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[Evidence-Based Review of Stroke Rehabilitation]

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The Rehabilitation of Severe Stroke
Evidence Tables

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22.3 Care of Individuals with Severe Stroke

22.3.1 Admission to Intensive Care Units

Table 22.3.1 Intensive Care Units and Patients with Severe Stroke

Author, Year Country PEDro Score	Methods	Outcomes
Navarrete-Navarro et al. (2003) Spain	Outcomes were measured for 132 stroke patients admitted to ICUs in 28 Spanish hospitals. Severity was measured using APACHE III and the GCS. Functional disability was measured 1 year post-stroke using the Barthel Index and the GCS. Lesion site, hospital LOS, mortality, morbidity, life support techniques, and neurosurgical intervention were measured.	Only 5.9% of those admitted to ICU were stroke patients. Mean age was 55.7 (±15.8) and 61% were male. Average LOS was 13 (±12.5) days. At ICU discharge, 73% of patients had severe disability (measured as a BI score <55 or a GCS of 3 or 4, 18% moderate disability, and 8% minimal – no disability. 74.2% of patients needed mechanical ventilation, 73.5% sedative drugs, and 57.6% hypotensive treatment. Mortality at year post-ICU discharge was 53% (P = 0.04). Severe stroke patients had more critical illness and consumed more resources.
Sulter et al. (2003) Netherlands RCT PEDro=6 $TPS_{Overall}$<48hr N_{Start}=54 N_{End}=54	**Population**: Stroke Care Monitoring Unit (SCMU): Mean age=68 ±14.7yr; Gender: Males=15, Females=12; Conventional Stroke Unit (SU): Mean age=67.6±16.0yr; Gender: Males=10, Females=17; **Intervention**: Patients were randomized to either a stroke care monitoring unit (SCMU) or a conventional stroke unit (SU). **Outcomes**: Mortality and poor outcomes defined as modified Rankin scale (mRS) score≥4 or a Barthel Index (BI)<60.	A poor outcome was seen in 7 (25.9%) patients in the SCMU group and in 13 (48.1%) in the SU group (P0.16). 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).
Jeng et al. (2008) Taiwan Observational No Score TPS_{Mean}≤12hr N_{Start}=850 N_{End}=850	**Population:** Mean age=65.3±14.4yr; Gender: Males=491, Females=359. **Intervention:** Patients admitted between 2002 and 2006 to an intensive care unit (ICU) were evaluated to determine measures observed in the first 12hr post-stroke that predict early mortality and functional outcomes. **Outcomes:** 3-month mortality; 3-month mortality or institutional care; National Institute of Health Stroke Scale (NIHSS: stroke severity); Barthel Index (BI: dependency).	The mean initial NIHSS score was 17.7±9.6 indicating moderate to severe neurological deficit. Of all patients, 3m after onset of stroke, 16.5% were dead, 21.1% were alive and cared for in an institutional setting, and 62.4% were alive and living at home. Examination of functional discharge revealed that 16.3% of patients were dead, 49.8% had poor functional outcomes, and 33.9% were relatively well. Survival rates for patients with ischemic stroke were 91.3% at 7d, 87.2% at 30d, and 84.8% at 90d. The initial high NIHSS score (all p<0.005), and the need for ventilator aid (all p<0.005), were independent variables related to death within 3m post stroke onset, death or institutional care at 3m, and of death or dependency at discharge in the ischemic stroke group.

		In patients with hemorrhagic strokes, initial NIHSS scores (all p<0.005), and requiring a ventilator (all p<0.005) were significant predictors of death at 3m, death or institutional care at 3m, and death or dependency at discharge.
Riachy et al. (2008) Lebanon	62 severe stroke patients (50% males, 62.2% Ischemic, mean age 65.8±12.3) admitted to an ICU were assessed for risk factors, life support techniques, and neurosurgical interventions. Participants were followed-up 1 year from admission and stroke severity was assessed using the APACHE II and the Glasgow coma scale (GCS). Functional ability was assessed with the Stroke Impact Scale (SIS-16) and Karnofsky score.	Severe stroke accounted for 7% of the ICU admissions. 16 patients died during the ICU stay and 7 in the follow-up period. For survivors, the mean early-APACHE II score was 13 (±3), the deceased score was 20 (±3). Early-GCS score for survivors was 11 (±2), deceased score was 6 (±4). ICU Discharge-APACHE II score for survivors was 10 (±5), deceased score was 16 (±4). ICU Discharge-GCS score for survivors was 13(±2), deceased score was 11 (±3). Mean ICU LOS was 11.2 (±15.4), for survivors it was 4 (2-12), for deceased 9 (4-21). Mechanical ventilation was needed in 37.1% of cases. Duration of mechanical ventilation had the highest risk ratio (2.45, 95% CI 1.36-4.43, p= 0.003) as a predictor of mortality.
Hu et al. (2010) Taiwan Prospective No Score TPS$_{Mean}$=6.7±6.7d N$_{Start}$=154 N$_{End}$=154	**Population**: Mean age=63.1±15.6yr; Gender: Males=99, Females=55. **Intervention**: Acute stroke patients with more severe neurological deficits (NIHSS>10) admitted to 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 (BI; activities of daily living); Walking ability at discharge.	11% of patients had a mild stroke, 44% of patients had a moderate stroke and 45% of patients were classified as severe stroke patients. Average length of stay in the ICU was 10.4±8.8d. The mean intensity of rehabilitation was 0.6sessions/d and each session was typically 30 to 45 minutes in length. Compared to patients with ischemic stroke, those with a hemorrhagic stroke had better improvements in the BI sale (39.8 vs. 28.2 points, p<0.024), and had higher proportion of regarding walking ability (67% vs. 50%, p<0.047). 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 (β=-1.79, 95% CI (-2.44,-1.15), p=0.0005). 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). Age (OR 0.94, 95% CI (0.92, 0.97), p<0.05), premorbid disability (OR 0.1, 95% CI (0.03,0.29), p<0.005), heart disease (OR 0.33, 95% CI (0.17,0.65), p<0.005), NIHSS score (OR 0.82, 95% CI (0.77,0.88), p<0.005), BI score (OR 1.08, 95% CI (1.05,1.11), p<0.005), urinary incontinence (OR 0.05, 95% CI (0.01,0.22), p<0.005), complications (OR 0.05, 95% CI (0.02,0.18), p<0.005), stroke

