td>Mean Age=NA; Gender: Male=NA, Female=NA.</td>
<td>Patients admitted to a stroke unit were randomized to receive either ordinary stroke unit services (OSUS) or stroke unit care with early supported discharge (ESUS). Care during the acute phase was similar between groups and involved early mobilization in addition to a standardized acute treatment program. The ESUS program included discharge planning, home visits, attending an outpatient clinic at 3-5wk post discharge and an educational meeting 3mo post discharge. Outcomes were analyzed at 52wk post stroke.</td>
<td>Modified Rankin Scale (mRS); Number of patients needed to treat in the ESUS group vs OSUS in order to achieve 1 more independent patient (NNT); Length of stay; Scandinavian Stroke Scale (SSS).</td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Study Design</td>
<td>PEDro Score</td>
<td>TPS Duration</td>
<td>Starting N</td>
<td>Ending N</td>
<td>Population</td>
<td>Intervention</td>
<td>Outcomes</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
<td>--------------</td>
<td>-------------</td>
<td>--------------</td>
<td>-------------</td>
<td>-----------</td>
<td>------------</td>
<td>-------------</td>
<td>----------</td>
</tr>
<tr>
<td>Donnelly et al. (2004)</td>
<td>Italy</td>
<td>RCT</td>
<td>6</td>
<td>&lt;4 wk</td>
<td>113</td>
<td>97</td>
<td>Median Age=68yr, 71yr; Gender: Male=NA, Female=NA.</td>
<td>Patients admitted with a stroke were randomized to either receive care from a community-based multidisciplinary stroke team (CST, N=59) or hospital rehabilitation (HR, N=54) including inpatient stay at a stroke unit and rehabilitation in a day hospital. The CST group received an average of 2.5 home visits/wk over 3 mo. Note: no further details provided concerning type of care.</td>
<td>Utilization of resources; Barthel Index (BI); Nottingham Activities of Daily Living (Nottingham ADL); Short-Form 36 Questionnaire (SF-36); EuroQol 5d (EuroQol); Patient satisfaction; Caregiver satisfaction.</td>
</tr>
<tr>
<td>Gattellari et al. (2009)</td>
<td>Australia</td>
<td>Case Control</td>
<td>No Score</td>
<td>NA</td>
<td>17,659</td>
<td>17,659</td>
<td>Median Age=76yr; Gender: Males=9300, Females=8359.</td>
<td>Patients were retrospectively analyzed before and after the implementation of stroke units in principal (N=12,519) and non-principal (N=5140) referral hospitals.</td>
<td>Mortality; Discharge destination.</td>
</tr>
</tbody>
</table>
stroke unit implementation (52.0% vs 55.8%; AOR=1.15, 95% CI, 0.96–1.37), while slightly fewer admissions with poor prognosis were discharged home afterward (30.9% vs 28.1%; AOR=0.84, 95% CI, 0.66–1.07).

6. In non-principal referral hospitals, there was an overall effect of time (AOR=1.30, 95% CI 1.05–1.60), which was similar for patients with (23.3% vs 30.2%; AOR=1.46, 95% CI 1.19–1.80) and without (47.8% vs 54.2%; AOR=1.24 95%CI 0.96–1.59) poor prognosis.

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Design</th>
<th>No Score</th>
<th>TPS Score</th>
<th>N Start</th>
<th>N End</th>
<th>Population</th>
<th>Intervention</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saposnik et al. (2009)</td>
<td>Canada</td>
<td>Case Control</td>
<td>No Score</td>
<td>TPS=NA</td>
<td>3756</td>
<td>3631</td>
<td>Mean Age=72.0yr; Gender: Males=1895, Females=1736.</td>
<td>Patients admitted to hospitals with a stroke unit (EG) or without (CG) over two years were retrospectively compared. Outcomes were assessed at 7d and 30d.</td>
<td>Mortality.</td>
</tr>
<tr>
<td>Langhorne et al. (2010a)</td>
<td>UK</td>
<td>Case Control</td>
<td>No Score</td>
<td>TPS=NA</td>
<td>157,639</td>
<td>119,017</td>
<td>Experimental Group (EG; N=47,432): Median Age=73yr; Gender: Males=21819, Females=25613. Control Group (CG; N=110,207): Median Age=75yr; Gender: Males=48932, Females=61275.</td>
<td>Patients admitted to hospitals with a stroke unit (EG) or without (CG) over 20 years were retrospectively compared. Outcomes were assessed at admission and discharge.</td>
<td>Mortality; Discharge destination.</td>
</tr>
<tr>
<td>Saposnik et al. (2011)</td>
<td>Canada</td>
<td>Cohort</td>
<td>No Score</td>
<td>TPS=NA</td>
<td>6223</td>
<td>6223</td>
<td>Mean age=72yr; Gender: Males= 52%, Females=48%.</td>
<td>To determine whether the benefit of a stroke unit admission is similar among all ischemic stroke subtypes</td>
<td>All-cause mortality at 30d after stroke.</td>
</tr>
</tbody>
</table>

1. Mortality rate at 7d was significantly lower in the EG than the CG in all age groups: <59yr (2.8% vs 7.0%; RR=0.40), 60-69yr (3.3% vs 6.8%; RR=0.49), 70-79yr (3.6% vs 8.8%; RR=0.78), and >80yr (8.0% vs 10.3%; RR=0.57).

2. Mortality rate at 30d was significantly lower in the EG than the CG in all age groups: <59yr (4.2% vs 8.7%; RR=0.48), 60-69yr (5.3% vs 8.6%; RR=0.61), 70-79yr (8.2% vs 13.5%; RR=0.61), and >80yr (17.4% vs 22.9%; RR=0.76).

3. Stroke unit care was an independent predictor of mortality at 7d (OR=0.55, 95% CI 0.40–0.77) and 30d (OR=0.66, 95% CI 0.52–0.84) after adjusting for age, sex, stroke severity, and comorbidities.

4. There was no significant interaction between care group and age group for mortality at 7d (p=0.80) or 30d (p=0.98).

1. Rate/odds of mortality was lower in the EG than CG for 1991–1995 (34.1% vs 39.8%; AOR=0.83), 1996–2000 (31.7% vs 35.9%; AOR=0.90), and 2001–2005 (29.0% vs 34.6%; AOR=0.87), with a mean difference of -5.1%/-3.0% for 1986-2005.

2. Rate/odds of discharge home was greater in the EG than CG for 1991–1995 (62.5% vs 50.5%; AOR=1.23), 1996–2000 (59.9% vs 53.6%; AOR=1.15), and 2001–2005 (63.2% vs 56.0%; AOR=1.17), with a mean difference of +6.7%/+5.0% for 1986-2005.
for age, gender, Charlson index, and stroke severity. The benefit was similar across all stroke subtypes. Sensitivity analyses showed that the results remained similar even after additional exclusion criteria were applied: N=3215; adjusted OR= 0.53; 95% CI 0.42–0.66).

Di Carlo et al. (2011)
Italy
PCT
No Score
TPS=NA
NStart=355
NEnd=355

Population: Mean Age=73.4±14.5yr; Gender: Male=192, Female=163.

Intervention: Patients admitted with a first ever stroke were divided to either receive care on a stroke unit (SU, N=140) or other geriatric wards (OGW, N=215). The stroke unit used standardized guidelines to provide acute care, prevention and management of complications, dysphagia screening, early mobilization and secondary prevention. Other general wards had no standardized programs and were only offered physiotherapy or speech therapy at the request of medical staff.

Outcomes: Utilization of resources; Length of stay (LOS); Discharge destination; Mortality at 3mo and 1yr; Death or dependency at 3mo and 1yr; Death or institutionalization at 3mo and 1yr; Barthel Index (BI); National Institute of Health Stroke Scale (NIHSS).

1. The resources used during hospital stay were significantly different between groups in regards to the use of a specialist physician in stroke (SU=100%, OGW=21.4%) (p<0.001), a specialist stroke nurse (SU=100%, OGW=3.3%) (p<0.001), a physiotherapist (SU=76.4%, OGW=45.1%) (p<0.001), a speech therapist (SU=61.4%, OGW=24.7%) (p<0.001), a psychologist (SU=6.4%, OGW=1.9%) (p=0.025), a dietician (SU=100%, OGW=21.4%) (p<0.001), a social worker (SU=45.0%, OGW=29.3%) (p=0.003), MRI (SU=51.1%, OGW=22.5%) (p<0.001), carotid duplex scan (SU=78.4%, OGW=58.7%) (p<0.001), transcranial Doppler (SU=80.6%, OGW=34.8%) (p<0.001), intravenous anticoagulant therapy (SU=13.6%, OGW=1.9%) (p<0.001), subcutaneous anticoagulant therapy (SU=39.3%, OGW=54.9%) (p=0.004) and thrombolysis (SU=39.3%, OGW=54.9%) (p<0.001).

2. No other significant differences in resource use were observed between groups.

3. No significant difference in the length of stay in acute care and in rehabilitation hospitals was observed between groups.

4. The discharge destination following acute care was different between groups with significantly more OGW patients discharged home (69.1% vs 56.7%) (p=0.026), significantly more SU patients discharged to rehabilitation hospitals (38.6% vs 21.3%) (p=0.001) and not significantly more OGW patients discharged to long-term care institutions (9.6% vs 4.7%) (p=0.116).

5. Mortality was significantly reduced in SU patients compared to OGW patients at 3mo (11.6% vs 20.4%) (p=0.032) and at 1yr (15.3% vs 28.5%) (p=0.005).

6. Death or dependency was significantly reduced in SU patients compared to OGW patients at 3mo (21.7% vs 37.5%) (p=0.002) and at 1yr (27.7% vs 42.5%) (p=0.005).

7. Death or institutionalization was significantly reduced in SU patients compared to OGW patients.
<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Study Design</th>
<th>No Score</th>
<th>TPS</th>
<th>NStart</th>
<th>NEnd</th>
<th>Population</th>
<th>Intervention</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>West et al. (2013)</td>
<td>Australia</td>
<td>Observational</td>
<td>No Score</td>
<td>TPS</td>
<td>≤14d</td>
<td>232</td>
<td>NStart=232</td>
<td>NEnd=232</td>
<td>There were some statistically significant differences between participants from each site: there were more males in the comprehensive stroke unit group, fewer partial anterior circulation infarcts, more lacunar infarcts, and more patients ambulant without aids prior to their stroke.</td>
</tr>
<tr>
<td>Inoue &amp; Fushimi (2013)</td>
<td>Japan</td>
<td>Case Control</td>
<td>No Score</td>
<td>TPS</td>
<td>NA</td>
<td>6977</td>
<td>NStart=6977</td>
<td>NEnd=6977</td>
<td>Mortality rate was significantly lower in the EG than CG for both hemorrhagic (14.8% vs 24.1%; p=0.0004) and ischemic (3.6% vs 5.7%; p&lt;0.003) stroke.</td>
</tr>
<tr>
<td>Badriah et al. (2013)</td>
<td>Japan</td>
<td>Retrospective</td>
<td>Mean Age=76.49±13.76yr; Gender: Male=86, Female=119.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Intensity of therapy was significantly associated with age (correlation coefficient=-0.27) (p&lt;0.001), previous disability history (correlation coefficient=-0.24) (p&lt;0.001).</td>
</tr>
</tbody>
</table>
Outcomes: Functional Independence Measure (FIM); Intensity of therapy (total therapy hours over length of stay in rehabilitation unit); Rehabilitation potential (change in total FIM from beginning of rehabilitation to discharge over maximum FIM minus total FIM at beginning of rehabilitation); Discharge to home.

* Note: only the stroke cohort (N=205, 24.6% of total population) was included in this description.

1. Effectiveness: At 90d after discharge, there were no statistically significant differences in FIM scores between the CSC group and the TSC group.

2. Efficiency: Compared to patients from the TSC group, the average length of hospital stay declined by 5 to 28d for patients from the CSC group. This difference was not statistically significant.

3. Compared to patients with a moderate severity of stroke (mRS=3 or mRS=4) from the TSC group, the average length of hospital stay for patients with moderate severity of stroke from the CSC group was 6.4d shorter in rehabilitation and 7.7d shorter for total length of hospital stay, even though these findings were not statistically significant.

1. There were a greater proportion of patients who achieved a reduction of high global dependence scores in NRC compared to those who received GRC. Change was reflected by a decrease from 50% at admission to 27% at discharge in contrast with 56% to 46% in GRC.

2. A larger proportion of patients >75yr in NRC showed an improvement in their total physical dependence score compared to GRC (54.2% and 35.8%, respectively). Statistically significant between-group differences were found for level of dependence based on the type of rehabilitation offered (p<10^-4).

3. This study found a significant association between rehabilitation setting and discharge (p<10^-4); the odds of discharge were higher.
1. Patients in the EG were significantly less likely to die in hospital than those in the CG from 2005 (ARR=0.849, 95% CI 0.830-0.868), 2006 (ARR=0.884, 95% CI 0.864-0.904), 2007 (ARR=0.864, 95% CI 0.844-0.884), 2008 (ARR=0.864, 95% CI 0.843-0.885), 2009 (ARR=0.870, 95% CI 0.847-0.894), and 2010 (ARR=0.879, 95% CI 0.854-0.905).

2. Mortality rates significantly decreased from 2005 to 2010 for patients in both the EG (10.57% to 9.22%; p=0.0001) and the CG (12.46% to 10.49%; p=0.001).

1. 89% were discharged to the community, and 67 (11%) were discharged to a long-term care facility.

2. Wait times: After DL implementation, the average wait time decreased to 4.4d, while prior, the average wait time was 44d.

3. Home-based community referral and visit rates: There was a large increase in referral rate and access to service by discipline, such that the associated change in frequency of referrals reflected a positive change: 11% increase in OT; 13% increase in PT; 24% increase in SLP; and 11% increase in SW.

4. The mean total LOS for the group receiving inpatient rehabilitation after acute care decreased for a 15.7d decrease in LOS in 2yr.

5. FIM change and FIM efficiency: FIM scores were not affected by the statistically significant reduction in LOS, (FIM LOS efficiencies improved, and FIM change scores remained stable).

6. The lowest 1yr readmission rates were observed for clients receiving enhanced therapy discharged directly home from the acute care setting.

7. The highest readmission rate was for those discharged from acute care directly home with neither home-based nor hospital-based rehabilitation service.
Based on analyzing their patient-specific characteristics (status/acute stroke sub-type and risk factors). Goal is to analyze status of patients

**Outcomes:** Korean Mini-Mental Status Examination (K-MMSE); Aphasia Quotients (AQ).

Hemorrhagic stroke patients; the rate of transfer to the rehabilitation department was higher for hemorrhagic stroke than ischemic stroke.

3. Discharge status for first-ever stroke patients differed between those who had been discharged from a rehabilitation department versus from other departments (12.1% were discharged from rehabilitation department vs 87.1% from other departments). Average length of stay was higher (52.2d) for patients discharged from rehabilitation than those from other departments (20.6d).

4. Descriptive results showed that almost half of the patients who were discharged from rehabilitation continued with further inpatient rehabilitation at another hospital and about a third of them were discharged to their respective homes. Those who were discharged home were ranked as having a less severity for stroke than those who were discharged to another rehabilitation hospital, at the time of discharge.

**Population:** Mean age=79yr; Gender: Males=359, Females=617.

**Intervention:** Saturday Rehabilitation service involved allied health team, more timely assessment of new patients with increased medical service, facilitation of patient admissions, discharges and provision of therapy for patients requiring critical rehabilitation support.

**Outcomes:** Functional Independence Measure (FIM).

1. Multivariate analyses revealed independent associations between the time period (pre/post-period of rehabilitation service) and discharge FIM score, after adjusting for gender, admission score, age, and LOS.

2. Compared to patients at pre-implementation of the weekend rehabilitation service, those who were admitted into rehabilitation after the service had commenced, had higher median FIM scores.