		type (OR 2.04, 95% CI (1.05,3.98), p<0.05), and rehabilitation intensity (OR 6.99, 95% CI (2.73,17.89), p<0.005) were all significantly associated with walking function. 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. After adjusting for severity and age, rehabilitation intensity accounted for 15% of the variance of walking function at discharge. Subgroup analysis for severe patients revealed that rehabilitation intensity (OR 49.91, 95% CI (36.56,63.26), p=0.0001) motor stage of upper extremity (OR 6.19, 95% CI (1.56,10.82, p=0.01), and age (OR -0.48, 95% CI (-0.86,-0.09), p=0.016) significantly predicted BI score at discharge. In the severe subgroup, rehabilitation intensity (OR 103.33, 95% CI (10.72,995.72), p=0.0001) and age (OR 0.94, 95% CI (0.89), p=0.044) significantly predicted walking function at discharge. Rehabilitation intensity was the best predictor of the BI score (p<0.0001) and walking function (p<0.0001) at discharge in patients with severe stroke.
Jammali-Blasi et al. (2011) Australia Prospective No Score TPS$_{Mean}$≤48hr N$_{Start}$=54 N$_{End}$=46	**Population**: Mean age=74.6±2.8yr; Gender: Males=31, Females=22. **Intervention**: Data from patients admitted between 2006 and 2007 to an acute stroke care unit (ASCU) was analyzed to identify associations between premorbid factors. Interviews were conducted at 90 day post stroke outcomes to follow-up on outcomes. **Outcomes**: Premorbid risk factors (atrial fibrillation, hypertension, high cholesterol, smoking, diabetes); Demographic factors (age, gender); Clinical and stroke characteristics (death, modified Rankin scale (mRS: disability), Barthel Index (BI: dependency), Short Form-36 (SF-36: health status)); Scandinavian Stroke Scale (SSS: stroke severity).	74.1% of the cohort experienced a first stroke, 81.5% reported that hypertension was the most frequent risk factor followed by high cholesterol (66.7%). The majority of the cohort experienced mild strokes and 22.9% of them were discharged home. Patients with atrial fibrillation had a lower SSS mean scores (mean scores: 38.42) and experienced more severe stroke in comparison with those who did not have atrial fibrillation (mean score: 45.77; p=0.037). At follow-up, 50% of the cohort had a BI score of above 95, which is indicative of independence. 56.8% of the cohort reported some level of disability (mRS≥2) and high levels of physical and mental morbidity (SF-36: physical score=46.69, mental score=46.38) at follow-up. There was no significant relationship between stroke severity and death by follow-up (p=0.056). No significant associations between mRS and the clinical characteristics of the patients was found. Significant differences in the mean BI scores were found in those who had experienced an ischemic stroke in comparison to those who had

		experienced a hemorrhagic stroke (p=0.017), indicating that individuals with ischemic strokes were less dependent at 90d. Patients experiencing their first stroke were found to be significantly less dependent (measured via BI scores) compared to those who experienced a subsequent stroke (p=0.000). Ischemic stroke patients had a higher physical component of the SF-36 score compared to those with hemorrhagic strokes (p=0.018). Those experiencing their first stroke had higher mean physical scores on the SF-36 compared to those with subsequent strokes (p=0.026).
Niewada et al. (2012) Poland Retrospective No Score $TPS_{weekday}$=863 ±1948mins $TPS_{weekend}$=682 ±1467mins N_{Start}=19667 N_{End}=19667	**Population**: Weekday Admissions Group (N=13743): Mean age=70.21 ±12.09yr; Gender: Males=48.8%, Females=51.2%. Weekend Admissions Group (N=5924): Mean age=71.37 ±11.64yr; Gender: Males=48.4%, Females= 51.6%. **Intervention**: A comparison of baseline characteristics between stroke patients who were admitted on weekdays vs. weekends. **Outcomes**: Death; modified Rankin Scale (mRS; poor outcome).	Compared to weekday patients, weekend patients were older, more likely to present consciousness disturbances at admission, and admitted within a shorter timeframe from stroke symptoms onset to hospital arrival, as well as a higher number of patients admitted within the first hours after stroke (p<0.001 for all). Results showed that stroke patients admitted on weekends had a worse prognosis: OR=1.137, p=0.0068, and OR=1.17, p=0.0003, for death and poor outcome, respectively.
Hayward et al. (2014) Australia Prospective No Score TPS_{Mean}=NA N_{Start}=239 N_{End}=239	**Population**: Mean age=70±13yr; Gender: Males=165, Females=74. **Intervention**: Patients with severe motor disability (FIM≤40) admitted to an inpatient rehabilitation unit were prospectively observed to determine if they can achieve clinically important improvements in motor function. **Outcomes**: Functional Independent Measure-Motor subscale (m-FIM); Length of stay (LOS); Time to rehabilitation; Age.	Patients with severe motor disability (m-FIM≤40) had a longer time from stroke onset to admission to inpatient rehabilitation and a longer LOS in rehabilitation compared to patients with less severe motor disability (m-FIM>40) (both p<0.001). Patients of all stroke severities (mild: m-FIM≥71; moderate: m-FIM=70-41; severe: m-FIM≤40) demonstrated a significant improvement in motor function from admission to discharge from inpatient rehabilitation (all p<0.001). Among 85% of patients shifted out of 'severe' motor disability on admission to either moderate (51.4%) or mild (32.9%) motor disability on discharge.

22.3.2 Stroke Severity and Rehabilitation Outcomes

Table 22.3.2 Stroke Severity and Rehabilitation Outcomes

Author, Year Country PEDro Score	Methods	Outcomes
Ween et al. (1996) USA	536 consecutive admissions with a primary diagnosis of stroke were prospectively followed. Patients with subarachnoid haemorrhages and strokes requiring cerebral surgical interventions	Admission FIM® influenced FIM® change across the population. Significant differences were seen between the group with admission FIM® <40 and those with

	were excluded. All patients included in the study received rehabilitation on general rehabilitation units in the standard, multi-disciplinary fashion. Independent measures suspected of influencing outcome were assessed within 2 or 3 days of admission (age, severity of deficit, lesion types, lesion site, existence of comorbidities, incontinence of bladder and socioeconomic constraints). Dependent measures were determined upon discharge (FIM®).	admission FIM® of 40-59, 60-80 and >80 groups. Large-vessel strokes did significantly worse than small-vessel strokes or haemorrhages. Incontinence was found to reflect the severity of deficit. Continence on admission was associated with 84% rate of home discharge, while incontinence on admission reduced rate to 55%. Patients admitted to rehabilitation with an early FIM® score of less than 40 almost always required long-term care in a nursing home facility. It was recommended that those with FIM® scores less than 40 (the more severely disabled) should likely go to a slower paced or less intensive rehab facility, including geriatric reactivation units.
Ween et al. (2000) USA	244 consecutive admissions to a rehabilitation hospital with a diagnosis of ischemic or hemorrhagic stroke were prospectively followed. Patients were excluded if they had extraaxial hemorrhages, a lag from stroke onset to rehabilitation admission of >30 days, or if they required readmission back to acute care from the rehabilitation hospital. Independent measures suspected of influencing outcomes were assessed.	AFIM® had a strong influence on all outcomes; specifically, severe strokes were associated with longer LOS and poorer functional status at discharge, while milder strokes were associated with being discharged home from the hospital. The lowest AFIM® (<30) group had significantly poorer functional status at discharge compared with the intermediate (60-80) group. Further, 73 of 80 (91%) patients with an AFIM®<50 remained dependent on discharge, whereas 77 of 90 (85%) patients with an AFIM®>70 were nondependent on discharge. 42 of the 74 (55%) patients with an AFIM® >50 and <70 remained dependent. The lowest AFIM® groups (<30-60) had significantly longer LOS compared with the 60-69 group.
McKenna et al. (2002) Australia	145 patients admitted to an Australian public hospital for rehabilitation after first-time stroke were evaluated retrospectively through a review of medical and occupational therapy records. Patients were excluded for numerous reasons including previous experience of stroke and diagnosis of subarachnoid hemorrhage. Independent measures included in the analysis were: age, sex, marital status, pre-stroke living setting, with whom patients were living, time period of admission for rehabilitation after stroke, side of stroke, admission MBI scores for conversion to motor FIM® scores, days from stroke onset to acute hospital admission, days of acute care, and comorbidities. Outcomes included in the analysis were: LOS, discharge	More severe strokes, defined by lower admission converted motor FIM® (FIM®MOT1) scores, were associated with longer LOS, as well as change in living setting or situation after discharge. For the low (13-46), moderate (47-62) and high (63-91) FIM®MOT1 groups, mean LOS (days) were 95.2, 59.9 and 47.6, respectively. The risk of needing to change living situations increased 8-fold for the lowest FIM®MOT1 group (13-46) (OR 8.02; 95% CI 2.40-26.79; p=0.001) compared with the highest FIM®MOT1 group (63-91). Further, of those with low (13-46), moderate (47-62) and high (63-91) FIM®MOT1 scores, 42.6,

	MBI scores for conversion to motor FIM® scores, discharge living setting, with whom patients were living on discharge, the reason for change in living setting (if appropriate), and the receipt of outpatient therapy.	25.6, and 19.5%, respectively, needed to change where they lived or with whom they lived on discharge. Additionally, living alone prior to stroke was associated with change in living setting or situation. Very old age (>75 years) was associated with more severe strokes and poorer functional status on discharge.
Appelros et al. (2002) Sweden	274 first-ever stroke patients were evaluated for risk factors. Data was analyzed using logistic regression models to determine factors independently associated with stroke. Severe stroke was classified as a NIHSS score ≥6.	Heart failure (OR 2.25, 95% CI 1.4-4.7), atrial fibrillation (OR 1.90, 95% CI 1.2-3.1), and dementia (OR 1.96, 95% CI 1.0-3.7) were associated with severe stroke. Only stroke severity (OR 24.42, 95% CI 8.5-89.7) and dementia (OR 2.35, 95% CI 1.1-5.0) were independent predictors of mortality at 28 days post-stroke. Heart failure, atrial fibrillation, and living alone were non-significantly associated with 28 day mortality. Age was not a significant predictor of stroke severity.
Kammersgaard et al. (2004) Denmark	1197 consecutive admissions to the stroke unit at Bispebjerg Hospital were stratified by age group and prospectively followed. Patients with TIAs or SAH were not included in the study. Independent measures suspected of influencing outcomes were assessed on admission: age groups (<85 years vs. >85 years), gender, initial stroke severity (Scandinavian Stroke Scale), time from stroke onset to admission, diabetes, atrial fibrillation, ischemic heart disease (IHD), hypertension, claudication, previous stroke or TIA, pre-existing disability, daily alcohol consumption and smoking.	Very old age was associated with more severe strokes, being female, having atrial fibrillation and pre-existing disability. Moreover, very old age, severe strokes and pre-existing disability were associated with poor short- and long-term prognosis. Admission stroke severity predicted death during hospital stay (OR 2.3 per 10 point decrease in SSS score; 95% CI 2.0-2.6, $p<0.0001$) as well as the combined outcome of death during hospital stay or discharge to a nursing home (OR 2.7 per 10 point decrease in SSS score; 95% CI 2.3-3.1, $p<0.0001$). Admission stroke severity also predicted long-term mortality [Hazard Ratio (HR) 1.4 per 10 point decrease in SSS score; 95% CI 1.3-1.5, $p<0.0001$] and the combined outcome of living in a nursing home or long-term mortality (OR 1.9 per 10 point decrease in SSS score; 95% CI 1.7-2.3, $p<0.0001$). The authors recommended considering several factors including very old age, pre-stroke medical and functional status, and onset stroke severity when planning treatment and rehabilitation after stroke.
Kimura et al. (2005) Japan	3335 acute ischemic stroke patients were identified as having a diagnosis of atrial fibrillation (AF). Multivariate logistic regression analysis was done on patient information compared with 12496 non-AF controls. Patient data was from the Japan Multi-centre Stroke	Female sex (OR 1.25, 95% CI 1.15-1.36), advanced age (OR 1.03, 95% CI 1.03-1.03), AF (OR 4.43, 95% CI 4.07-4.83), and history of stroke (OR 1.32, 95% CI 1.22-1.43) were independent factors associated with severe stroke. The mean NIHSS admission score