3. The results showed that for those who received the Saturday rehabilitation service, the median difference in discharge score increased. This was a statistically significant change in median difference scores (p<0.001).

4. In comparing the main groups of patients receiving speciality-specific care, the regression analysis showed that the largest median FIM change was found in the neurorehabilitation group, even though this finding was not statistically significant.

5. Within-group FIM change score differences for Geriatric Evaluation and Management (GEM) patients showed that the median FIM change in the post-implementation group compared to pre-implementation group was statistically significant (p=0.04). No statistically significant difference in discharge FIM scores was found in the pre-and post-implementation of this
Generally observed that the rate of discharge of patients with an improved functional status increased without increasing the length of their stay in rehabilitation. The medical team also noticed their admission capacity improved.

6.5 Impact of Care Pathways and Guidelines

Table 6.5: Studies evaluating the impact of care pathways

<table>
<thead>
<tr>
<th>Author, Year Country</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamrin et al. (1990) Sweden RCT PEDro=4</td>
<td>280 acute stroke patients were assigned to be managed by a systematized care procedure with written care plans in accordance with the nursing process model or to be managed according to conventional care.</td>
<td>Functional improvements within each group were equal and no significant differences between the two groups were found on any of the outcome measures.</td>
</tr>
<tr>
<td>Falconer et al. (1993) USA RCT PEDro=5</td>
<td>121 patients were randomized to either the Critical Path Method (CPM), which functions like an interdisciplinary team in the planning, monitoring and control of patient’s program and progress, or to usual care (multidisciplinary rehabilitation team), which served as the control.</td>
<td>Of the 80 subjects who completed satisfaction questionnaires, general satisfaction scores at discharge were significantly lower in the CPM group compared to the control group. There were no differences between the groups in motor or cognitive functions at discharge and no differences in the average length of stay or hospital charges.</td>
</tr>
<tr>
<td>Sulch et al. (2000) UK RCT PEDro=6</td>
<td>152 patients were randomized to be managed by an Integrated Care Pathway (ICP) based on evidence of best practice, professional standards and existing infrastructure for facilitating interdisciplinary coordination, improving discharge planning and reducing length of hospital stay or were to be managed by conventional multidisciplinary care (control). (see Figure)</td>
<td>There were no differences in mortality rates, frequency of institutionalization or LOS between the two groups. Conventional multidisciplinary care resulted in higher BI scores between 4 and 12 weeks and higher Quality of Life scores at 12 weeks and 6 months, compared to the ICP group patients.</td>
</tr>
<tr>
<td>Mosimaneotsile et al. (2000) USA Case Series No Score TPS=11d</td>
<td>Population: Mean Age=69yr; Gender: Males=649, Females=590. Intervention: Patients in rehabilitation one year before (T0; N=171), one year after (T1; N=336), two years after (T2; N=354), and three years after (T3; N=375) implementation of an integrated care</td>
<td>1. Mean FIM score at admission significantly increased over time (F=5.1, p&lt;0.01; T0=60.1±16.8; T1=59.8±17.8; T2=61.9±18.7; T3=64.6±16.7). 2. Mean FIM score at discharge significantly decreased over time (F=3.3, p&lt;0.05);</td>
</tr>
</tbody>
</table>
pathway were retrospectively analyzed. **Outcome:** Functional Independence Measure (FIM); Length of stay (LOS); Discharge destination.

1. Mean FIM change significantly decreased over time ($F=23.5$, $p<0.001$; $T_0=91.0\pm22.0$; $T_1=89.5\pm22.1$; $T_2=85.6\pm21.9$; $T_3=87.4\pm18.7$).
2. Mean LOS significantly decreased over time ($F=7.2$, $p<0.01$; $T_0=18.0\pm6.6$ d; $T_1=16.8\pm7.0$ d; $T_2=15.6\pm6.8$ d; $T_3=15.6\pm6.2$ d).
3. Mean FIM efficiency (FIM/LOS) decreased over time ($T_0=1.7$, $T_1=1.8$, $T_2=1.5$, $T_3=1.5$).
4. Discharge destinations did not significantly change over time ($\chi^2=5.1$, $p>0.05$): home ($T_0=86\%$, $T_1=86\%$, $T_2=82\%$, $T_3=85\%$), hospital ($T_0=5\%$, $T_1=6\%$, $T_2=5\%$, $T_3=4\%$), or care facility ($T_0=9\%$, $T_1=8\%$, $T_2=13\%$, $T_3=11\%$).
5. Predictors of FIM score at discharge included study year ($r=0.07$, $p<0.05$), time to admission ($r=0.20$, $p<0.01$), and FIM score at admission ($p<0.001$).
6. Predictors of LOS included study year ($r=0.12$, $p<0.01$), time to admission ($r=0.16$, $p<0.01$), and FIM score at admission ($p<0.001$).

**Duncan et al.** (2002)  
USA Observational No Score  
288 stroke patients in 11 Dept. of Veteran Affairs Medical centres, hospitalized between 1998 and 1999 were followed prospectively for 6 mos. The degree of compliance with the AHCPR guidelines was correlated with FIM scores.  
Average compliance scores in acute and post acute settings were 68.2% and 69.5%, respectively. Greater levels of adherence to the rehabilitation guidelines were associated with higher FIM scores.

**Hoenig et al.** (2002)  
USA Observational No Score  
Additional analyses from Sulch et al. 2000. Quality of life was assessed using the EuroQol Visual Analogue Scale (EQ-VAS) at 6 mos. Patients receiving conventional multidisciplinary therapy had significantly higher QoL scores at 6 mos compared to patients in Integrated Care Pathway group (median 72 vs. 63, $p<0.005$).

**Sulch et al.** (2002a)  
UK RCT PEDro=6  
Additional analyses from Sulch et al. 2000, investigating the frequency of stroke specific assessments associated with either ICP or multidisciplinary care. Increased frequency of stroke-related assessments with ICP, including testing for inattention (84% vs. 60%, $p=0.015$) and nutritional assessments (89% vs. 70%, $p=0.024$). Early discharge notifications to general practitioners were also higher among patients in the ICP group.

**Sulch et al.** (2002b)  
UK RCT PEDro=6  
Prospective, multicenter, single-blinded evaluating the following models of care: stroke units, mobile services, and conventional care. 21 selected processes of care (PoC) were identified and abstracted from medical records. The PoCs reflected aspects of care received within 24 hours of admission, documentation and general management, and included CT scan, swallowing assessment, allied health assessment, documentation of premorbid functioning and discharge needs, measures to avoid aspiration, deep vein thrombosis and use of antiplatelet.

Adherence to key PoC was higher in SUs than in other models. For all patients, adherence to PoC was associated with improved mortality at discharge and trends found with independence at home.468 of 1701 eligible patients participated. (28%) Overall PoC adherence rates for individual care models were SU 75%, mobile service 65%, and conventional care 52% ($P<0.001$). The adjusted odds of participants being alive at discharge if adhering to all or all but 1 PoC was significant (OR 3.63; 95% CI: 1.04 to 12.66; $P=0.043$). Important trends at 28 weeks were found for being at home (aOR 3.09; 95% CI: 0.96 to 9.87;
agents at discharge related to care models and participant outcomes. Data were collected at acute hospitalization (median 9 days) and at medians of 8 and 28 weeks after stroke.

P=0.058) and independent (aOR 2.61; 95% CI: 0.96 to 7.10; P=0.061), with complete PoC adherence.

| **Kwan et al.** (2004) Australia Case Control No Score TPS=5d N_start=351 N_end=351 | **Population**: Experimental Group (EG; N=197): Mean Age=74.5±12.2yr; Gender: Males=96, Females=101. Control Group (CG; N=154): Mean Age=74.5±11.7yr; Gender: Males=77, Females=77. **Intervention**: Patients in acute care before (CG) and after (EG) the implementation of an integrated care pathway were retrospectively compared. **Outcomes**: Mortality; Discharge; Complications. | 1. EG was less likely than CG to die by 5d (AOR=0.69, 95% CI 0.25-1.92) and in hospital (AOR=0.63, 95% CI 0.30-1.36), but these differences were not significant. 2. EG was less likely than CG to be discharged to institution by 5d (AOR=0.97, 95% CI 0.45-2.09) and from hospital (AOR=0.88, 95% CI 0.55-1.42), but these differences were not significant. 3. EG was more likely than CG to be discharged home by 5d (AOR=1.06, 95% CI 0.57-1.98) and from hospital (AOR=1.38, 95% CI 0.80-2.38), but these differences were not significant. 4. EG was significantly less likely than CG to have a urinary tract infection (AOR=0.37, 95% CI 0.15-0.91, p<0.05). There were no significant differences between groups for any/all other complications (e.g. fever, pneumonia, seizure, pressure sore). |
| **Taylor et al.** (2006) New Zealand Case Control No Score TPS=NA N_start=153 N_end=153 | **Population**: Experimental Group (EG; N=76): Median Age=77yr; Gender: Males=33, Females=43. Control Group (CG; N=77): Median Age=78yr; Gender: Males=34, Females=43. **Intervention**: Patients in acute care before (CG) and after (EG) the implementation of an integrated care pathway were retrospectively compared. **Outcomes**: Length of stay (LOS); Medical management. | 1. Median LOS was not significantly different between EG and CG for medical wards (5.5d vs 6d, p>0.05) or rehabilitation wards (21d vs 21d, p>0.05). 2. Medical management (i.e. investigations at admission, treatment of specific medical issues, and risk factor treatment at discharge) was not significantly different between groups. |
| **Middleton et al.** (2011) QASC study Australia RCT PEDro=8 | 1,696 stroke patients admitted to an acute stroke unit (ASU) within 48 hours of onset of symptoms were randomized to care on an ASU with standardized treatment protocols to manage fever, hyperglycaemia, and swallowing dysfunction with multidisciplinary team building workshops or to a control ASUs received only an abridged version of existing guidelines. The primary outcomes were 90-day death or dependency (modified Rankin scale [mRS] >/=2), Barthel index, and SF-36 physical and mental component summary scores. 19 ASUs were randomly assigned to intervention (n=10) or control (n=9). Intervention ASU patients were significantly less likely to be dead or dependent at 90 days (42% vs. 58%, p=0.002). Patients in the intervention ASU also had a better SF-36 mean physical component summary score (p=0.002). There were no significant differences between groups in mean BI scores or SF-36 mental component summary scores and no differences in 30-day mortality between groups. | 1. EG was more likely than CG to be discharged home by 5d (AOR=1.06, 95% CI 0.57-1.98) and from hospital (AOR=1.38, 95% CI 0.80-2.38), but these differences were not significant. |
| **Panella et al.** (2012) Italy RCT PEDro=6 | 14 hospitals were randomized to a clinical pathway (CP) group or to a non intervention/usual care (UC) arm. Healthcare workers in the CP arm received 3 days of training in quality improvement of CPs and in use of a standardized package including information on evidence-based key interventions and indicators. Healthcare workers in the usual-care arm followed their standard procedures. The primary outcome was 30-day mortality. 7-day mortality, LOS, readmission and institutionalization were not significantly different between groups. There was no difference in the 30-day mortality between groups (CP: 7.6% vs. UC: 10.5%, p=0.34). Compared with patients in the UC group, the patients in the CP arm had a significantly lower risk of mortality at 7 days (OR = 0.10; 95% CI 0.01 to 0.95) and significantly lower rates of adverse functional outcomes, expressed as the odds of not returning to pre-stroke functioning in their daily life (OR = 0.42; 95 CI 0.18 to 0.98). There were no differences between groups on the other outcomes. |
rates after discharge, dependency levels, and complication rates were also assessed.

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Study Design</th>
<th>Score Type</th>
<th>TPS</th>
<th>Start</th>
<th>End</th>
<th>Population:</th>
<th>Intervention:</th>
<th>Outcomes:</th>
<th>Results:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avis et al. (2012)</td>
<td>UK</td>
<td>Case Series</td>
<td>No Score</td>
<td>TPS&lt;24hr</td>
<td>NStart=1918</td>
<td>NEnd=1683</td>
<td>Mean Age=71.7±13.2yr; Gender: Males=926, Females=992.</td>
<td>Patients from multiple hospitals across Europe were retrospectively assessed according to the Organized Care Index (OCI). Outcomes were assessed at 7d, 30d, 3mo, and 12mo.</td>
<td>Mortality.</td>
<td>At 7d, mortality rate was significantly lower (p&lt;0.01) when OCI=3 (0.8%) than OCI=1 (9.3%) or OCI=2 (3.7%). At 30d, mortality rate was significantly lower (p&lt;0.01) when OCI=3 (7.2%) than OCI=1 (17.7%) or OCI=2 (12.0%). At 3mo, mortality rate was significantly lower (p&lt;0.01) when OCI=3 (12.6%) than OCI=1 (19.4%) or OCI=2 (16.4%). At 12mo, mortality rate was lower when OCI=3 (21.2%) than OCI=1 (22.2%) or OCI=2 (22.4%), but the difference was not significant.</td>
</tr>
<tr>
<td>Bray et al. (2013)</td>
<td>UK</td>
<td>Observational</td>
<td>No Score</td>
<td>TPSmedian=475min</td>
<td>NStart=36197</td>
<td>NEnd=36037</td>
<td>Median Age=77yr; Gender: Males=17723, Females=18474.</td>
<td>Patients from multiple hospitals across the country were assessed according to the corresponding organizational quality scores (OQS) and care processes (CP). Outcomes were assessed at 30d.</td>
<td>Mortality.</td>
<td>OQS=5-6 was associated with reduced mortality when compared to OQS=0-4 in univariate (OR=0.60, p&lt;0.001), adjusted multivariate (OR=0.74, p&lt;0.001), and instrumental variable (OR=0.62, p=0.0001) analyses. Consultation from a stroke specialist within 24hr (CP1) was associated with reduced mortality in univariate (OR=0.77, p&lt;0.001) and adjusted multivariate (OR=0.88, p&lt;0.009) analyses. Brain scan within 24hr (CP2) was associated with reduced mortality in univariate analysis (OR=0.89, p=0.01), but not adjusted multivariate analysis (OR=0.96, p=0.49). Visit from a nurse and a therapist within 24hr (CP3) was associated with reduced mortality in univariate (OR=0.82, p&lt;0.001) and adjusted multivariate (OR=0.90, p=0.028) analyses. Nutrition screening and swallow assessment (CP4) within 72hr was associated with reduced mortality in univariate (OR=0.78, p&lt;0.001) and adjusted multivariate (OR=0.76, p&lt;0.0001) analyses. Admission to stroke unit within 4hr was not associated with reduced mortality in univariate (OR=0.96, p=0.19) or adjusted multivariate (OR=0.99, p=0.75) analyses. Antiplatelet therapy and adequate nutrition within 72hr was associated with reduced mortality in univariate (OR=0.24, p&lt;0.001) and adjusted multivariate (OR=0.46, p&lt;0.0001) analyses.</td>
</tr>
<tr>
<td>Chau et al. (2014)</td>
<td>China</td>
<td>Quasi-experimental study</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Population: Intervention group (N=50): Mean age=71.5±10.5yr; Gender: Males=24, Females=26. Control group (N=105): Mean age=72.3±10.2yr; Gender: Males=62, Females=43.</td>
<td>This study looked at the functional Changes in outcome measures at 1yr:</td>
<td>Between-group differences for all outcome measures were not statistically significant for any of the outcome measures. Except for functional status, the change scores</td>
<td></td>
</tr>
</tbody>
</table>
and cognitive status of stroke patients as they underwent a new model of services. These services include Physiotherapy and Occupational therapy 6d a week as well as additional features of round-the-clock nursing and residential care, improved home like environment and advanced rehabilitation equipment.

**Outcomes:** Chinese version of *Modified Barthel Index* (MBI); *Mini-Mental Status Examination* (MMSE).

**Deng et al.** (2014)  
**China**  
**RCT**  
**PEDro=5**  
**NStart=332**  
**NEnd=332**

**Population:** Experimental Group (EG; N=166): Mean Age=66.74±8.57yr; Gender: Males=104, Females=62. Control Group (CG; N=166): Mean Age=66.32±8.95yr; Gender: Males=100, Females=66.