	Investigators' Collaboration registry.	was higher in AF patients than controls (12 vs. 5; p < 0.0001). Severe stroke was defined as a NIHSS score ≥11. 45.1% of AF patients returned home post-stroke compared to 66.4% of non-AF patients (p<0.0001).
Maulden et al. (2005) USA Observational No Score TPS_{Mean}=13.8±18.7d N_{Start}=969 N_{End}=969	**Population**: Mean age=66.6±14.4yr; Gender: Males=504, Females=465. **Intervention**: Participants with moderate or severe strokes were assessed to determine the association between days from stroke symptom to rehabilitation admission and rehabilitation outcomes. **Outcomes**: Total Functional Independence Measure (FIM); Motor FIM (m-FIM); Activities of Daily Living (ADL); Length of Stay (LOS).	In the moderately impaired patients, days from stroke symptom onset to rehabilitation admission was significantly associated with discharge total FIM (p<0.001), discharge m-FIM (p=0.001), discharge mobility FIM (p=0.042), discharge ADL FIM (p<0.001) and rehab LOS (p<0.001). For the severe stroke group, days from stroke symptom onset to rehabilitation admission was significantly associated with discharge total FIM (p=0.08), discharge m-FIM (p=0.003), discharge mobility FIM (p<0.001), and discharge ADL FIM (p=0.001) but not LOS (p=0.394).
Rabadi et al. (2008) Retrospective No Score $TPS_{Overall}$≤4wk N_{Start}=668 N_{End}=668	**Population**: 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). Mean age=70.30±12.61yr; Gender: Males=311, Females=357. **Intervention**: To determine whether cognitively impaired patients benefit from admission to an acute rehabilitation unit. **Outcomes**: Change in total FIM instrument score; Cognitive FIM subscore; Length of stay (LOS); FIM efficiency; Discharge disposition (home vs not-to-home) (primary outcomes).	Patients with cognitive impairment had more severe strokes based on the degree of neurologic impairments (motor, visual, sensory), both individually and collectively (p<0.001). 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). 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). 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).
Hu et al. (2010) Taiwan Prospective No Score TPS_{Mean}=6.7±6.7d N_{Start}=154 N_{End}=154	**Population**: Mean age=63.1±15.6yr; Gender: Males=99, Females=55. **Intervention**: Acute stroke patients with more severe neurological deficits (NIHSS>10) admitted to 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 (BI; activities of daily living); Walking ability at discharge.	11% of patients had a mild stroke, 44% of patients had a moderate stroke and 45% of patients were classified as severe stroke patients. Compared to patients with ischemic stroke, those with a hemorrhagic stroke had better improvements in the BI sale (39.8 vs. 28.2 points, p<0.024), and had higher proportion of regarding walking ability (67% vs. 50%, p<0.047). 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 (β=-1.79, 95% CI (-2.44,-1.15), p=0.0005). 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). Age (OR 0.94, 95% CI (0.92, 0.97), p<0.05), premorbid disability (OR 0.1, 95% CI (0.03,0.29), p<0.005), heart disease (OR 0.33, 95% CI (0.17,0.65), p<0.005), NIHSS score (OR 0.82, 95% CI (0.77,0.88), p<0.005), BI score (OR 1.08, 95% CI (1.05,1.11), p<0.005), urinary incontinence (OR 0.05, 95% CI (0.01,0.22), p<0.005), complications (OR 0.05, 95% CI (0.02,0.18), p<0.005), stroke type (OR 2.04, 95% CI (1.05,3.98), p<0.05), and rehabilitation intensity (OR 6.99, 95% CI (2.73,17.89), p<0.005) were all significantly associated with walking function. 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. Subgroup analysis for severe patients revealed that rehabilitation intensity (OR 49.91, 95% CI (36.56,63.26), p=0.0001) motor stage of upper extremity (OR 6.19, 95% CI (1.56,10.82, p=0.01), and age (OR -0.48, 95% CI (-0.86,-0.09), p=0.016) significantly predicted BI score at discharge. In the severe subgroup, rehabilitation intensity (OR 103.33, 95% CI (10.72,995.72), p=0.0001) and age (OR 0.94, 95% CI (0.89), p=0.044) significantly predicted walking function at discharge. Rehabilitation intensity was the best predictor of the BI score (p<0.0001) and walking function (p<0.0001) at discharge in patients with severe stroke.
Kashihara et al. (2011) Japan Retrospective No Score TPS_{Mean}=NA N_{Start}=51	**Population:** Mean age=70.5±10.1yr; Gender: unspecified. **Intervention:** Examine the possibility of predicting the long-term outcome of severe stroke patients from the ADL status (Barthel Index (BI) scores ≤40) at discharge. Severe stroke	28 participants improved on the BI score, and 23 participants were classified as unimproved. The improved group was significantly younger (mean age=66.5±8.7yr) compared to the unimproved group (mean

N_{End}=51	patients at discharge with BI≤40 were divided into two groups retrospectively, improved and unimproved. Assessments were conducted at discharge, 3, and 6mo after onset. **Outcomes:** Functional Independence Measure (FIM); Barthel Index (BI).	age=76.1±8.7yr; p<0.01). Statistical examination revealed a difference in recovery with regard to gender (p<0.01), with more males recovering compared to females.
de Villiers et al. (2011) Netherlands Observational TPS_{Mean}<2wk N_{Start}=196 N_{End}=196	**Population:** Median Age=60yr; Gender: Male=61, Female=135. **Intervention**: Patients from a socio-economically disadvantaged community with a stroke were followed up at 2wk, 3mo and 6mo post discharge. **Outcomes**: Modified Rankin Scale (mRS); Mortality at 6mo post stroke; Risk of death; Housing condition.	The proportion of patients with a disability according to the mRS at discharge was significantly different between patients alive and dead at 6mo post discharge with more dead patients having a severe disability (mRS≥4) (91.1% vs 68.9%) and more alive patients having a moderate disability (mRS=3) (25.8% vs 4.4%) (p=0.001). Severe stroke patients (n=45) did not qualify for inpatient rehabilitation and 20 (44.4%) died <6mo post discharge. Cox hazard regression showed that moderate disability (mRS=3) and severe disability (mRS≥4) were independently associated with risk of death (moderate: hazard ratio (HR)=0.02, 95% CI 0.002-0.33; severe: HR=0.10, 95% CI 0.01-0.81) compared to mild disability (p=0.02). Multivariate logistic regression showed that severe disability at 6mo was independently associated with poor housing conditions (odds ratio=3.42, 95% CI 1.22-9.59) (p=0.02).
Chung et al. (2012) USA Retrospective TPS_{Mean}=NA N_{Start}=223 N_{End}=223	**Population**: Mean Age=NA; Gender: Male=93, Female=130. **Intervention**: Patients with a severe stroke (the most severe group defined by the Center for Medicare and Medicaid Services) discharged to acute care after ≥2d in inpatient rehabilitation (n=86) or discharged into the community from inpatient rehabilitation (n=137) were included. **Outcomes**: Functional Independence Measure at discharge and admission from inpatient rehabilitation: motor, cognitive, total; Stroke related neurologic deficits: dysphagia, hemiparesis, language deficits, other neurologic deficits.	Mean cognitive FIM scores were significantly lower in the acute care group compared to the community care group at admission (12.1±7.4 vs 14.7±6.7 respectively) (p<0.000) and discharge (14.5±7.7 vs 21.8±6.1 respectively) (p<0.000) Mean motor FIM scores were significantly lower in the acute care group compared to the community care group at admission (17±4.9 vs 20.6±5.6 respectively) (p<0.000) and discharge (22±10.6 vs 46±15.2 respectively) (p<0.000) Mean total FIM scores were significantly lower in the acute care group compared to the community care group at admission (29.1±10.9 vs 35.4±10.5 respectively) (p<0.000) and discharge (36.5±15.6 vs 67.7±18.9 respectively) (p<0.000) The duration from stroke onset to admission to the inpatient rehabilitation facility was not significantly different between groups. No significant differences between groups were observed in the proportion of patients with stroke related dysphagia, hemiparesis

		and language deficits. Other stroke related neurologic deficits were significantly more prevalent in the community care group compared to the acute care group (22.6% vs 10.5% respectively) (p=0.021).
Mutai et al. (2013) Japan Retrospective No Score TPS$_{Overall}$=NA N$_{Start}$=192 N$_{End}$=192	**Population**: Mean age=72.4 ±10.8yr; Gender: Males=140, Females=0. **Intervention**: Examined patients who were sent to inpatient rehabilitation. **Outcomes**: Frenchay Activities Index (FAI); modified Rankin scale (mRS); Geriatric Depression Scale (GDS).	Multivariable logistic regression analyses showed that age (OR=0.93; 95%CI: 0.89–0.97; p= 0.002), recurrence of stroke (OR=0.33; 95%CI: 0.13–0.85; p=0.022), moderate paralysis (OR=0.08; 95%CI: 0.01–0.43; p=0.003), severe paralysis (OR=0.10; 95%CI: 0.01–0.81; p=0.030), and motor FIM at discharge (OR, 1.06; 95%CI: 1.02–1.09; p=0.001) were all significantly associated with ADL independence at follow-up. Multivariable logistic regression analyses showed that sex (OR=0.43; 95%CI: 0.18–0.99; p=0.045), hemorrhagic stroke type (OR=2.28; 95%CI: 1.01–5.22; p=0.041) and motor FIM at discharge (OR=0.98; 95%CI: 0.96– 0.99; p=0.001) were significantly associated with the presence of depression at follow-up. FAI score (β=-0.39, p<0.001) and sex (β=-0.15; p=0.043) were significant predictors of a GDS score at follow-up, among other variables in a stepwise regression model (age, sex, mRS, follow up, FAI score, living situation, and long-term care insurance).
Hayward et al. (2014) Australia Prospective No Score TPS$_{Mean}$=NA N$_{Start}$=239 N$_{End}$=239	**Population**: Mean age=70±13yr; Gender: Males=165, Females=74. **Intervention**: Patients with severe motor disability (FIM≤40) admitted to an inpatient rehabilitation unit were prospectively observed to determine if they can achieve clinically important improvements in motor function. **Outcomes**: Functional Independent Measure-Motor subscale (m-FIM); Length of stay (LOS); Time to rehabilitation; Age.	Patients with severe motor disability (m-FIM≤40) had a longer time from stroke onset to admission to inpatient rehabilitation and a longer LOS in rehabilitation compared to patients with less severe motor disability (m-FIM>40) (both p<0.001). Patients of all stroke severities (mild: m-FIM≥71; moderate: m-FIM=70-41; severe: m-FIM≤40) demonstrated a significant improvement in motor function from admission to discharge from inpatient rehabilitation (all p<0.001). About 85% of patients shifted out of 'severe' motor disability on admission to either moderate (51.4%) or mild (32.9%) motor disability on discharge.

22.4 The Outcomes of Severe Stroke Rehabilitation

Table 22.4 The Impact of Stroke on Rehabilitation Outcomes

Author, Year Country PEDro Score	Methods	Outcomes
Kalra et al. (1993) UK 5 (RCT)	252 stroke patients, at 2 weeks post-stroke, were randomized to a stroke rehabilitation unit or a general medical ward. The patients were stratified into 3 groups based on Orpington Prognostic Score: mild-to-moderate stroke (n=63), moderate-to-severe stroke (n=145), and severe-to-very severe stroke (n=36). Patients in both groups had a median Barthel score of 5 at the time of randomization.	For patients in the most severe group, stroke rehabilitation did not influence functional outcome, with Barthel scores rising to a median of 6 in both groups. Length of hospital stay, however, was reduced by more than half (52.3 days vs. 122.2 days, p<0.001). The number of patients discharged home also improved (16% vs. 6%) but this did not reach statistical significance given the low number of participants. Mortality was much lower in the stroke rehabilitation group (39% vs. 67%, p<0.05).
Kalra & Eade (1995) UK 5 (RCT)	76 stroke patients with a poor prognosis (Orpington Prognostic Score of <5) resulting from severe stroke were randomized to care on a stroke unit or a general medical unit.	Patients treated in the stroke unit had shorter LOS (43 vs. 58 days), lower mortality (21% vs. 46%) and a higher rate of discharge home (47% vs. 19%). There were no differences in median Barthel Index scores between the two groups.
Jorgensen et al. (1995) Jorgensen et al. (2000) Denmark Observational No Score TPS_{Mean}=NA N_{Start}=1241 N_{End}=1241	**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. **Intervention:** Stroke patients admitted to either a general medical ward (GW) for rehabilitation and treatment, or to a dedicated stroke unit (SU) were assessed to determine if the beneficial effects of treatments are due to the unit where they received rehabilitation/treatment. **Outcomes:** Initial mortality rate; Poor outcome (via death during hospital stay or discharge to a nursing home facility); Length of hospital stay (LOHS); 1yr mortality rate; 5yr mortality rate.	The risk factor of hypertension was significantly higher in the SU patients compared to the GW patients (p=0.003). Risk factors such as diabetes, ischemic heart failure, former stroke, and atrial fibrillation were not significantly different between the two groups. Men in treated in the GW had poorer outcomes (38% vs. 28%, p=0.03), and had longer LOHS (58 vs. 40, p=0.004) compared to those treated in the SU. Women treated in the GW had lower LOHS (68 vs. 46, p=0.001) compared to those treated in the SU. Those aged<75yr treated in the GW had poorer outcomes (31% vs. 23%, p=0.04), longer LOHS (59 vs. 40, p=0.003), and higher 1yr mortality (30% vs. 21%, p=0.03) compared to those treated in the SU. Those aged≥75yr treated in the GW had poorer outcomes (54% vs. 44%, p=0.02), and longer LOHS (68 vs. 46, p=0.001) compared to those treated in the SU. Those with mild strokes treated in the GW had significantly poorer outcomes (31% vs. 22%, p=0.01), longer LOHS (61 vs. 37, p=0.001), higher 1yr mortality rate (28% vs. 22%, p=0.04), and higher 5yr mortality rate (65% vs. 56%, p=0.02) compared to those treated in the SU. More severe stroke patients treated in the GW died (74% vs. 55%, p=0.01), had poorer outcomes (90% vs. 74%, p=0.01), and had a higher 1yr mortality rate (77% vs. 62%, p=0.02) compared to