**Intervention:** Patients from multiple hospitals in one region were randomized to an integrated care pathway (EG) or conventional care (CG). Outcomes were assessed at admission, discharge, and 90d.

**Outcomes:** NIH Stroke Scale (NIHSS); Barthel Index (BI); Length of stay (LOS); Cost of hospitalization; Mortality.

1. Mean LOS in hospital was significantly shorter in EG than CG (17.93±6.35d vs 21.18±6.50d, p<0.01).
2. Mean hospitalization cost was significantly lower in EG than CG ($1923.56±1066.82 vs $2214.72±694.59, p<0.01).
3. Mean NIHSS score at 14d was not significantly different between EG and CG (4.15±2.53 vs 5.04±3.12, p=0.10).
4. Mean BI score at 90d was not significant different between groups (p=0.12).
5. Mortality rate was not significantly different between EG and CG (3.0% vs 2.4%, p=0.72).

**Brusco et al.** (2015)  
**Australia**  
**PCT**  
**No Score**  
**TPSOverall=NA**  
**NStart=996**  
**NEnd=996**

**Population:** Mean age=74±13yr; Gender: Males=37%, Females=64%.

**Intervention:** Control Group Care (N=500): Monday to Friday rehabilitation; Intervention group care (N=496): Monday to Saturday rehabilitation. This economic evaluation was a comparison of these two rehabilitation services. The outcome measures were measured at baseline (admission) and 6-and-12mo following discharge from rehabilitation.

**Outcomes:** Quality of life utility index score; Functional Independence Measure (FIM).  
*MCID increase of .18 in QOL  
*MCID seen with FIM increase of 22.

1. There were no statistically significant differences between the intervention and control groups for the HRQoL from baseline and 12mo follow-up, after discharge from rehabilitation.
2. The probability of achieving a MCID for HRQoL index score was 11% higher for intervention group patients compared to control group patients at 12mo while at 6mo, the probability of attaining a MCID in the intervention group was 19% higher.
3. For the FIM outcome, there were no statistically significant differences between the intervention and control groups at 12mo after discharge from rehabilitation. However, there was a statistically significant change in FIM scores for the intervention group found at 6mo after discharge (p=0.05).
4. Results from the economic evaluation suggest that the intervention is cost effective, since it is
The Elements of Stroke Rehabilitation

6.6 Timing of Stroke Rehabilitation

Table 6.6 Studies evaluating the timing of stroke rehabilitation

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Country</th>
<th>PEDro Score</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paolucci et al. (2000)</td>
<td></td>
<td></td>
<td>A case controlled study of 135 stroke patients who received: 1) rehabilitation within the first 20 days</td>
<td>Higher dropout rate was noted in the short onset group. Barthel Index scores in the short onset group were lower than in the long onset group.</td>
</tr>
</tbody>
</table>

1. Mortality rate at 90d was significantly lower in EG than CG (7.8% vs 20%, p=0.022). ICP was significantly associated with mortality according to bivariate correlation analysis (r=0.175, p=0.026), bivariate regression analysis (OR=0.33, 95% CI 0.12-0.90, p=0.03), and multivariate regression analysis (β=1.202, p=0.042).
2. Mortality was significantly associated with AP in bivariate correlation analysis (r=0.438, p<0.0005) and bivariate regression analysis (OR=24.18, 95% CI 7.6-76.9, p<0.0005).
3. Median BI score was not significantly different between EG and CG at discharge (80 vs 80, p=0.64) or 90d (95 vs 100, p=0.54). The rate of patients with BI>60 was also similar between groups (64.9% vs 65.4%).
4. Median mRS score was not significantly different between EG and CG at discharge (2 vs 2, p=0.80) or 90d (1 vs 1, p=0.86). The rate of patients with mRS<2 was also similar between groups (57.1% vs 57.6%).
5. Incidence of AP was lower in EG than CG, but the difference was not significant (6.5% vs 15.3%; RR=0.42, 95% CI 0.16-1.14, p=0.062).
6. Risk of mechanical ventilation was lower in EG than CG, but the difference was not significant (7.8% vs 17.6%; OR=0.39, 95% CI 0.14-1.07, p=0.05).
<table>
<thead>
<tr>
<th>Country</th>
<th>Study</th>
<th>Score</th>
<th>Patients and Intervention</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italy</td>
<td>No Score</td>
<td>Yagura et al. (2003)</td>
<td>1056 patients were divided into 3 groups based on the time from stroke onset to admission to rehabilitation: Grp 1 &lt;90 days; Grp 2 91-180 days; Grp 3 &gt;180 days.</td>
<td>1. Walking status improved in 71% of non-ambulatory patients in Grp 1, 55% in Grp 2 and 44% in Grp 3. ADLs improved in 67% of totally dependent patients in Grp 1 and 50% in Grps 2 and 3. 74% of patients in Grp 1 were discharged home compared to 60% in Grps 2 and 3.</td>
</tr>
<tr>
<td>Japan</td>
<td>No Score</td>
<td>Musicco et al. (2003)</td>
<td>1,716 stroke patients, with moderate to severe disability, consecutively admitted to 20 Italian hospital rehabilitation centers in 1997 and 1998 were followed. Three negative patient outcomes were considered: death, early failure (premature, unwanted interruption of rehabilitation program; absence of any improvement at hospital discharge), and late failure in terms of severe disability (Barthel Index score &lt;40) or poor quality of life (Medical Outcomes Study 36- Item Short-Form Health Survey; questionnaire score &lt;80) 6 months after admission.</td>
<td>1. Patients who initiated the rehabilitative procedures early (within 7d after stroke) had better long-term outcomes than did those who initiated the rehabilitation after more than 1 month (OR=2.12; 95% CI, 1.35-3.34) or from 15 to 30 days after the acute cerebrovascular event (OR=2.11; 95% CI, 1.37-3.26). 2. The presence of dementia and pressure ulcers on admission was associated with worse outcomes (OR for any failure or death=1.31; 95% confidence interval [CI], 1.03-1.67; OR=1.63; 95% CI, 1.12-2.37, respectively).</td>
</tr>
<tr>
<td>Canada</td>
<td>No Score</td>
<td>Salter et al. (2006)</td>
<td>435 patients admitted to an inpatient stroke rehabilitation program within 150 days of a first unilateral stroke were studied. Patients were grouped according to time from onset of stroke to admission to the rehabilitation unit: 0 – 15, 16-30, 31-60, 61-90 and 91-150 days.</td>
<td>1. FIM scores at admission and discharge as well as FIM change and FIM efficiency were significantly higher for early admission than for delayed admission patients. LOS was significantly longer among delayed admission patients. There were significant differences on admission and discharge FIM scores, FIM change and LOS between groups of patients admitted 0 – 15 and 16-30 days post stroke as well as between patients admitted from 16 – 30 days and 31-60 days. However, no significant differences in FIM admission, FIM discharge, FIM change scores or LOS were noted between patients admitted from 31 – 60 and 61-90 days or 61 – 90 and 91-150 days post stroke.</td>
</tr>
<tr>
<td>Canada</td>
<td>No Score</td>
<td>Gagnon et al. (2006)</td>
<td>418 stroke patients, matched on age, gender and degree of stroke severity were retrospectively analyzed according to the time from stroke onset to admission to a stroke rehabilitation unit. Three cohorts were assembled; onset &lt; 20 days (short), onset 20-40 days (moderate), and onset &gt; 40 days (long). Admission, discharge FIM, FIM efficiency, FIM change and LOS were assessed.</td>
<td>1. There were no significant differences between the groups (short, moderate long) on any of the variables assessed. LOS was similar (51 vs. 48 vs. 47 days), as was FIM efficiency (0.53 vs. 0.62 vs. 0.53).</td>
</tr>
<tr>
<td>Australia</td>
<td>8 (RCT)</td>
<td>Bernhardt et al. (2008a)</td>
<td>Population: Mean Age=74.7±12.5yr; Gender: Male=38, Female=33. Intervention: Patients were randomized to receive either standard care (no further details) or very early mobilization (VEM) in addition to standard care. VEM began &lt;24hr post stroke and consisted of</td>
<td>1. There was no significant difference in the number of deaths between groups (SC, 3 of 33; VEM, 8 of 38; p=0.20). Almost all deaths occurred in patients with severe stroke. After adjusting for age, baseline NIHSS score and premorbid mRS score, the odds of experiencing a</td>
</tr>
</tbody>
</table>
N\text{Start}=71
N\text{End}=71

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Sitting, standing or walking ≥2x/d for 6d/wk.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment lasted for 14d or until discharge.</td>
<td>Good outcome were significantly higher at 12 months for the VEM group (OR: 8.15, 95% CI 1.61-41.2, p&lt;0.01). There was also a trend towards good outcome at 3 months, but not at 6 months.</td>
</tr>
<tr>
<td>Mortality; Modified Rankin Scale (mRS); Adverse events; Number of falls;</td>
<td>2. Death at 3 mo post stroke occurred in 11 (15.5%) patients with a greater proportion of VEM patients dying compared to standard care patients (21% vs 9.1% respectively).</td>
</tr>
<tr>
<td>Excessive fatigue; Deterioration of speech, consciousness level or movement of the arm, leg or eye.</td>
<td>3. Significantly greater amounts of mobilization were experienced by the VEM group compared to standard care patients (median 167 min vs 69 min respectively) (p=0.003).</td>
</tr>
<tr>
<td>Outcomes</td>
<td>4. The time from onset to mobilization was significantly lower in the VEM group compared to the standard care group (18.1 hr vs 30.8 hr respectively) (p&lt;0.001).</td>
</tr>
<tr>
<td>Adverse events; Number of falls; Excessive fatigue; Deterioration of speech, consciousness level or movement of the arm, leg or eye.</td>
<td>5. The number of serious adverse events at 3 mo was not significantly different between groups.</td>
</tr>
<tr>
<td>1. Patients with a good outcome (mRS&lt;3) were significantly higher at 12 months for the VEM group (OR: 8.15, 95% CI 1.61-41.2, p&lt;0.01). There was also a trend towards good outcome at 3 months, but not at 6 months.</td>
<td>6. Significantly greater amounts of mobilization were experienced by the VEM group compared to standard care patients (median 167 min vs 69 min respectively) (p=0.003).</td>
</tr>
<tr>
<td>2. Death at 3 mo post stroke occurred in 11 (15.5%) patients with a greater proportion of VEM patients dying compared to standard care patients (21% vs 9.1% respectively).</td>
<td>7. The number of serious adverse events at 3 mo was not significantly different between groups.</td>
</tr>
<tr>
<td>3. The time from onset to mobilization was significantly lower in the VEM group compared to the standard care group (18.1 hr vs 30.8 hr respectively) (p&lt;0.001).</td>
<td>8. No significant differences were observed in the total number of falls &lt;3 mo post stroke.</td>
</tr>
<tr>
<td>4. The adverse events included stroke progression in 7 patients, pneumonia in 7, recurrent stroke in 1, myocardial infarction in 2, atrial fibrillation in 1 and other events in 11.</td>
<td>9. No significant difference was observed in deterioration from 0-7 d post intervention between groups.</td>
</tr>
<tr>
<td>5. The number of serious adverse events at 3 mo was not significantly different between groups.</td>
<td>10. Excessive fatigue was not significantly different between groups.</td>
</tr>
<tr>
<td>6. Significantly greater amounts of mobilization were experienced by the VEM group compared to standard care patients (median 167 min vs 69 min respectively) (p=0.003).</td>
<td>11. The proportion of patients with a good outcome (mRS&lt;3) was not significantly different between groups at 3 mo, 6 mo and 12 mo post stroke.</td>
</tr>
</tbody>
</table>

---

### Additional Analysis from AVERT Trial

Additional analysis from AVERT trial, examining the number and severity of complications between groups. Complications were classified according to type (complications of immobility, stroke-related, co-morbidity related, psychological and other) and severity.

1. Within 3 months of admission there were no differences in the number or severity of complications between groups. Patients in the SC group experienced a total of 91 counts of complications while patients in the VEM group experienced 87. There were no differences in the severity of complications between groups.

### Charts of 76 Patients Admitted for Inpatient Rehabilitation Following First-Ever Stroke

The charts of 76 patients admitted for inpatient rehabilitation following first-ever stroke were reviewed. Associations with, and predictors of, BI gains were examined at 1, 3, 6 and 12 months.

1. Time from stroke onset to rehabilitation was negatively associated with BI gains at 1 mo and 1 yr.

### Population

**Mean age=63.1±15.6 yr; Gender:** Males=99, Females=55.

**Intervention:** Acute stroke patients with more severe neurological deficits (NIHSS>10) admitted to the charts of 76 patients admitted for inpatient rehabilitation following first-ever stroke were reviewed. Associations with, and predictors of, BI gains were examined at 1, 3, 6 and 12 months.

1. Stroke severity (assessed using the NIHSS scale), age, rehab intensity, admission BI score and onset to admission were all significant predictors of increases in BI scores, explaining 64% of the
the stroke intensive care unit (ICU) were prospectively assessed to examine the rehabilitation commencement time and intensity as predictors of functional outcomes. **Outcomes:** Sociodemographic data; Medical data; Barthel Index; Walking ability at discharge.

1. The mean start time of rehabilitation was 6.7 days after stroke onset.
2. 11% of patients had a mild stroke, 44% of patients had a moderate stroke and 45% of patients were classified as severe stroke patients.
3. Average length of stay in the ICU was 10.4±8.8 days.
4. The mean intensity of rehabilitation was 0.6 sessions/day and each session was typically 30 to 45 minutes in length.
5. Compared to patients with ischemic stroke, those with a hemorrhagic stroke had better improvements in the BI score (p<0.024), and had higher proportion of regarding walking ability (p<0.047).
6. Admission NIHSS score was the most important predictor of the BI score at discharge, with patient with a higher score on admission being more dependent on discharge from hospital (p=0.0005).
7. The intensity of rehabilitation and onset-to-commencement of rehabilitation were significantly correlated with the BI score at discharge after controlling for initial severity and age (p<0.05).
8. Age (p<0.05), premorbid disability (p<0.005), heart disease (p<0.005), NIHSS score (p<0.005), BI score (p<0.005), urinary incontinence (p<0.005), complications (p<0.005), stroke type (p<0.05), and rehabilitation intensity (p<0.005) were all significantly associated with walking function.
9. The admission NIHSS score was the best predictor of walking ability at discharge, with each point increase in the NIHSS score, indicating a decrease in chance of about 13% of regaining independent walking function.
10. After adjusting for severity and age, rehabilitation intensity accounted for 15% of the variance of walking function at discharge.
11. Subgroup analysis for severe patients revealed that rehabilitation intensity (p=0.0001) motor stage of upper extremity (p=0.01), and age (p=0.016) significantly predicted BI score at discharge.
12. In the severe subgroup, rehabilitation intensity (p=0.0001) and age (p=0.044) significantly predicted walking function at discharge.
13. Rehabilitation intensity was the best predictor of variability in model. Starting rehab one day sooner resulted in a 0.65 point increase in BI score. Timing of rehab was not a significant predictor an independent walking at the time of discharge, but was a predictor of BI score at discharge.
The Elements of Stroke Rehabilitation