		those treated in the SU. Patients with comorbidities treated in the GW had poorer outcomes (51% vs. 39%, p=0.01), longer LOHS (68 vs. 43, p=0.001), higher 1yr mortality rate (48% vs. 38%, p=0.02), and higher 5yr mortality rate (84% vs. 73%, p=0.01).
Ronning & Guldvog (1998) Norway 6 (RCT)	251 stroke patients eligible for admission to a stroke rehabilitation unit were randomized to an inpatient tertiary-care rehabilitation unit or care in the community. The patients were in hospital a median of approximately 10 days prior to randomization.	Average LOS in the rehabilitation hospital group was 27.8 days. In the community group, 41% of the patients were admitted to a nursing home, 29% initially received some form of outpatient therapy, and 30% did not receive any form of organized rehabilitation. Treatment in the hospital rehabilitation unit resulted in fewer patients who were dependent (Barthel Index <75) or dead (23% versus 38%; p=0.01) 7 months post-stroke. This difference was more pronounced for stroke patients with an admission Barthel Index score of <50 (n = 114). In this group, 32% of the hospital rehabilitation unit patients were dead or dependent at 7 months, as compared with 62% of the community based patients. Moreover, those patients with an admission Barthel <50 reached a higher level of functional independence at the 7 month follow-up in response to hospital-based rehabilitation (Barthel score of 90), as compared with community-based care (Barthel score of 73). Organized interdisciplinary care resulted in a 40% reduction in dependency or death at 7-month follow-up for all stroke patients (23% vs. 38%) and a 48% reduction in patients with more severe stroke (32% vs. 62%).
Sandstrom et al. (1998) USA No Score	Stroke patient records with early-motor FIM® scores between 13 and 44, and between the ages of 16-44 were analyzed. 293 cases were identified and categorized by demographic, LOS, discharge location, cost, and FIM® score.	46% of patients were discharged to the community, 26% to extended care units, and 28% to a long-term care nursing facility. LOS had little association with discharge location. Patients discharged to long-term care facilities cost an average of 17% more ($25,104 vs. $21,467) than those discharged home. As well, those discharged home had higher admission and discharge FIM® scores (mean motor FIM® scores 33.5 vs. 20). Discharge motor FIM® score was a better predictor of discharge location than admission motor FIM® score (Correlation = 0.46 vs. 0.30).
Lofgren et al. (1999) Sweden No Score	47 surviving severe stroke patients were followed-up at 3 months. All participants had been admitted to a specialized geriatric stroke ward post-acute care. All participants live in their homes and were interviewed regarding their psychological wellness using the Philadelphia Geriatric Center Morale Scale	Of all the participants, 43% were classified as having high scores for psychological well-being. 21% were classified as having moderate psychological wellness and 36% had poor. Depression was shown to have the largest negative association (-0.78 correlation with the PGCMS score, p=<0.01) with a patient's

	(PGCMS).	psychological wellness (n=26, 55% of participants). Social situation, functional ability, age, gender, ability to communicate, and need for assistance showed much less association with the PGCMS score.
Fagerberg et al. (2000) Sweden 8 (RCT)	249 elderly patients (>70 years) were allocated to stroke unit care or conventional care with 2:1 randomization. All patients in this prospective, 1-year study had been hospitalized for acute stroke without previous cerebral lesion and without recognized need of care. Main outcome measures were: patients living at home after 1 year, ability to complete activities of daily living, health-related quality of life score, death or institutional care, and death or dependence.	No significant overall differences were found in the outcomes between stroke patients receiving rehabilitation in the stroke unit and those receiving care in the general medical ward. However, benefits were found for those stroke patients with concomitant cardiac disease. At three months post-stroke, patients with concomitant cardiac disease who received treatment in the stroke unit had a lower rate of combined death or dependency (28% vs. 49%). However, this difference was no longer apparent at 12 months. In patients with more severe stroke, there was a trend in favour of the stroke rehabilitation group, although this did not reach clinical significance. This may be explained by the low number of patients with severe stroke involved in the study.
Nolfe et al. (2003) Italy No Score	69 stroke patients identified as having very severe disability post-first stroke were evaluated at discharge from rehabilitation and followed-up at 6 months. Severe disability was classified as a FIM® score of 18-39. This measurement was taken at admission, discharge and follow-up. Age of participants was also evaluated.	At 6 month follow-up, 15 patients (21.7%) were lost, 27 (39.1%) had died and 27 (39.1%) returned home. Lost patients were not included in the long-term analysis. Inpatient rehabilitation was 60 days, and no one underwent outpatient rehabilitation. Patients who died during the study period were on average 4 years older than the survivors (not significant). The discharge-FIM® score median was 27. The median SSS score at follow-up was 8 in all age groups. Those with higher FIM® scores upon discharge had the most improvement at follow-up.
Claesson et al. (2003) and Claesson et al. (2000) Sweden RCT PEDro=6 TPS$_{Mean}$<7d N$_{Start}$=249 N$_{End}$=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).	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. The readmission rate at <90d post stroke was 14% in the stroke unit and 23% in the general ward. The readmission length at <90d post stroke was 2d in the stoke unit and 4d in the general ward. At 90d post stroke, 5% of the stroke unit and 15% of the general ward patients were still hospitalized for the index stroke. 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

	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; Length of hospital stay at 1yr post stroke; Morality at 1yr post stroke.	readmission (stroke unit=10d, general ward=12d). No significant difference was observed between groups in length of hospital stay at 1yr post stroke (stroke unit=44%, general ward=51%). 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). The proportion of patients living at home at 1yr post stroke was 72% in the stroke unit and 71% in the general ward. The proportion of patients institutionalized at 1yr post stroke was 10% in the stroke unit and 19% in the general ward. Readmission rates 1yr post stroke were not significantly different between severity groups with 44% of patients readmitted with mild stroke, 57% with moderate stroke and 38% with severe stroke (p=0.39). The length of readmission stay per patient at 1yr post stroke was not significantly different between severity groups (mild=10d, moderate=14d and severe=10d) (p=0.15). The number of hospital or institution free days per patient at 1yr post stroke was significantly different between severity groups (mild=319d, moderate=223d and severe=173d) (p<0.001). Mortality at 1yr post stroke was highest in the severe stroke group at 45% compared to 34% in the moderate stroke group and 13% in the mild stroke group.
Somerford et al. (2004) USA Retrospective No Score TPS$_{Overall}$=NA N$_{Start}$=6449 N$_{End}$=6449	**Population**: Mean age=72.2 (71.8, 72.6)yr; Gender: Males=50.8%, Females=49.2%. **Intervention**: Study assesses factors influencing ischemic stroke length of stay (LOS) while considering discharge destination. **Outcomes**: Length of stay.	The average LOS for all ischemic stroke-related admissions was 28 days (95% CI: 26-30). 95% of patients were discharged within 4 months of hospitalization. With censoring, and with no assumption on time-to-discharge distribution, patients who were admitted directly to a hospital that had a stroke unit experienced a relatively longer stay than those who received care at a hospital without a stroke unit: an average LOS=30 days (95%CI: 28-31) and 26 days (95% CI: 24-28), respectively. The study found that the impact of stroke unit was significant after accounting for demographic characteristics and comorbid conditions of the patients (HR=0.92, 95%CI: 0.87, 0.97).
Teasell et al. (2005) Canada No Score	196 severely disabled stroke rehabilitation patients admitted to a slow-stream stroke unit who met specific inclusion criteria (admitted within 6 months of stroke onset and non-ambulatory at the time of admission) were	The median admission and discharge FIM® scores were 46 (IQR 20, range 19-96) and 70 (IQR 30, range 18-121), respectively. FIM® scores were only available for 181 of the patients. The median change in FIM® score was +22 (IQR 19, range -25

		included. There were 92 females and 104 males with an average (+SD) age of 72 + 11 years. Patients were admitted to the program a mean of 56 + 33 days following the onset of symptoms.	to 66). The mean LOS (+SD) was 88 + 39 days (median 84, IQR 54, range 11 to 232). Despite the fact that 142 (72.4%) of these stroke rehabilitation patients remained wheelchair dependent, 85 patients (43.4%) returned to their own home upon discharge, while the remainder were admitted to nursing homes or hospitals closer to their homes. The results from multiple logistic regression analysis demonstrated that the most powerful predictors of successful discharge home in descending order of importance were: admission FIM® score, age, male sex and no history of previous stroke.
Yagura et al. (2005) Japan No Score	Reported on the efficacy of an interdisciplinary stroke rehabilitation unit (SRU; defined as having regular team conferences) compared to a general rehabilitation ward (GRW; without such conferences) within the same rehabilitation hospital. 178 patients were admitted within 3 months of stroke onset and were allocated to either the SRU or the GRW, depending on bed availability.	Significantly more patients with severe disability were discharged home in the SRU group compared with the GRW group (47.4% vs. 0%, p< 0.0001). There were no significant differences between the groups with respect to increase in FIM® score, Stroke Impairment Assessment Set score, length of hospital stay, or cost. The authors concluded that patients with severe stroke appeared to benefit most from regular interdisciplinary stroke team conferences in the SRU and had an improved discharge disposition.
Maulden et al. (2005) USA Observational No Score TPS$_{Mean}$=13.8±18.7d N$_{Start}$=969 N$_{End}$=969	**Population**: Mean age=66.6±14.4yr; Gender: Males=504, Females=465. **Intervention**: Participants with moderate or severe strokes were assessed to determine the association between days from stroke symptom to rehabilitation admission and rehabilitation outcomes. **Outcomes**: Total Functional Independence Measure (FIM); Motor FIM (m-FIM); Activities of Daily Living (ADL); Length of Stay (LOS).	In the moderately impaired patients, days from stroke symptom onset to rehabilitation admission was significantly associated with discharge total FIM (p<0.001), discharge m-FIM (p=0.001), discharge mobility FIM (p=0.042), discharge ADL FIM (p<0.001) and rehab LOS (p<0.001). For the severe stroke group, days from stroke symptom onset to rehabilitation admission was significantly associated with discharge total FIM (p=0.08), discharge m-FIM (p=0.003), discharge mobility FIM (p<0.001), and discharge ADL FIM (p=0.001) but not LOS (p=0.394).
Deutsch et al. (2006) US No Score	Compared the outcomes and reimbursement of care provided to sub groups of stroke patients in 2 sub-acute rehabilitation settings [i.e. inpatient rehabilitation facilities (IRFs) and skilled nursing facilities (SNFs)]. Data was included from 58724 patient records. Case-mix grouping was used to develop sub groups based on severity. The most severe strokes (CMG 108-114) consisted of individuals with motor FIM® scores 12-38.	IRF patients were more likely to be discharged to the community. Significant difference between the 2 groups was seen for severe stroke patients <82 years among other subgroups. Motor FIM® gains were higher by an average of 2.4 points (95% CI 1.56 to 3.24) in IRF patients with severe motor disabilities, 2.39 points (95% CI: 1.45 to 3.32) for individuals with severe motor disabilities and ≥82 years of age, and 4.24 (95% CI: 3.45 to 5.03) for individuals with severe motor disabilities and <82 years of age. Median IRF LOS was significantly shorter than median LOS in SNFs across most subgroups. Cost of rehabilitation was higher in IRFs when compared to SNFs.