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Design</th>
<th>PEDro</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Langhorne et al. (2010b)</strong></td>
<td>Scotland</td>
<td>RCT</td>
<td>7</td>
<td>32 acute stroke patients (stroke onset &lt; 36 hrs) were randomized to 1 of 4 nurse-led treatment protocols: (a) standard stroke unit care, (b) early mobilization (EM) where patients were encouraged to sit, stand or walk within 24 hrs of stroke and to repeat at least 4 x/day, (c) automated physiological monitoring (AM) or (d) combined EM and AM. 1. With respect to the comparison of EM vs. control, the EM patients were significantly less likely to experience a medical complication resulting from immobility, after correcting for age, baseline NIH score and co-interventions, within the first 5 days of stroke. There was no longer a significant difference between groups at the 3-month assessment point.</td>
</tr>
<tr>
<td><strong>Wang et al. (2011)</strong></td>
<td>USA</td>
<td>Case Series</td>
<td>No Score</td>
<td>Population: Mean Age=63.6±13.5yr; Gender: Males=1036, Females=872. Intervention: Patients admitted to an inpatient rehabilitation hospital (IRH) with moderate (n=614) or severe (n=1294) impairments were retrospectively analyzed based on time to admission (TTA). Outcomes: Functional Independence Measure (FIM). 1. In patients with moderate impairment, TTA was significantly correlated with gains in Total FIM score (r=−0.19, p&lt;0.0001) and Motor FIM score (r=−0.18, p&lt;0.0001), but not Cognition FIM score (r=−0.07, p=0.08), during IRH stay. 2. Each additional day of TTA caused significant mean decreases in gains to Total FIM (−0.07±0.02, p&lt;0.0001) and Motor FIM (−0.06±0.01, p&lt;0.0001), but not Cognition FIM (−0.01±0.01, p=0.23). 3. These patients achieved a greater Total FIM gain when admitted to an IRH within 21d of stroke onset. 4. In patients with severe impairment, TTA was significantly correlated with gains in Total FIM score (r=−0.25, p&lt;0.0001), Motor FIM score (r=−0.24, p&lt;0.0001), and Cognition FIM score (r=−0.10, p&lt;0.001) during IRH stay. 5. Each additional day of TTA caused significant mean decreases in gains to Total FIM (−0.08±0.01, p&lt;0.0001), Motor FIM (−0.06±0.01, p&lt;0.0001), and Cognition FIM (−0.01±0.003, p&lt;0.0001). 6. These patients achieved a greater Total FIM gain when admitted to an IRH within 30d of stroke onset. 7. Patients with severe impairment had significantly longer mean TTA than those with moderate impairment (30.9±37.4d vs 19.8±24.7d, p&lt;0.0001). 8. TTA was significantly associated with age (r=0.01, p=0.0026), hemorrhagic stroke (r=0.300, p&lt;0.0001), previous stroke (r=0.027, p&lt;0.0001), and admission FIM score (r=−0.01, p&lt;0.0001).</td>
</tr>
<tr>
<td><strong>Cumming et al. (2011)</strong></td>
<td>Australia</td>
<td>RCT</td>
<td>7</td>
<td>Additional analysis from AVERT trial. 1. Patients in the very early and intensive mobilization group returned to walking significantly sooner than did standard stroke unit care controls (P=0.032; median 3.5 vs. 7.0 days). There were no differences in proportions of patients who were independent on the BI (score of 20) or who had achieved a good</td>
</tr>
</tbody>
</table>

6. The Elements of Stroke Rehabilitation

[www.ebrsr.com](http://www.ebrsr.com)
<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Study Design</th>
<th>PEDro Score</th>
<th>Key Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diserens et al. (2012)</td>
<td>Switzerland</td>
<td>RCT</td>
<td>7</td>
<td>50 acute ischemic stroke patients with NIHSS score &gt;6 were randomized to an early protocol in which patients were mobilized out of bed after 52 hours or to a delayed protocol where patients were mobilized after seven days. All patients were treated with physiotherapy immediately after their admission. The primary outcome was development of a serious complication during hospitalization. Secondary outcomes included minor complications, which did not increase length of stay significantly. 8% of patients with Rankin scores of 0-2 at 3 months and changes in cerebral blood flow.</td>
</tr>
<tr>
<td>Sundseth et al. (2012)</td>
<td>Norway</td>
<td>RCT</td>
<td>7</td>
<td>65 patients admitted to a stroke unit within 24 hours after stroke were assigned to either VEM within 24 hours of admittance or mobilization between 24 and 48 hours (control group). The primary outcome was the proportion of poor outcome (modified Rankin scale score, 3-6). Secondary outcomes were death rate, change in neurological impairment (National Institutes of Health Stroke Scale score), and dependency (Barthel Index 0-17).</td>
</tr>
<tr>
<td>Bai et al. (2012)</td>
<td>China</td>
<td>RCT</td>
<td>4</td>
<td>364 patients with hemorrhagic stroke were randomized to receive a standardized, three-stage rehabilitation program or to a control group that was treated with standard hospital ward, internal medical intervention. Patients in the experimental group began therapy within 24 hours of admission. Therapy was provided for 45 min/day x 5 days/week. During the first month, therapy continued in hospital and the community for 6 months. Outcomes assessed at baseline, 1, 3 and 6 months included the simplified Fugl-Meyer Assessment Scale (FMA) and Modified Barthel Index (MBI).</td>
</tr>
<tr>
<td>Alkan et al. (2011)</td>
<td>Turkey</td>
<td>Observational Study</td>
<td>NA</td>
<td>Population: Mean age = 68.14±8.96yr; Gender: Males = 64yr, Females = 74yr. Intervention: Rehabilitation was offered to patients within 100d of first cerebrovascular event (CVA)/stroke; onset of rehabilitation was provided at 5 different time points: within first 20d; 21-40d; 41 to 60d; 61 to 80d and 81 to 100d. Physiotherapy (PT) rehabilitation protocol was used.</td>
</tr>
</tbody>
</table>

Outcome on the Rivermead Motor Assessment Scale (score of 10-13) at either 3 or 12 months. VEM group assignment was a significant, independent predictor of independence on the BI at 3 months, but not at 6 months. VEM group assignment was a significant, independent predictor of good outcome on RMA at both 3 and 12 months.

1. Eight patients were in the delayed group were transferred to other hospitals and were not included in the analysis. There were 2 (8%) severe complications in the 25 early mobilization patients and 8 (47%) in the 17 delayed mobilization patients (P < 0.006). There were no differences in the total number of complications or in any of the other outcomes. There were no differences in blood flow in the 26 patients (62%) who underwent serial transcranial Doppler ultrasonography.

1. The median time to first mobilization was 13 hrs for patients in the VEM group and 33 hrs for patients in the control group. At 3 months, the odds of a poor outcome, death and dependency were non-significantly higher in the control group after adjusting for age and stroke severity: (OR, 2.70; 95% CI, 0.78-9.34; P=0.12; OR, 5.26; 95% CI, 0.84-32.88; P=0.08, and OR, 1.25; 95% CI, 0.36-4.34; P=0.73, respectively).

1. Patients in both groups improved over the study period, although patients in the experimental group achieved significantly greater gains on both FMA and MBI scores (p<0.05). The greatest improvement was observed in the first month post-stroke.

1. Results from the Kruskall-Wallis Test showed that there were no statistically significant differences among the groups with respect to efficiency and effectiveness. This suggested that results of rehabilitation were not affected by the timing of rehabilitation offered within the first 100d post-stroke period.
offered to patients and was performed for 60 mins, twice daily (120min/day in total). PT was generally provided for those who required training for neglect, speech therapy, swallowing, bowel and bladder dysfunction, and individual training as required. No specific rehabilitation protocol was disclosed in the paper.

**Outcomes:** Brunnstrom Recovery Scale (BRS); Functional Independence measure (FIM).

<table>
<thead>
<tr>
<th><strong>Population</strong></th>
<th><strong>Intervention</strong></th>
<th><strong>Outcomes</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bai et al. (2014)</strong> China RCT PEDro=6 TPS&lt;6=10±5.31d TPS&gt;6=10.20±5.72d NStart=165 NEnd=154</td>
<td>Experimental group (EG; N=83): Mean age=67.63±9.52yr; Gender: Males=51, Females=31. Control group (CG; N=82): Mean age=66.04±10.13yr; Gender: Males=51, Females=32.</td>
<td>MAS scores in the EG were lower than those in the CG at month 6, in the elbows, fingers and plantar flexors (p&lt;0.05) and also in the fingers, and plantar flexors at month 3 (p&lt;0.03).</td>
</tr>
<tr>
<td><strong>Liu et al. (2014)</strong> China RCT PEDro=8 TPS&lt;6=48hr TPS&gt;6=7d NStart=243 NEnd=227</td>
<td>Experimental Group (EG; N=122): Mean Age=58.5±12.3yr; Gender: Males=67, Females=55. Control Group (CG; N=121): Mean Age=59.1±15.5yr; Gender: Males=70, Females=51.</td>
<td>1. Mean BI score was greater in the EG than CG at 3mo (68.3±22.0 vs 67.7±14.3) and 6mo (73.8±23.2 vs 61.3±20.4); the latter difference was clinically meaningful (≥5). 2. Mean SF-36 Physical Component Summary was greater in the EG than CG at 3mo (41.2±7.8 vs 40.1±6.0) and 6mo (43.8±7.9 vs 37.4±9.0); the latter difference was clinically meaningful (≥2). 3. Rate of patients experiencing &lt;2 AEs within 6mo was significantly greater in the CG than EG (83% vs 31%, p&lt;0.001). 4. Risk of mortality within 6mo was greater in the CG than EG (11% vs 3%; HR=4.25, 95%CI=1.20-15.07).</td>
</tr>
<tr>
<td><strong>Sundseth et al. (2014)</strong> Norway RCT PEDro=7 TPS&lt;6=10.5hr (8.5-22.3hr) TPS&gt;6=35.8hr (28.0-41.0hr) NStart=52 NEnd=51</td>
<td>Mean Age=76.4±9.4yr; Gender: Males=25, Females=27. Patients were randomized to receive very early (&lt;24hr; N=27) or early (≥24hr; N=25) mobilization. Outcomes were assessed at baseline and 3mo.</td>
<td>1. Very early mobilization was not a significant predictor of good outcome (MRS≤2; OR=0.40, p=0.12). 2. Good outcome was not significantly predicted by admission NIHSS score (OR=0.90, p=0.11), age (OR=0.96, p=0.23), gender (OR=2.50, p=0.12), or various stroke risk factors (e.g. previous stroke, hypertension, diabetes).</td>
</tr>
<tr>
<td><strong>Bernhardt et al. (2015)</strong> Australia RCT</td>
<td>Experimental Group (EG; N=1054): Mean Age=72.3yr; Gender: Males=643, Females=411. Control Group (CG; N=1050): Mean Age=72.7yr; Gender: Males=643, Females=407.</td>
<td>1. The adjusted odds of favourable outcome (MRS&lt;2) favoured the CG over the EG (50% vs 46%; OR=0.73, p=0.004). 2. The adjusted odds of &gt;50% patients passing the</td>
</tr>
</tbody>
</table>
**Intervention:** Patients were randomized to receive very early mobilization (VEM; EG) or standard care (CG). VEM was delivered within 24hr of stroke onset for up to 14d. Standard care was delivered daily for up to 14d. Outcomes were assessed at baseline and 3mo.

**Outcomes:** Modified Rankin Scale (MRS); 50m Walking Test (50MWT); Adverse Events (AEs).

50MWT were not significantly different between the EG and CG (OR=11.04, p=0.459).

3. There were no significant differences between the EG and CG in odds of mortality (OR=1.34, p=0.113), non-fatal serious AEs (OR=0.88, p=0.194), immobility serious AEs (OR=0.92, p=0.665), or neurologic serious AEs (OR=1.26, p=0.108).

4. In subgroup analyses of patients based on age, stroke severity, stroke type, and time to first mobilization (TTFM), the adjusted odds of favourable outcome favoured the CG over the EG, but none of these interactions were significant (p>0.05).

5. EG had significantly more rehabilitation than the CG (p<0.0001) in terms of median daily frequency (6.5x/d vs 3x/d), median daily amount (31min vs 10min), and median total amount (202min vs 70min), as well as significantly earlier median TTFM (18.5hr vs 22.4hr, p<0.0001).

6. TTFM (per extra 1hr) was significantly associated with reduced odds of favourable outcome (OR=0.99, p=0.036) and passing the 50MWT (HR=0.99, p<0.001).

7. Median daily frequency of rehabilitation (per extra 1x) was significantly associated with increased odds of favourable outcome (OR=1.13, p<0.001) and passing the 50MWT (OR=1.66, p<0.001; HR=1.10, p<0.001), and with reduced odds of mortality (OR=0.78, p<0.01) and neurologic serious AEs (OR=0.89, p=0.001).

8. Median daily amount of rehabilitation (per extra 5min) was significantly associated with reduced odds of favourable outcome (OR=0.94, p<0.001), passing the 50MWT (OR=0.85, p<0.001; HR=0.96, p<0.001), and nonfatal serious AEs (OR=0.96, p=0.01).

---

**Population:** Experimental Group (EG; N=18): Mean Age=64±18yr; Gender: Males=6, Females=12.

Control Group (CG; N=19): Mean Age=66±16yr; Gender: Males=7, Females=12.

**Intervention:** Patients were randomized to receive very early mobilization (VEM; EG) or standard care (CG). VEM was delivered within 48hr of stroke onset for 30min/d, 5d/wk up to 14d. Standard care was delivered 15min/d up to 14d. Outcomes were assessed at baseline (N=37), 14d (N=36), and 3mo (N=29).

**Outcomes:** National Institutes of Health Stroke Scale (NIHSS); Modified Barthel Index (MBI); Modified Rankin Scale (MRS); Length of Stay (LOS); Complications; Mortality.

---

1. Mean NIHSS scores were lower in the EG than CG at baseline (10±7 vs 11±6, p=0.71), 14d (7±6 vs 10±7, p=0.20), and 3mo (5.1±6.3 vs 5.5±4.3, p=0.84), but these differences were not significant.

2. Median MBI score at 3mo was higher in EG than CG (85 vs 80), but the difference was not significant (p=0.51).

3. Patients with MBI≥85 at 3mo was greater in the EG than CG (57% vs 47%), but the difference was not significant (p=0.51).

4. Patients with MRS≤1 at 3mo was greater in the EG than CG (25% vs 6%), but the difference was not significant (p=0.33).

5. Patients with MRS≤2 at 3mo was greater in the
CG than EG (53% vs 50%), but the difference was not significant (p=0.87).
6. Median LOS was greater in the CG than EG (10d vs 8d), but the difference was not significant (p=0.66).
7. Complication rate at 3mo was higher in the EG than CG (18% vs 12%), but the difference was not significant (p=0.50).
8. Mortality rate at 3mo was higher in the EG than CG (13% vs 12%), but the difference was not significant (p=0.68).

**Wang et al. (2015)**
USA
Case Series
No Score
TPS\text{mean}=10.1\pm19.8d
N\text{Start}=5224
N\text{End}=5224

**Population:** Mean Age=69.2\pm13.6yr; Gender: Males=2649, Females=2575.

**Intervention:** Patients admitted to an inpatient rehabilitation hospital (IRH) with mild (n=649), moderate (n=2185), or severe (n=2390) impairments were retrospectively analyzed based on time to admission (TTA).

**Outcomes:** Functional Independence Measure (FIM).

1. In patients with severe impairment, patients with TTA < 14d had significantly greater gain in Motor FIM score than those with TTA > 15d (p<0.002), while patients with TTA < 7d had significantly greater gain in Cognition FIM score than those with TTA > 15d (p<0.006).
2. In patients with moderate impairment, patients with TTA < 7d had significantly greater gain in Motor FIM score than those with TTA > 15d (p<0.005), but there was no significant association between TTA and Cognition FIM score.
3. In patients with mild impairment, there was no significant association between TTA and FIM scores.

**Chippala & Sharma (2016)**
India
RCT
PEDro=7
TPS\text{EG}=18hr (17-20hr)
TPS\text{CG}=31hr (29-35hr)
N\text{Start}=86
N\text{End}=80

**Population:** Experimental Group (EG; N=40): Mean Age=59.32\pm9.80yr; Gender: Males=20, Females=20.
Control Group (CG; N=20): Mean Age=60.57\pm11.34yr; Gender: Males=22, Females=18.

**Intervention:** Patients were randomized to receive very early mobilization (VEM; EG) or standard care (CG). VEM was delivered within 24hr of stroke onset for 5-30min at least 2x/d for 7d. Standard care was delivered 1x/d for 7d. Outcomes were assessed at admission, discharge, and 3mo follow-up (N=80).

**Outcomes:** Barthel Index (BI).

1. EG showed a significant mean increase in BI score from admission to discharge (33.12\pm7.73, p<0.05) and from admission to follow-up (45.25\pm13.77, p<0.05).
2. CG showed a significant mean increase in BI score from admission to discharge (21.00\pm12.15, p<0.05) and from admission to follow-up (28.25\pm12.38, p<0.05).
3. Improvement on the BI was significantly greater in the EG than the CG from admission to discharge (p<0.001) and from admission to follow-up (p<0.001).
4. Based on BI scores, independence was achieved in significantly more of the EG than the CG at discharge (70% vs 33%, p<0.01) and follow-up (85% vs 45%, p<0.01).

**Morreale et al. (2016)**
Italy
RCT
PEDro=7
TPS_{EG1}=17\pm2hr
TPS_{EG2}=17\pm3hr
TPS_{CG1}=18\pm1hr
TPS_{CG2}=17\pm1hr
N\text{Start}=340

**Population:** Experimental Group 1 (EG1; N=110): Mean Age=64\pm14yr; Gender: Males=80, Females=30.
Experimental Group 2 (EG2; N=110): Mean Age=63\pm12yr; Gender: Males=81, Females=29.
Control Group 1 (CG1; N=60): Mean Age=63\pm15; Gender: Males=42, Females=18.
Control Group 2 (CG2; N=60): Mean Age=64\pm13yr; Gender: Males=43, Females=17.

**Intervention:** Patients were randomized to receive rehabilitation with proprioceptive neuromuscular

1. In the PNF groups, mean BI scores significantly improved (p<0.01) from baseline to 3mo in EG1 (46\pm8 to 63\pm6) and CG1 (47\pm3 to 62\pm9), and from baseline to 12mo in EG1 (46\pm8 to 89\pm2) and CG1 (47\pm3 to 71\pm9). Improvement was significantly greater in EG1 than CG1 at 12mo (p=0.02), but there was no significant difference at 3mo (p=0.492).
2. In the CTE groups, mean BI scores significantly improved (p<0.01) from baseline to 3mo in EG2
facilitation (PNF) or cognitive therapeutic exercise (CTE), either early (<24hr) or late (>4d) post stroke: early PNF (EG1), late PNF (CG1), early CTE (EG2), or late CTE (CG2). Early groups received postural alignment and positioning for 15min/d, with 45min/d of passive/active proximal joint mobilization (PNF) or guided movements during attention tasks (CTE), for 4d. Late groups received only postural alignment and positioning for 60min/d for 4d. After 4d, all groups received inpatient rehabilitation with PNF or CTE (2.15hr/d, 7d/wk) for 14wk, followed by outpatient rehabilitation with PNF or CTE (1.30hr/d, 5d/wk) for up to 38wk. Outcomes were assessed at baseline, 3mo (N=302), and 12mo (N=293).

Outcomes: Barthel Index (BI); Modified Rankin Scale (MRS); Motricity Index (MI); Six-Minute Walk Test (6MWT); Adverse Events (AEs).

3. In PNF and CTE groups, mean MRS scores significantly improved (p<0.01) from baseline to 3mo (4±1 to 3±1) and from baseline to 12mo (4±1 to 2±1). There were no significant differences in improvements between early and late groups at 3mo or 12mo (p>0.05).

4. MI scores at 12mo were significantly greater in the early groups than late groups for both upper limbs (p=0.01) and lower limbs (p=0.001).

5. 6MWT scores at 12mo were significantly greater in the early groups than late groups (p=0.01).

6. In terms of AEs, the early groups had significantly lower rates of shoulder pain syndrome than the late groups (p<0.04). They also had lower rates of pressure sores and total AEs, as well as higher rates of infections and thrombosis, but these differences were not significant.

7. There were no significant differences between PNF and CTE groups for any outcome at any time point.

### 6.7 Intensity of Therapy

#### 6.7.1 Intensity of Physical and Occupational Therapy

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Country</th>
<th>PEDro Score</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith et al. (1981)</td>
<td>Australia and UK</td>
<td>5 (RCT)</td>
<td>133 recovering stroke patients were randomized to one of 3 groups: 1) intensive outpatient rehabilitation therapy 6hrs/day x 3 days/week, 2) conventional outpatient therapy (3 hrs/day, 3 days/week) or 3) home visits by a nurse with no therapy.</td>
<td>At 3 months, the greatest improvement in ADL scores was observed in patients who received intensive therapy, followed by patients who received conventional therapy and finally by patients who did not receive any therapy. A similar pattern was repeated at 12 months. The greatest proportion of patients whose scores deteriorated at both 3 and 12 months was reported in patients who did not receive any therapy.</td>
</tr>
<tr>
<td>Sivenius et al. (1985)</td>
<td>Finland</td>
<td>5 (RCT)</td>
<td>95 consecutive stroke patients able to tolerate an intensive rehabilitation program were randomized at one-week following stroke to either an intensive physiotherapy program on a stroke unit or a control group receiving conventional physiotherapy on a general medical unit.</td>
<td>Patients receiving intensive physiotherapy had significantly improved their level of ADL and mobility at 3, 6 and 12 months. The greatest gains were achieved in the first 3 months.</td>
</tr>
<tr>
<td>Study</td>
<td>Sample Size</td>
<td>Randomization</td>
<td>Intervention</td>
<td>Findings</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------------</td>
<td>---------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Sunderland et al. (1992)</td>
<td>132 patients</td>
<td>Randomized to receive either conventional therapy (control) or enhanced arm therapy which included Bobath exercises, EMG biofeedback, micro-computer games and goal setting.</td>
<td>Severe sub-group: No significant differences between the groups. Mild sub-group: Patients receiving enhanced therapy scored higher on the Extended Motricity Index, the 9-hole peg test and on the Motor Club Assessment than those receiving conventional therapy.</td>
<td></td>
</tr>
<tr>
<td>Richards et al. (1993)</td>
<td>27 patients</td>
<td>Randomized to receive one of three therapies: 1) Early intensive therapy incorporating the use of a tilt table, resisted exercises and treadmill, beginning ~8 days post stroke, for 1.7 hrs/day x 5 weeks (experimental); 2) Early conventional therapy included traditional approach with therapy beginning ~9 days post stroke, for 1.8 hrs/day x 5 wks (control 1); or 3) Conventional therapy beginning 13 days post stroke, 0.72 hours/day x 5 wks (control 2).</td>
<td>At week 6, gait speed in the 2 control groups was similar and lower than the experimental group. By months 3 and 6, the gait speed between all groups was similar.</td>
<td></td>
</tr>
<tr>
<td>Nugent et al. (1994)</td>
<td>54 stroke patients</td>
<td>Received a weight-bearing exercise (WBE) program that continued until patients scored 6 on the Motor Assessment Scale (MAS) for walking or until discharge.</td>
<td>Significant overall Pearson correlation (r=.45) between the number of WBE repetitions and change in MAS scores.</td>
<td></td>
</tr>
<tr>
<td>Sunderland et al. (1994)</td>
<td>97 patients</td>
<td>Follow-up of 97 patients participating in the 1992 study.</td>
<td>At one-year follow-up there were no significant differences between the 2 groups on any of the outcome measures (Extended Motricity Index, 9-hole peg test or Frenchay Activities Index).</td>
<td></td>
</tr>
<tr>
<td>Werner and Kessler (1996)</td>
<td>49 stroke patients</td>
<td>Randomized to receive either intensive 12 week rehabilitation therapy for 1 hour a day for 4 days a week, or to no rehabilitation therapy (control).</td>
<td>Significant improvements of FIM-motor scores were noted at 3 months for the treatment group; however no significant differences in FIM-MM gains were observed between the 2 groups from 3 to 9 months. Significant decline in SIP scores was observed in the treatment group at 3 months.</td>
<td></td>
</tr>
<tr>
<td>Logan et al. (1997)</td>
<td>111 stroke patients</td>
<td>Randomized to receive either enhanced services or received usual services. Patients in the enhance therapy group were seen significantly sooner following discharge (9 vs. 22.5 days), received more visits (6 vs. 2.5) and more therapy time (240 vs. 85 min) than patients receiving usual service.</td>
<td>At 3 months, the patients in the enhanced therapy group had higher EADL scores compared to patients receiving usual care. However, at 6 months, there were no differences between the two groups on any of the outcome measures.</td>
<td></td>
</tr>
<tr>
<td>Feys et al. (1998)</td>
<td>100 patients</td>
<td>A multicentre trial of 100 patients (2 to 5 weeks after stroke onset) received either additional sensorimotor treatment 30 min x 5 days/wk x 6 wks (treatment) or a placebo treatment (control).</td>
<td>There were no differences in Fugl-Meyer (FM) scores between the groups at 6 wks. Patients in the experimental group scored higher on the FM at 6 and 12 months follow-up than the placebo treatment. No significant differences between the groups were observed in Action Research Arm (ARA) or Barthel Index (BI) scores. Patients in both groups improved significantly over time in FM, ARA and BI scores.</td>
<td></td>
</tr>
<tr>
<td>Kwakkel et al. (1999)</td>
<td>101 patients</td>
<td>Randomized 14 days following stroke to receive one of 3 therapies: 1) arm training, 2) leg training or 3) basic rehabilitation only. Leg and arm treatments were applied for 30 min 5 days/week x 20 weeks. All patients received basic rehabilitation.</td>
<td>At week 26, significant differences in median Action Research arm (ARA) scores between the three groups were observed. Median Barthel Index and ARA scores of patients in both arm and leg training groups were significantly higher when compared to the control group.</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Sample Size</td>
<td>Design</td>
<td>Intervention Details</td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------</td>
<td>-------------</td>
<td>--------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Lincoln et al. (1999)</td>
<td>UK</td>
<td>282 patients</td>
<td>7 (RCT)</td>
<td>282 patients randomized to receive one of 3 therapy groups: 1) routine physiotherapy (RPT), 2) routine therapy with additional PT from a qualified therapist (QPT) or 3) routine therapy with additional PT from a physiotherapist assistant (APT). The intervention groups (QPT, APT) received 10 hrs of additional physiotherapy over 5 weeks.</td>
</tr>
<tr>
<td>Ruff et al. (1999)</td>
<td>USA</td>
<td>113 patients</td>
<td>3 (quasi-RCT)</td>
<td>113 stroke patients received either therapy 6 days/wk or received therapy 7 days/wk. OT/PT/SLP interventions.</td>
</tr>
<tr>
<td>Parry et al. (1999)</td>
<td>UK</td>
<td>114 patients</td>
<td>7 (RCT)</td>
<td>Sub-group analysis of Lincoln et al. 1999 study.</td>
</tr>
<tr>
<td>Partridge et al. (2000)</td>
<td>UK</td>
<td>114 patients</td>
<td>8 (RCT)</td>
<td>114 patients randomized to receive either 30 minutes or 60 minutes of physiotherapy daily for an unspecified period of time.</td>
</tr>
<tr>
<td>Kwakkel et al. (2002)</td>
<td>Netherlands</td>
<td>6, 9 and 12 month follow up to Kwakkel et al. 1999.</td>
<td>8 (RCT)</td>
<td>6, 9 and 12 month follow up to Kwakkel et al. 1999.</td>
</tr>
<tr>
<td>Pohl et al. (2002)</td>
<td>Germany</td>
<td>60 ambulatory patients</td>
<td>6 (RCT)</td>
<td>60 ambulatory patients with hemiparesis, for at least 4 weeks, caused by right or left supratentorial ischemic stroke or intracerebral hemorrhage, exhibiting impaired gait were randomized into 1 of 3 groups: structured speed-dependent treadmill training (STT) where increased in walking speed with each session; limited progressive treadmill training (LTT) in which training speed was increased by no more than 5% of the maximum initial walking speed each week; and, conventional gait therapy (CGT) involving physiotherapeutic gait therapy based on latest PNF and Bobath concepts. Patients were evaluated before training, 2 and 4 weeks post-training on over ground walking speed, cadence, stride length and FAC.</td>
</tr>
<tr>
<td>Slade et al. (2002)</td>
<td>UK</td>
<td>141 patients</td>
<td>7 (RCT)</td>
<td>141 patients (62% with stroke) were randomized to receive conventional occupational therapy and physiotherapy or enhanced therapy (67% more) during in-patient rehabilitation.</td>
</tr>
<tr>
<td>Sullivan et al. (2002)</td>
<td>USA</td>
<td>24 patients</td>
<td>5 (RCT)</td>
<td>24 patients with unilateral stroke within the MCA or basilar artery distribution resulting in unilateral hemiparesis were randomized to receive body weight treadmill training (BWSTT) at slow, fast or variable speeds after patients were stratified by SSV.</td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Sample Size</td>
<td>Design</td>
<td>Results</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
<td>-------------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>Di Lauro et al. (2003)</td>
<td>Italy</td>
<td>60</td>
<td>7 (RCT)</td>
<td>There were no significant differences in the NIH or BI scores of patients at either 14 days or 180 days following treatment.</td>
</tr>
<tr>
<td>Fang et al. (2003)</td>
<td>China</td>
<td>60</td>
<td>8 (RCT)</td>
<td>Patients from the AEP group had a high drop-out rate (n = 28), but those remaining made relatively better functional recovery at 30 days than those from the RT group measured by the Barthel Index. There was significantly greater improvement from admission to day 30 demonstrated by Barthel Index scores, for patients in the AEP group compared to those in the RT group. There were no differences in other stroke outcomes such as motor function, neurological deficit severity, or psychiatric status.</td>
</tr>
<tr>
<td>Rodgers et al. (2003)</td>
<td>United Kingdom</td>
<td>203</td>
<td>7 (RCT)</td>
<td>There was no significant difference between groups on any outcome measure (Action Research Arm Test, Motricity Index, Frenchay Arm Test, upper limb pain, Barthel ADL, Nottingham E-ADL) at 3 and 6 months after stroke. There was no significant difference in service costs between groups.</td>
</tr>
<tr>
<td>Sonoda et al. (2004)</td>
<td>Japan</td>
<td>No Score</td>
<td></td>
<td>Admission FIM scores between the 2 groups were similar (80.9, conventional vs. 81.2, FIT), however at discharge the FIT group had higher average FIM scores (97.1 vs. 105.0, p&lt;0.01) and FIM efficiency, (change/LOS) (0.19 vs. 0.33, p&lt;0.01). Hospital stays were also shorter for patients in the FIT group (72.9 vs. 81.1 days). The days of onset of stroke to admission into rehabilitation were 54 days for patients in the conventional group and 50 days for patients in the FIT group.</td>
</tr>
<tr>
<td>GAPS (2004)</td>
<td>UK</td>
<td>60</td>
<td>7 (RCT)</td>
<td>The augmented therapy group received more direct time with therapists (62 vs. 35 min/day) and were more active (8.0% versus 4.8% time standing or walking) than normal therapy controls. There were trends favouring the augmented group in the outcomes of achievement to independent walking earlier, and higher RMI scores at three months. However, there was no significant difference in any other outcome.</td>
</tr>
</tbody>
</table>

Locomotor severity. Treatment was provided for 20 minutes for 12 sessions over 4 weeks. Self-selected over ground walking velocity (SSV) was assessed at onset, middle and end of training and 1 and 3 months later.
<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Score</th>
<th>Description</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keren et al. (2004)</td>
<td>Israel</td>
<td>No Score</td>
<td>Data were prospectively collected from 50 first-ever stroke patients admitted for inpatient rehabilitation an average of 14 days post stroke. The relationship between functional outcome, measured by motor and cognitive FIM and the duration and intensity of therapy was examined.</td>
<td>There was a correlation between duration of occupational therapy and gains in FIM motor and cognition scores but no correlation with either physical therapy or SLP therapy. Predictors of improvement in motor FIM scores were younger age, admission FIM (both motor and cognitive) and receipt of SLP therapy. Predictors of improvement in cognitive FIM scores were admission FIM (cognitive), early admission to rehab and intensity of occupational therapy.</td>
</tr>
<tr>
<td>Jette et al. (2005)</td>
<td>USA</td>
<td>No Score</td>
<td>Retrospective analysis of 4,988 patients (993 with stroke), evaluating LOS and functional improvement.</td>
<td>Higher intensity of therapy was associated with shorter lengths of stay. Patients receiving &lt; 1 hour of therapy/day had an average LOS of 21.4 (19.7–23.3) days, compared to those who received 1-1.5 hour/day (16.9;15.7-18.1) days or &gt;1.5 hours/day (15.5;14.2-16.9) days. The odds of improving both independence in mobility and functional independence were associated with increasing intensity of therapy.</td>
</tr>
<tr>
<td>Langhammer et al. (2007)</td>
<td>Norway</td>
<td>6 (RCT)</td>
<td>75 stroke patients discharged from acute inpatient rehabilitation were randomized to receive an intensive outpatient exercise program emphasizing strength, balance and endurance or to a control group of regular exercise. Patients in the intensive group received physiotherapy during four periods with a minimum of 20 hours every third month. Treatment was carried out in home, at clinics or during inpatient rehabilitation. Subjects in the control group received follow-up treatment or rehabilitation only as required. Motor Assessment Scale (MAS, BI and grip strength measured with a vogorimeter (bars) were assessed at discharge from the acute ward and at 3,6,12 months.</td>
<td>There were no differences between groups at any of the testing intervals. The mean differences from acute discharge to one year were:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MAS</td>
<td>+2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>BI</td>
<td>+5.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Grip strength (paretic hand)</td>
<td>0.23</td>
</tr>
<tr>
<td>Langhammer et al. (2008)</td>
<td>Norway</td>
<td>9 (RCT)</td>
<td>Additional outcomes reported from 2007 study. The primary outcome, assessed at admission, discharge and 3, 6, and 12 months post stroke onset was the Nottingham Health Profile (NHP).</td>
<td>There was a trend towards better Health-Related Quality of Life as measured by the NHP in the standard exercise group at 12 months (mean score: 16.2 vs. 17.9, p=0.05). On the 6 subscales, at 12 months, there were no significant differences between the groups except in the area of physical mobility where patients in the standard group fared better (mean score: 17.9 vs. 36.6, p=0.04).</td>
</tr>
<tr>
<td>Langhammer et al. (2009)</td>
<td>Norway</td>
<td>8 (RCT)</td>
<td>Additional outcomes reported from 2007 study. The main outcome was Instrumental Activities of Daily Living (IADL), motor function, gait performance, balance, grip strength, and muscle tone. Additional outcome measures included Motor Assessment Scale, 6-Minute Walk Test, Berg Balance Scale, Timed Up-and-Go Test, grip strength, Modified Ashworth Scale, and pulse monitoring. The patients were tested on admission, at discharge, and after 3, 6, and 12 months post stroke.</td>
<td>Patients in both groups improved over time. The only significant difference between the groups was one component of the IADL scale, favouring the control group (ability to use the telephone independently).</td>
</tr>
<tr>
<td>Authors</td>
<td>Location</td>
<td>Score</td>
<td>Study Design</td>
<td>Summary</td>
</tr>
<tr>
<td>------------------</td>
<td>----------</td>
<td>-------</td>
<td>--------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Huang et al.</td>
<td>Taiwan</td>
<td>No Score</td>
<td>(2009)</td>
<td>The charts of 76 patients admitted for inpatient rehabilitation following first-ever stroke, were reviewed. Associations with, and predictors of BI gains were examined at 1, 3, 6 and 12 months.</td>
</tr>
<tr>
<td>Hu et al.</td>
<td>Taiwan</td>
<td>No Score</td>
<td>(2010)</td>
<td>154 patients admitted to a stroke intensive care unit were studied prospectively to examine the effects of timing of admission and intensity of therapy on outcome using regression analyses.</td>
</tr>
<tr>
<td>Askim et al.</td>
<td>Norway</td>
<td>8 (RCT)</td>
<td>(2010)</td>
<td>62 patients having suffered a stroke within the previous 14 days were randomized to receive either standard stroke unit care (including 2 daily sessions of therapy, 5 days/week) with early supported discharge or to an intensive therapy group which received the same care (SU + ESD) but with more intensive therapy: an additional 3 task-specific therapy sessions/week for 4 weeks following discharge from the SU and an additional session thereafter for the next 8 weeks. Each session lasted 30-50 minutes and additional training at home was encouraged. The primary outcome was Berg Balance Scale (BBS) score, assessed at 26 weeks. Additional outcomes included Motor Assessment Scale (MAS), BI and the Step test.</td>
</tr>
<tr>
<td>Park et al.</td>
<td>Korea</td>
<td>6 (RCT)</td>
<td>(2011)</td>
<td>25 subjects, an average of 28 months following stroke with hemiparesis who with a walking speed of &lt;0.7 m/s were randomly assigned to either the experimental group or the control group, with 13 and 12 subjects, respectively. All subjects received a routine physical therapy in an inpatient setting. The subjects in the experimental group also received community-based ambulation training (1 hr, 3X/week x 4 weeks). Outcomes were assessed before and after treatment. They included; 10-metre walk test, 6-minute walk test, community walk test, walking ability questionnaire and activities-specific balance.</td>
</tr>
<tr>
<td>Cauraugh et al.</td>
<td>USA</td>
<td>6 (RCT)</td>
<td>(2011)</td>
<td>18 patients with chronic stroke were randomized to receive one treatment protocol or 10. Patients in the single protocol group received 1 treatment session and those in the long-term practice group completed 10 treatment protocols over 16 months. All protocol sessions were 6 hours long (90 minutes 1 day/week/4 weeks) and were separated by 22 days. The treatment included bilateral arm movements and active neuromuscular stimulation.</td>
</tr>
</tbody>
</table>
The primary outcome was the Box & Block test and was administered at baseline, at the end of one protocol, at 7 and at 16 months.

### Van Wijk et al. (2012)
*Australia* 8 (RCT)

Additional analysis from AVERT trial (Bernhardt et al. 2008) examining if patients who received early mobilization also received a greater amount of therapy compared to patients who did not. Adverse events at 3 months was the primary outcome.

Patients in the VEM group received a greater dose of therapy (49 vs. 18 min/day, p<0.001), that was given more frequently (3.8 vs. 1 session/day, p<0.001) and they spent a greater percentage of the day out of bed (77% vs. 42%, p<0.001) compared with patients in the control group. There was no difference in the number of immobility-related adverse events between groups (18 vs. 22).

### Wang et al. (2013)
*USA* Retrospective Cohort

**Population:** Mean age= 64.8yr; Gender: Males=57.4%, Females=61.4%.

**Intervention:** Combined therapy for inpatient rehabilitation that included physical therapy, occupational therapy, speech and language therapy. Offering such a combined form of therapy was to show any association found between the intensity of rehabilitation therapy and functional gain, while controlling for other factors.

**Outcomes:** Functional Independence Measures (FIM); subscales: ADL, mobility, cognition and total FIM scores.

Results of correlational analyses (general trends):
1. Overall, weak correlations were found between average duration of PT, OT, SLT and total therapy and ADL, mobility, cognition and total FIM scores.

Results from the multiple linear regressions for functional gain:
1. Higher total FIM gain was significantly associated with at least 3 or more hours of daily rehabilitation treatment compared to rehabilitation treatment offered less than 3 hours per day. The statistical model adjusted for age at IRH admission, gender, comorbidity index, total cognition scores and total motor scores at IRH admission.

No statistically significant differences were found between groups who received between a minimum of 3 to 3.5 hours of rehabilitation treatment daily and those who received at least 3.5 or more hours of rehabilitation treatment per day.

### Severinsen et al. (2014)
*Denmark* RCT

**PEDro=5**

**TPSRT=19(8-36)mo**

**NStart=48**

**NEnd=43**

**Population:** Aerobic Therapy group (AT; n=13): Median age=69yr (50-80); Gender: Males=9, Females=4. Resistance Therapy group (RT; n=14): Median age=68yr (57-78); Gender: Males=11, Females=3. Sham Therapy group (ST; n=16): Median age=66yr (52-80); Gender: Males=11, Females=5.

**Intervention:** Participants were randomized to receive resistance training (RT), aerobic training (AT), or sham training (ST; low intensity resistance exercises) 3x/wk for 12wk. All group specific interventions were 1hr sessions. Outcomes were assessed at baseline, 12wk, and 1yr follow-up.

**Outcomes:** 6-Minute Walk Test (6MWT); 10-Metre Walk Test (10MWT); Leg Strength.

1. There was no significant difference in 6MWT over time across all 3 groups (p=0.0911).
2. There was a significant difference in 10MWT over time in the 3 groups (p=0.0037); RT (p<0.05) and ST (p<0.005) groups showed an increase, however there was no between group difference at 12wk; at 1yr RT and ST remain unchanged whereas AT group decreased 10MWT time (p<0.001), significantly different from RT (p<0.01) and ST (p<0.001).
3. Non-paretic leg strength significantly increased in RT group at 12wk and 1yr (all p<0.0001), significantly larger than both AT and ST groups at 12wk (p<0.001) and 1yr (p<0.05).
4. Paretic leg strength significantly increased in the RT group at 12wk (p<0.0001), significantly different from AT group (p<0.05), but not ST group (p=0.09); at 1yr RT group improvement was preserved (p<0.001) and compared to AT group (p<0.05).

### English et al.

**Population:** Seven-Day/Week Therapy group (7D; 1. All groups showed significant improvements in 6. The Elements of Stroke Rehabilitation  

[www.ebrsr.com](http://www.ebrsr.com)
### Hemiparesis; right side (RS; n=15) and left side (LS; n=37)

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Design</th>
<th>TPS (d)</th>
<th>Participants</th>
<th>Population</th>
<th>Intervention</th>
<th>Outcomes</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boyne et al. (2016)</td>
<td>USA</td>
<td>RCT</td>
<td>3.8±2.9yr</td>
<td>116</td>
<td>High-Intensity Interval Training group</td>
<td>Participants were randomly assigned to receive high-intensity interval training (HIT; 30sec bursts of maximally tolerated treadmill with intermittent rest periods) or moderate intensity continuous training (MCT; 45-50% of maximal heart rate) for 25min 3x/wk over 4wk. Outcomes were assessed at baseline, 4wk, and 3mo and 6mo follow-ups.</td>
<td>VO2 Peak; Ventilatory Threshold; 10-Metre Walk Test (10MWT); 6-Minute Walk Test (6MWT).</td>
<td>1. HIT group had a greater improvement in VO2 peak and ventilatory threshold (+2.2 and +4.4, respectively) compared to MCT group (-1.3 and +0.4, respectively), Effect Size: 0.99 and 1.95, respectively. 2. HIT group had a greater improvement in 10MWT (+0.1) compared to MCT group (+0.01), Effect Size: 1.44. 3. There was no difference in 6MWT improvement between HIT (+15) and MCT (+15) group, Effect Size: 0.</td>
</tr>
<tr>
<td>Burnfield et al. (2016)</td>
<td>USA</td>
<td>Pre-Post</td>
<td>19±5d</td>
<td>20</td>
<td>Mean age=68±10yr; Gender: Males=7, Females=3.</td>
<td>All participants engaged in single sessions of partial body weight support treadmill training (PBWSTT) at 4 predetermined speeds (0.5, 1.0, 1.5, and 2.0mph). Outcomes were measured before and after each session.</td>
<td>Stride Length; Cadence; Limb Support; Muscle Activation; Rate of Perceived Exertion (RPE).</td>
<td>1. Stride length, cadence, and paretic single limb support increased with faster walking speeds (p≤0.001). 2. Non-paretic single limb support remained nearly constant at all speeds. 3. Faster walking resulted in greater peak and mean muscle activation in the paretic medial hamstrings, vastus lateralis and medial gastrocnemius, and non-paretic medial gastrocnemius (p≤0.001). 4. RPE was greatest at the fastest compared to two slowest speeds (p&lt;0.05).</td>
</tr>
<tr>
<td>Hara et al. (2016)</td>
<td>Japan</td>
<td>Case Series</td>
<td>45.9±48.5mo</td>
<td>25</td>
<td>Mean age=61.8±14.1yr; Gender: Males=15, Females=10.</td>
<td>Researchers retrospectively analyzed patients who received 11 sessions of low frequency repetitive transcranial magnetic stimulation (LF-rTMS) to the contralesional hemisphere and 2 sessions of intensive occupational therapy (IOT) per day over 15d. Patients were analyzed by side of hemiparesis; right side (RS; n=15) and left side (LS;</td>
<td>1. Both RS and LS individuals significant improved in FMA scores after treatment (p&lt;0.05). 2. Only RS individuals improved in WMFT and TMT-B times after treatment (p&lt;0.05); however, LS individual times did not improve (p&gt;0.05). 3. Both RS and LS individuals significant improved in ARAT times after treatment (p&lt;0.05). 4. There was no significant improvement in RS or LS individuals in TMT-A times after treatment.</td>
<td></td>
</tr>
</tbody>
</table>
### Kakuda et al. (2016)

**Population:** Mean age = 61.4 ± 13.0 yr; Gender: Males = 1138, Females = 587.

**Intervention:** Participants underwent a combination protocol of repetitive transcranial magnetic stimulation (rTMS; 20 min 2x/d over 15d), intensive occupational therapy (OT; 60 min 2x/d over 15d), and self-exercise (60 min 2x/d over 15d) for upper limb hemiparesis. Patients had a rest day once per week. Outcomes were measured at baseline, discharge and 4wk follow-up.

**Outcomes:** Fugl-Meyer Assessment (FMA); Wolf Motor Function Test (WMFT); Action Research Arm Test (ARAT); Trail Making Test A & B (TMT-A, TMT-B).

1. Overall, there was a significant improvement in FMA, WMFT, and FAS from baseline to discharge (all p < 0.001).
2. The improvements made at discharge remain significant for the patients (n = 690) assessed at 4wk follow-up (all p < 0.001).

### Lang et al. (2016)

**Population:** 3200 group (32; n = 20): Mean age = 59.9 ± 12.8 yr; Gender: Males = 13, Females = 7. 6400 group (64; n = 21): Mean age = 62.1 ± 6.6 yr; Gender: Males = 16, Females = 5. 9600 group (96; n = 21): Mean age = 60.0 ± 8.3 yr; Gender: Males = 11, Females = 10. Individual Maximum group (IM; n = 20): Mean age = 60.9 ± 13.4 yr; Gender: Males = 12, Females = 8.

**Intervention:** Participants were randomized to receive either 3200, 6400, 9600, or individualized maximum (IM) repetitions, during 1hr sessions, 4d/wk for 8wk. Outcomes were assessed at baseline and post-treatment.

**Outcomes:** Action Research Arm Test (ARAT).

1. ARAT scores for the 32, 96, and IM groups improved over time as indicated by slopes (all p < 0.05).
2. The ARAT slope of the 64 group was smaller and significantly different from the 32 and IM groups (p < 0.001).

### Madhavan et al. (2016)

**Population:** Mean age = 58 ± 2.7 yr; Gender: Males = 4, Females = 7.

**Intervention:** Participants completed two 40 min treadmill-training sessions: High-Intensity Interval Treadmill Training (HIITT) alone and HIITT preceded by anodal transcranial direct current stimulation (tDCS) enhanced with a skill acquisition task (e-tDCS+HIITT). Outcomes were assessed at baseline and post-testing.

**Outcomes:** Gait Speed; Motor Evoked Potentials (MEP) of Tibialis Anterior (TA).

1. There was no significant improvement in gait speed after testing (p > 0.05).
2. There was a significant correlation between MEP of the non-paretic TA (p < 0.05) and the paretic TA (p < 0.05) for both HIITT and e-tDCS+HIITT sessions.

### Park et al. (2016)

**Population:** Stroke group (EX; n = 16): Mean age = 63.2 ± 2.7 yr; Gender: Males = 14, Females = 2. Healthy Control group (CG; n = 10): Mean age = 56.6 ± 2.9 yr; Gender: Males = 5, Females = 5.

**Intervention:** Stroke participants performed 2 sessions of unassisted intensive reach training with 600 movements per session. Outcomes were at baseline, post-treatment for each session, and 1mo

1. The EX group had a significant decrease in MT in all assessment periods (all p < 0.0001).
2. The EX group had a significant decrease in movement peaks in all assessment periods (all p < 0.0001).
3. The EX group had a significant improvement in BBT scores at 1d and 1mo (all p < 0.004).
### Weinstein et al. (2016)

**USA RCT (6)**

<table>
<thead>
<tr>
<th>TPS&lt;sub&gt;ASAP&lt;/sub&gt;</th>
<th>TPS&lt;sub&gt;DEUCC&lt;/sub&gt;</th>
<th>TPS&lt;sub&gt;UCC&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>45.2±20.3d</td>
<td>45.0±22.8d</td>
<td>47.0±23.9d</td>
</tr>
</tbody>
</table>

**Population:** Accelerated Skill Acquisition Program group (ASAP; n=119): Mean age=60.9±13.7yr; Gender: Males=64, Females=55. Dose-Equivalent Occupational Therapy group (DEUCC; n=120): Mean age=59.9±10.5yr; Gender: Males=67, Females=53. Monitoring-Only Occupational Therapy group (UCC; n=122): Mean age=61.1±13.1yr; Gender: Males=72, Females=50.

**Intervention:** Participants were randomized to receive Structured, task-oriented upper extremity training (Accelerated Skill Acquisition Program [ASAP; 1hr sessions 3x/wk over 10wk]; dose-equivalent occupational therapy (DEUCC; 1hr sessions 3x/wk over 10wk); or monitoring-only occupational therapy (UCC; no dose specification). Outcomes were assessed at baseline and 12mo follow-up.

**Outcomes:** Movement Time (MT); Movement Peaks; Box and Block Test (BBT).

1. There was no significant difference in WMFT scores: ASAP versus DEUCC (p=0.18); ASAP versus UCC (p=0.72); DEUCC versus UCC (p=0.08).
2. There was no significant difference in hand SIS scores: ASAP versus DEUCC (p=0.99); ASAP versus UCC (p=0.42); DEUCC versus UCC (p=0.49).

### Wu et al. (2016)

**USA RCT (5)**

<table>
<thead>
<tr>
<th>TPS&lt;sub&gt;INT&lt;/sub&gt;</th>
<th>TPS&lt;sub&gt;UC&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2±4.0yr</td>
<td>6.2±5.0yr</td>
</tr>
</tbody>
</table>

**Population:** Intensive Comparison or Robot-Assisted Therapy group (INT; n=99): Mean age=65±11yr; Gender: Males=95, Females=4. Usual Care group (UC; n=28): Mean age=63±12yr; Gender: Males=27, Females=1.

**Intervention:** Participants were randomized to either intensive therapy (INT; average of 1024 movements per session) or usual care (UC). INT group was further divided into robot-assisted (RT) group and intensive comparison (ICT) group. Outcomes were assessed at baseline, 12wk, and 36wk.

**Outcomes:** Fugl-Meyer Assessment (FMA); Wolf Motor Function Test (WMFT); Stroke Impact Scale (SIS).

1. Overall, INT group had significantly greater FMA at 12wk (p=0.005), but not 36wk (p=0.051) compared to the UC group; RT group had a significantly greater FMA at 12wk (p=0.005) and 36wk (p=0.026) compared to the UC group; ICT group had a significantly greater FMA at 12wk (p=0.007), but not 36wk (p=0.2) compared to the UC group.
2. Overall, INT group had no significant difference in WMFT at 12wk (p=0.052), but it was significantly greater at 36wk (p=0.022) compared to the UC group; RT group had a significantly greater WMFT at 12wk (p=0.046), but not at 36wk (p=0.051) compared to the UC group; ICT group had no significant difference in WMFT at 12wk (p=0.1), but it was significantly greater at 36wk (p=0.016) compared to the UC group.
3. Overall, INT group had a significantly greater SIS at 12wk (p=0.002), but no at 36wk (p=0.4) compared to the UC group; RT group had a significantly greater SIS at 12wk (p=0.005), but not at 36wk (p=0.3) compared to the UC group; ICT group had a significantly greater SIS at 12wk (p=0.008), but not at 36wk (p=0.3) compared to the UC group.
### 6.7.1.1 Caregiver Mediation and Intensity of Physical Therapy

#### Table 6.7.1.1 Studies evaluating the intensity of caregiver-mediated physical and occupational therapy

<table>
<thead>
<tr>
<th>Author, Year Country</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Galvin et al. (2011)</strong> Ireland RCT PEDro=8 TPS_EG=18.9±2.9d TPS_CG=19.7±3.0d N_Start=40 N_End=37</td>
<td><strong>Population:</strong> Fitness and Mobility Exercise Program group (EG; n=20): Mean age=63.15±13.3y; Gender: Males=13, Females=7. Control group (CG; n=20): Mean age=69.95±11.69y; Gender: Males=7, Females=13. <strong>Intervention:</strong> Participants were randomized to receive additional fitness and mobility exercise (FAME) program that was caregiver mediated or conventional therapy alone for 5mo. Outcomes were assessed at baseline, post-treatment, and 3mo follow-up. <strong>Outcomes:</strong> Fugl-Meyer Assessment (FMA); Motor Assessment Scale; Berg Balance Scale (BBS); 6-Minute Walk Test (6MWT); Barthel Index (BI); Nottingham Extend Activities of Daily Living Index (ADLs); Caregiver Strain Index.</td>
<td>1. There was a significant improvement in favor of the EG group in FMA, Motor Assessment, BBS, 6MWT, BI and ADLs at post-treatment (p&lt;0.05). 2. Improvements persisted at the 3mo follow-up but only 6MWT was statistically significant (p&lt;0.05). 3. Participants in the EG group were also significantly more integrated into their community at follow-up (p&lt;0.05). 1. Family members in the EG group reported a significant decrease in their levels of caregiver strain at the follow-up when compared with those in the control group (p&lt;0.01).</td>
</tr>
<tr>
<td><strong>Agrawal et al. (2013)</strong> USA RCT PEDro=5 TPS_EG=3.5±1.08mo TPS_CG=3.7±1.34mo TPS_EG=3.5±1.08mo N_Start=30 N_End=30</td>
<td><strong>Population:</strong> 90 Minute group (90; n=10): Mean age=55.8±4.1y; Gender: Males=7, Females=3. 60 Minute group (60; n=10): Mean age=55.7±6.24y; Gender: Males=5, Females=5. Control group (CG; n=10): Mean age=55.2±6.12y; Gender: Males=7, Females=3. <strong>Intervention:</strong> Participants were randomized to receive 90 or 60min of caregiver supported Graded Repetitive Arm Supplementary Program (GRASP) in combination with usual care or usual care alone for 4wk. Outcomes were measured at baseline and post-treatment. <strong>Outcomes:</strong> Fugl-Meyer Assessment (FMA) Upper Extremity; Chedoke Arm and Hand Activity Inventory (CAHAI).</td>
<td>1. In all the 3 groups, there was a significant improvement (p&lt;0.001) with both FMA and CAHAI; however, the 90 group showed more significant difference compared to 60 and CG groups.</td>
</tr>
<tr>
<td><strong>Dai et al. (2013)</strong> Taiwan RCT PEDro=6 TPS_EG=56.88±38.93d TPS_CG=73.88±37.86d N_Start=55 N_End=48</td>
<td><strong>Population:</strong> Additional Virtual Reality group (EG; n=24): Mean age=57.21±12.23yr; Gender: Males=16, Females=8. Conventional Therapy group (CG; n=24): Mean age=57.21±12.23yr; Gender: Males=12, Females=12. <strong>Intervention:</strong> Participants were randomized to receive additional virtual reality therapy with caregiver assistance (EX) or conventional therapy (CG) alone for 4wk. Outcomes were assessed at baseline, 14d and 28d. <strong>Outcomes:</strong> Behavioral Inattention Test Conventional (BITC); Functional Independence Measure (FIM); Postural Assessment Scale for Stroke (PASS); Falls.</td>
<td>1. Both groups significantly improved over time in BITC (all p&lt;0.01), FIM (all p&lt;0.01), and PASS (all p&lt;0.01), but not Falls (EG: p=0.08, CG: p=0.123). 2. There was no significant difference between groups in BITC (p=0.13), FIM (p=0.093), PASS (p=0.094), and Falls (p=0.561).</td>
</tr>
</tbody>
</table>
Barzel et al. (2015)  
Germany  
RCT  
PEDro=7  
TPS6mo=56.57±47.3  
TPS9mo=45.65±57.6  
NStart=156  
NEnd=147  
**Population:** Home Constraint Induced Movement Therapy group (EG; n=85): Mean age=62.55±13.73yr; Gender: Males=51, Females=34. Control group (CG; n=71): Mean age=65.30±12.63yr; Gender: Males=43, Females=28.  
**Intervention:** Participants were randomized to receive additional home Constraint Induced Movement Therapy (CIMT) with caregiver coaching assistance or standard therapy alone for 4wk. Outcomes were assessed at baseline, post-treatment, 3mo, and 6mo.  
**Outcomes:** Motor Activity Log – Quality of Movement (MAL-QOM); Wolf Motor Function Test – Performance Time (WMFT-PT).  
1. Patients in both groups improved in MAL-QOM (p<0.0001 for EG versus p=0.0003 for CG); however, patients in the EG group improved significantly more than patients in the CG group (p=0.0156). These changes remained significant at 3 and 6mo.  
2. Both groups also improved in WMFT-PT (p=0.0006 for EG versus p=0.0004 for CG), the extent of improvement did not differ between groups (p=0.8152). These changes remained insignificant at 3 and 6mo.

Wang et al. (2015)  
Taiwan  
RCT  
PEDro=7  
TPS6mo=18.0±15.2m  
TPS9mo=18.5±17.1m  
NStart=51  
NEnd=51  
**Population:** Caregiver-Mediated Home-Based group (EG; n=25): Mean age=62.0±9.5yr; Gender: Males=13, Females=12. Control group (CG; n=26): Mean age=65.4±10.6yr; Gender: Males=17, Females=9.  
**Intervention:** Participants were randomized to receive additional caregiver-mediate home-based exercise (EG) or usual care alone (CG) for 12wk. Outcomes were assessed at baseline and post-treatment.  
**Outcomes:** Free-Walking Velocity (FWV); Maximum Walking Velocity (MWV); 6-Minute Walk Test (6MWT); Berg Balance Scale (BBS); Barthel Index (BI).  
1. EG group had a significantly greater improvement in FWV (p=0.006), 6MWT (p=0.003), BBS (p=0.006), and BI (p=0.008) compared to the CG group.  
2. There was no significant difference between groups in MWV (p=0.052).

### 6.7.2 Intensity of Language Therapy of Aphasia Post-Stroke

**Table 6.7.2 Studies evaluating the intensity of aphasia therapy**

<table>
<thead>
<tr>
<th>Author, Year Country PEDro Score</th>
<th>Methods</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Meikle et al. (1979)</strong> UK RCT PEDro=4</td>
<td>31 patients who had sustained a stroke 3 weeks prior and passed through the acute phase being left with disabling dysphasia were randomly assigned to 1 of 2 groups. One group received conventional speech therapy from a quality speech therapist while the other group received therapy from a non-professional volunteer.</td>
<td>No significant differences were observed between the two groups on PICA scores.</td>
</tr>
<tr>
<td><strong>David et al. (1982)</strong> UK RCT PEDro=5</td>
<td>155 aphasic stroke patients at 3 weeks post-stroke were randomised to receive either therapy from a speech language pathologist for 30 hours over 15 to 20 weeks or from an untrained volunteer providing support and encouragement for a similar time.</td>
<td>Patients in both groups showed improvement; however, no significant differences in FCP scores were noted between the groups.</td>
</tr>
<tr>
<td><strong>Lincoln et al. (1984)</strong></td>
<td>327 aphasic stroke patients who were able to cope with language testing assessment were randomised</td>
<td>Patients in both groups demonstrated improvement; however, no significant differences in</td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Design</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
<td>--------</td>
</tr>
<tr>
<td>RCT PEDro=6</td>
<td>at 10 weeks post-stroke to receive 2, 1 hour therapy sessions per week at either a hospital or at home for 34 weeks or to receive no treatment.</td>
<td>language recovery were noted between the groups on the Porch Index of Communicative Ability (PICA) Functional Communication Profile (FCP) and the Boston Diagnostic Aphasia (BDAE).</td>
</tr>
<tr>
<td>Shewan et al. (1984) Canada</td>
<td>100 aphasic stroke patients who failed to recover their language skills within the first 2 to 4 weeks post-stroke were randomized to one of 3 treatments: (1) language oriented therapy (LOT) provided by a speech language pathologist (SLP), (2) stimulation facilitation therapy (ST) provided by a SLP and (3) unstructured settings therapy (UNST) provided by nurses. Patients who did not want/were unable to participate formed a control group. Patients in each of the 3 treatment groups received 3, 1-hour sessions a week for 1 year.</td>
<td>No difference in Western Aphasia Battery (WAB) scores, its subsets Language Quotient (LQ) and Cortical Quotient (CQ) scores and Auditory Comprehension Test for Sentences scores between the groups. The LQ scores of patients in the treatment groups were significantly higher compared to the control groups. Individually, LOT and ST patients significantly improved compared to the control patients, but no significant differences were observed between the UNST and the control group. The CQ scores of the treatment groups were significantly higher compared to patients in the control group. Individually, ST patients had higher CQ scores than the controls but the LOT and UNST groups were not significantly different from the controls.</td>
</tr>
<tr>
<td>Wertz et al. (1986) USA</td>
<td>121 male veterans under the age of 75 years, between 2 to 4 weeks after onset of a single thromboembolic stroke with lesion confined to the left hemisphere and demonstrated language severity from 10th-80th percentile on PICA on entry into the study were randomized into one of three groups: (1) 8 to 10 hours a week of clinic treatment with speech therapy for 12 weeks followed by 12 weeks of no treatment; (2) 8 to 10 hours a week of home treatment by a trained volunteer for 12 weeks followed by no treatment; or (3) Treatment deferred for 12 weeks followed by 12 weeks of clinic treatment with a speech therapist.</td>
<td>After 1st 12 weeks of treatment clinic treated patients performed significantly better than those deferred on the PICA. No significant difference were noted between home treated and clinic or between home treated and deferred treated patients. After 24 weeks of treatment there was no significant difference between any groups.</td>
</tr>
<tr>
<td>Hartman (1987) USA</td>
<td>60 right-handed patients with acute aphasia due to left hemisphere stroke were randomly assigned to receive 1 of 2 therapies for six months, beginning one month post-stroke: Conventional speech therapy provided by professional speech pathologists twice weekly or emotionally supportive counselling therapy, also provided by professional speech pathologists at the same intervals. Language function was measured by the Porch Index of Communicative Ability. 50 patients were also retested at 10 months post stroke.</td>
<td>No significant difference in the amount of improvement between the two groups.</td>
</tr>
<tr>
<td>Brindley et al. (1989) UK</td>
<td>This study involved Broca’s aphasic patients defined by the Boston Diagnostic Aphasic Examination without predominate apraxia who were 1 year post stroke. Two groups of 5 patients each received five hours of speech therapy for 5 days a week for 12 weeks. An intensive period of therapy was alternated with non-intensive period pre-course and a similar 12-week non-intensive period post-stroke.</td>
<td>Significant improvement on Functional Communication Profile (FCP) details in movement, speech, reading, and overall score were noted during the intensive period. There was a significant ratio of improvement on FCP between intensive period and 2nd non-intensive period in movement, speech and overall score. Language Assessment Remediation and Screening Procedure showed</td>
</tr>
</tbody>
</table>
Marshall et al. (1989) USA RCT PEDro (5) 121 males, 2 to 12 weeks onset of a single left hemisphere thrombosis infarct resulting in aphasia were randomized to receive: 1) home therapy treatment of aphasia given by wife, friend or relative, 2) treatment by Speech Language Pathologist or 3) treatment by Speech Language Pathologist deferred for 12 weeks. Therapy was provided for 8 to 10 hours a week for 12 weeks. At 12 weeks SLP group showed significantly more improvement than deferred group. Improvement noted in home treatment group did not differ from SLP group. At 24 weeks deferred treated group caught up to other 2 groups and no significant differences between groups was noted.

Poeck et al. (1989) Germany No Score 160 aphasic stroke patients with CT evidence of left hemisphere involvement only, beyond the acute stage of neurological illness were studied. Patients received intensive language treatment for 9 hr/week, for 6-8 weeks. These results were compared to those of a previous multicentre study of 92 German aphasic patients who did not receive language treatment. Patients were sub-grouped as early or late treated patients. In the early phase mean gains for each measure was significant for both treatment and control group on the token test and for repetition. About 2/3 of treatment patients showed a significant improvement in Aachen Aphasia Test.

Prins et al. (1989) Amsterdam RCT PEDro=5 32 patients with aphasia for at least 3 months following a left hemispheric stroke were randomized to receive either systematic therapy (STAC) or conventional therapy (STIM). The STAC was comprised of a series of 28 different tasks on four levels: nonverbal, phonology, lexical-semantics and morphosyntax. The STAC group received treatment 2 times a week for 5 months. The STIM group received therapy during the same period of time with the same frequency as the STAC group. Patients were tested in two parts: subtests for auditory comprehension (items used as practice material in the STAC group) and 8 tests for auditory comprehension, reading comprehension and oral expression (items not used as practice material in either treatment group). No significant differences were noted between the groups on any of the test batteries. There were no results reported for the non-treatment control group.

Bakheit et al. (2007) UK RCT PEDro=7 Aphasic stroke patients were randomly allocated to one of 3 groups: 5 hours (intensive therapy group, n=51), 2 hours (standard therapy group n=46) while 19 patients were recruited for 2 hours per week of therapy and were treated by National Health Service (NHS) staff (NHS group). Subjects received speech and language therapy per week for 12 consecutive weeks starting as soon as practicable after the stroke. The Western Aphasia Battery (WAB) assessments were at baseline and 4, 8, 12 and 24 weeks after the start of therapy. Patients in the intensive, standard and NHS received, on average 4.3, 1.6 and 0.57 hr/week of therapy. The improvement in aphasia was least in patients who were in the NHS group. The mean WAB scores at week 12 for the intensive, standard and NHS groups were 70.3, 66.2 and 58.1, respectively. There was no treatment effect of intensive therapy (p > 0.05), but there was a statistically significant difference between the standard study and the NHS groups (p = 0.002 at week 12 and 0.01 at week 24).

Wambaugh et al. (2013) USA Population: Age Range: 34-53yr; Gender: Males=3, Females=1. Intervention: Treatment assignment for each 1. All participants demonstrated improvements in accuracy of production of treated items for all applications of treatment.
<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>Intervention</th>
<th>Outcomes</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Martins et al. (2013) Portugal RCT (7) TPS&lt;sub&gt;E&lt;/sub&gt;=7.67±2.97wk TPS&lt;sub&gt;C&lt;/sub&gt;=7.47±3.60wk N&lt;sub&gt;Start&lt;/sub&gt;=30 N&lt;sub&gt;End&lt;/sub&gt;=18 (SPIRIT)</td>
<td>Experimental group (EX; n=15): Mean age=58.27±12.3yr; Gender: Males=10, Females=5. Control group (CG; n=15): Mean age=55.7±6.24yr; Gender: Males=5, Females=5.</td>
<td>Participants were randomized to receive intensive speech and language therapy (EX; 2hr/d, 5d/wk, 10wk) or regular therapy (2hr/wk, 50wk). Outcomes were assessed at 10, 50 and 62wk.</td>
<td>Articulatory accuracy</td>
<td>1. Although patients in the EX obtained higher AQ scores than those in the CG in all re-evaluations, there was a non-significant main effect for treatment groups (p=0.64). 2. Similar findings were obtained in the analysis of the FCP scores that increased significantly from baseline to re-evaluations (p&lt;0.001), with no treatment group (p=0.68).</td>
</tr>
</tbody>
</table>

| Wambaugh, Wright et al. (2014) USA Observational No score TPS=12-255mo N<sub>Start</sub>=4 N<sub>End</sub>=4 | Population: Age Range: 36-72yr. Gender: Males=all. | This study combined both modified-Response Elaboration Training (M-RET) with Sound Production Treatment (SPT), an already established Apraxia of Speech (AOS) treatment. Thus, CAAST = Combined Aphasia and Apraxia of Speech Treatment (CAAST) is the intervention of interest in this study. The goals of this study were to examine effects of a newly developed behavioral treatment that targets aphasia and AOS simultaneously. | Narrative discourse elicitation stimuli; Speech elicitation stimuli. | 1. Increases in production of content were found for all participants. 2. Varied results in speech production measures across participants. 3. All participants demonstrated substantial increases in production of CIUs in response to trained picture sets and these increases were consistent with previous RET findings in the literature. 4. There were consistent positive findings for generalization to untreated picture sets. 5. Discrepancies across participants for CIU production findings may be attributed to... |
6. Generally, CAAST outcomes were similar to those of RET and M-RET, relative to CIU production.

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Country</th>
<th>PEDro Score</th>
<th>Methods</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dignam et al.</td>
<td>2015</td>
<td>Australia</td>
<td>PCT</td>
<td>TPS&lt;sub&gt;EC&lt;/sub&gt;=47.3±49.3m o  TPS&lt;sub&gt;CG&lt;/sub&gt;=31.1±51.4m o  N&lt;sub&gt;Start&lt;/sub&gt;=34  N&lt;sub&gt;End&lt;/sub&gt;=32</td>
<td>Population: Intensive Therapy group (EX; n=16): Mean age=56.9±10.3yr; Gender: Males=14, Females=2. Distributed Therapy group (CG; n=18): Mean age=60.0±11.5yr; Gender: Males=14, Females=4. Intervention: Participants with aphasia were recruited to participate in an intensive (n=16; 16hr/wk, 3wk) versus distributed (n=18; 6hr/wk, 8wk) therapy program. Treatment included 48 hours of impairment, functional, computer, and group-based aphasia therapy. Outcomes were assessed at baseline, post-treatment and follow-up. Outcomes: Boston Naming Test (BNT).</td>
</tr>
</tbody>
</table>

### 6.8 Durability of Rehabilitation Gains

#### 6.8.1 Previous Reviews

**Table 6.8.1. The durability of rehabilitation gains**

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Country</th>
<th>PEDro Score</th>
<th>Methods</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stevens et al.</td>
<td>1984</td>
<td>UK</td>
<td>RCT</td>
<td>PEDro=6</td>
<td>228 acute stroke patients were randomized to receive care on a stroke rehab ward or a general medical ward.</td>
</tr>
<tr>
<td>Strand et al.</td>
<td>1985</td>
<td>Sweden</td>
<td>No Score</td>
<td></td>
<td>293 acute (within 7 days) stroke patients were allocated to receive care on either a non-intensive stroke ward (n=110) or a general medicine ward (n=183).</td>
</tr>
<tr>
<td>Davidoff et al.</td>
<td>1991</td>
<td>USA</td>
<td>No Score</td>
<td></td>
<td>The ADL scores of 139 “middle-band” stroke patients who had received inpatient rehabilitation were reviewed at admission and discharge and at one-year follow-up from inpatient rehabilitation.</td>
</tr>
<tr>
<td>Indredavik et al.</td>
<td>1991</td>
<td>Norway</td>
<td>RCT</td>
<td>PEDro=7</td>
<td>220 acute (within 7 days) stroke patients randomized to either a combined acute/rehabilitation stroke unit or a general medical unit.</td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Design</td>
<td>Score</td>
<td>Patients/Methods</td>
<td>Findings</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
<td>--------</td>
<td>-------</td>
<td>-----------------</td>
<td>----------</td>
</tr>
<tr>
<td>Borucki et al. (1992)</td>
<td>USA</td>
<td>No Score</td>
<td>71 stroke rehabilitation inpatients were divided into 2 age categories (&lt;69 yrs and &gt; 70 yrs) and followed for up to 24 months following discharge.</td>
<td>No differences in the Barthel Index (BI) scores for the younger vs. the older patients at 6, 12 or 24 months. The frequency of new or progressive disease was the same for both age groups while death or placement in a nursing home was more frequent among the older patients. The probability of maintaining discharge BI scores at 24 months was 55% for the younger group and 25% for the older group. Although this difference was non-significant, the possibility of a type II error.</td>
<td></td>
</tr>
<tr>
<td>Ferrucci et al. (1993)</td>
<td>Italy</td>
<td>No Score</td>
<td>Self-reported disability and neural impairment were measured in 50 stroke patients at discharge from a rehabilitation program and at 3 and 6 months later.</td>
<td>Functional disability was significantly reduced at 3 and 6 months. There was also a reduction in neural impairment, as measured by the Fugl-Meyer scale.</td>
<td></td>
</tr>
<tr>
<td>Juby et al. (1996)</td>
<td>UK</td>
<td>RCT PEDro=6</td>
<td>315 stroke patients were randomized to receive care on either an interdisciplinary stroke unit or to care on a general medical and geriatric unit an average of 2 weeks post stroke onset.</td>
<td>At both 6 months and 1 year, stroke unit patients had higher Nottingham Extended ADL scores. At one year, stroke unit patients had better scores on the General Health Questionnaire. At 6 months, stroke unit patients had higher Barthel Index scores and Rivermead Mobility Index scores compared to patients treated on the other units. Cognitive readjustment was better for patients on the stroke unit at 6 months.</td>
<td></td>
</tr>
<tr>
<td>Indredavik et al. (1997)</td>
<td>Norway</td>
<td>RCT PEDro=7</td>
<td>5-year follow-up study of 220 stroke patients examining long-term survival and functional state of stroke, initially randomized to either a combined acute/rehabilitation stroke unit or a general medical unit.</td>
<td>5 years following stroke, a greater proportion of patients originally treated on the stroke unit were alive, residing at home with higher BI scores when compared to patients treated on the general medical unit.</td>
<td></td>
</tr>
<tr>
<td>Juby et al. (1998)</td>
<td>USA</td>
<td>No Score</td>
<td>The functional outcomes of 68 stroke patients were assessed 1 to 5 years after discharge from rehabilitation. FIM scores were obtained through telephone interviews.</td>
<td>Patients’ FIM scores improved significantly from admission to discharge from rehabilitation. There was a trend towards improvement of scores up to one year. There were non-significant declines in FIM scores in years 4 and 5.</td>
<td></td>
</tr>
<tr>
<td>Broeks et al. (1999)</td>
<td>The Netherlands</td>
<td>No Score</td>
<td>54 patients with first-ever stroke who underwent inpatient stroke rehabilitation were assessed at 3-8 and 16 weeks and at 4 years. Average age at time of stroke was 53.2 years</td>
<td>Most upper arm recovery, assessed by the Fugl-Meyer scale occurred during the first 16 weeks post stroke. Improvement continued for after 16 weeks in 10 patients. For 13 patients recovery only started after 16 weeks. After 4 years, fair to good recovery (FM score &gt;20) was observed in 31 patients. At 4 years 52 patients had Barthel Index scores &gt; 60 and 33 patients had BI scores of 100. There was a group of patients that achieved a BI score of 100 and had a non-functional affected arm. Only 14/54 patients had intact sensory function and only 9/54 patients had normal muscle tone. Serious shoulder pain persisted in 11/54 patients at 4 years.</td>
<td></td>
</tr>
<tr>
<td>Indredavik et al. (1999)</td>
<td>Norway</td>
<td>RCT PEDro=7</td>
<td>220 unselected hospitalized stroke patients randomized to receive care on either a stroke unit or a general medical ward. 10-year follow-up study of Indredavik et al. (1991).</td>
<td>At 10-years post stroke, a greater proportion of patients initially treated on the stroke unit were alive (25 vs. 13%), residing in their homes (20 vs. 8%) and had BI scores &gt;60 (20 vs. 8%) compared to patients treated on a general medical ward.</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Setting</td>
<td>Participants</td>
<td>Intervention</td>
<td>Follow-up</td>
<td>Outcomes</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------</td>
<td>--------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>-----------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Lincoln et al. (2000)</td>
<td>UK RCT</td>
<td>315 patients</td>
<td>Randomized to receive care on either a stroke unit or to care on a general medical and geriatric unit. 5-year follow-up study of Juby et al. 1996 (n=159).</td>
<td></td>
<td>Relative risks of death, death or disability and death or institutional care were all in direction of favourable outcomes for patients initially treated on the stroke unit.</td>
</tr>
<tr>
<td>Kwakkel et al. (2002)</td>
<td>Netherlands RCT</td>
<td>110 patients</td>
<td>Randomly allocated to one of three groups for a 20 week rehabilitation program with an emphasis on (1) upper limb function, (2) lower limb function or (3) immobilization with an inflatable pressure splint (control group). Follow up assessments within and between groups were compared at 6, 9, and 12 months after stroke.</td>
<td></td>
<td>No significant differences between the groups were found from 6 months onward for: Barthel Index, Functional Ambulation Categories, Action Research Arm test, comfortable and maximal walking speed, Nottingham health profile part 1, sickness impact profile-68 and Frenchay activities index.</td>
</tr>
<tr>
<td>Drummond et al. (2005)</td>
<td>UK RCT</td>
<td>10 year</td>
<td>Follow up of Juby et al. 1996</td>
<td></td>
<td>Of 176 patients originally allocated to receive treatment on a stroke unit, 122 (69%) were dead, 31 were disabled (Barthel Index 0-17) and 9 were in institutionalized care. (8 were untraced and 4 refused to give consent for follow-up). Of the 139 allocated to a conventional ward, 111 (80%) were dead, 9 were disabled, 2 were in institutional care. (7 were untraced and 4 refused to give consent for follow-up). The relative risks for: death (0.87, 95% CI; 0.78 to 0.97), death or disability (0.91, 95% CI; 0.94 to 1.05) and death or institutional care 0.91 (0.83 to 1.00).</td>
</tr>
<tr>
<td>Bernhardt et al. (2008b)</td>
<td>Australia RCT</td>
<td>71 patients</td>
<td>Randomly assigned to receive standard care (SC) (n=33) or SC plus very early mobilization (VEM) (n=38) until discharge or 14 days. The primary safety outcome was the number of deaths at 3 months. A good outcome, defined as a modified Rankin Score (mRS) of 0-2 at 3, 6 and 12 months was also assessed.</td>
<td></td>
<td>18% of patients screened were suitable for recruitment. There was no significant difference in the number of deaths between groups (SC, 3 of 33; VEM, 8 of 38; p=0.20). Almost all deaths occurred in patients with severe stroke. After adjusting for age, baseline NIHSS score and premorbid mRS score, the odds of experiencing a good outcome were significantly higher at 12 months for the VEM group (OR: 8.15, 95% CI 1.61-41.2, p&lt;0.01). There was also a trend towards good outcome at 3 months, but not at 6 months.</td>
</tr>
</tbody>
</table>
References


www.ebrsr.com


---

6. The Elements of Stroke Rehabilitation

**www.ebrsr.com**