Saposnik et al. (2009) Canada Prospective No Score TPS$_{Overall}$=NA N$_{Start}$=3631 N$_{End}$=3631	**Population**: Mean age=72yr (range: <59 to 80+); Gender: Unspecified. **Intervention**: To determine which factors were related to improved survival status among older adults with stroke, and determine whether access to stroke care, delivery of health services and clinical outcomes after stroke are affected by age. **Outcomes**: indicators of quality stroke care: use of thrombolysis; dysphagia screening; admission to a stroke unit; carotid imaging; antithrombotic therapy; and warfarin for atrial fibrillation at discharge (primary outcomes). Risk-adjusted stroke fatality, discharge disposition, pneumonia, and length of hospital stay (secondary outcomes).	There were no significant differences in stroke care delivery by age group. Stroke fatality increased with age, with a 30-day risk adjusted fatality of 7.1% (95%CI: 4.5 to 9.7), 6.5% (4.1 to 8.8), 8.8% (7.1 to 10.5), and 14.8% (13.2 to 16.3) , for those aged 59 or younger, 60 to 69, 70 to 79, and 80 years or older, respectively, p<0.001. Those aged older than 80 years had a longer length of hospitalization, increased risk of pneumonia, and higher disability at discharge compared to those younger than 80. This group was also less likely to be discharged home. The risk of disability after stroke increased with age, according to the proportion of patients with the following modified Rankin scores ≥3: 46.3%, 5.4%, 63.2% and 72.7% in the respective age groups: aged 59 or younger, 60 to 69, 70 to 79, and 80 or older (p<0.001). Multivariable analyses revealed that lower stroke severity, lack of neurological deterioration, management by a multidisciplinary stroke team, and use of antithrombotics were common variables associated with better survival at different points in time.
Smith et al. (2010) Canada Retrospective No Score TPS$_{Overall}$=NA N$_{Start}$=6223 N$_{End}$=6223	**Population**: Age range: 51 to 84yr; Gender: Unspecified; Stroke Severity on admission: Mild (Canadian Neurological Scale (CNS) ≥8); Moderate: 5-7; Severe: ≤4. **Interventions**: To analyze the effect of organized stroke care in all stroke subtypes in a longitudinal cohort study. **Outcomes**: 30-day mortality.	Both stroke subtype and organized care index (OCI) were significantly associated with mortality in the overall cohort: higher OCI was strongly associated with a lower odds of 30-day mortality in each ischemic stroke subtype (adjusted OR: 0.16 to 0.3, p<0.001, controlling for age, gender, stroke severity and medical comorbidities by logistic regression. The reduction in mortality was slightly lower in patients with large artery stroke (aOR=0.34) compared to lacunar stroke (aOR=0.16, p=0.04) or other stroke (aOR=0.17, p=0.02). Numbers needed to treat to prevent 1 death at 30 days, ranged from 4 to 9 across the subtypes.
Kashihara et al. (2011) Japan Retrospective No Score TPS$_{Mean}$=NA N$_{Start}$=51 N$_{End}$=51	**Population:** Mean age=70.5±10.1yr; Gender: unspecified. **Intervention:** Examine the possibility of predicting the long-term outcome of severe stroke patients from the ADL status (Barthel Index (BI) scores ≤40) at discharge. Severe stroke patients at discharge with BI≤40 were divided into two groups retrospectively, improved and unimproved. Assessments were conducted at discharge, 3, and 6m after onset. **Outcomes:** Functional Independence Measure (FIM); Barthel Index (BI).	28 participants improved on the BI score, and 23 participants were classified as unimproved. The improved group was significantly younger (mean age=66.5±8.7yr) compared to the unimproved group (mean age=76.1±8.7yr; p<0.01). Statistical examination revealed a difference in recovery with regard to gender (p<0.01), with more males recovering compared to females.
Koennecke et al. (2011)	**Population:** Mean age=71.15±13.05yr; Gender:	In-hospital mortality was 5.4%.

Berlin Observational No Score TPS$_{Mean}$=NA N$_{Start}$=16518 N$_{End}$=16518	Males=8397, Females=8121. **Intervention:** Patients admitted to 14 stroke units were examined to determine the extent of demographics, clinical characteristics, comorbidities, and complications contribute to the risk of in-hospital mortality and morbidity in acute stroke. **Outcomes:** Mortality; Length of Stay (LOS); Stroke severity; Age; Prestroke disability; Pneumonia incidence.	In patients with LOS≤7d, 37.5% of in-hospital deaths were attributed to stroke severity, 22.1% to sociodemographics (age and prestroke disability), and 28.9% to increased intracranial pressure or other complications. In those with LOS>7, age and stroke severity accounted for 44.1% of the deaths, whereas pneumonia accounted for 12.2%, other complications 12.6% and increased intracranial pressure accounted for 8.3%.
de Villiers et al. (2011) Netherlands Observational TPS$_{Mean}$<2wk N$_{Start}$=196 N$_{End}$=196	**Population**: Median Age=60yr; Gender: Male=61, Female=135. **Intervention**: Patients from a socio-economically disadvantaged community with a stroke were followed up at 2wk, 3mo and 6mo post discharge. **Outcomes**: Modified Rankin Scale (mRS); Mortality at 6mo post stroke; Risk of death; Housing condition.	The proportion of patients with a disability according to the mRS at discharge was significantly different between patients alive and dead at 6mo post discharge with more dead patients having a severe disability (mRS≥4) (91.1% vs 68.9%) and more alive patients having a moderate disability (mRS=3) (25.8% vs 4.4%) (p=0.001). Severe stroke patients (n=45) did not qualify for inpatient rehabilitation and 20 (44.4%) died <6mo post discharge. Cox hazard regression showed that moderate disability (mRS=3) and severe disability (mRS≥4) were independently associated with risk of death (moderate: hazard ratio (HR)=0.02, 95% CI 0.002-0.33; severe: HR=0.10, 95% CI 0.01-0.81) compared to mild disability (p=0.02). Multivariate logistic regression showed that severe disability at 6mo was independently associated with poor housing conditions (odds ratio=3.42, 95% CI 1.22-9.59) (p=0.02).
Di Carlo et al. (2011) Italy Prospective TPS$_{Mean}$=NA N$_{Start}$=355 N$_{End}$=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 in acute care and rehabilitation; 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).	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=3.34%) (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 dietitian (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). No other significant differences in resource use were observed between groups.

		No significant difference in the length of stay in acute care and in rehabilitation hospitals was observed between groups.
		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).
		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).
		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).
		Death or institutionalization was significantly reduced in SU patients compared to OGW patients at 3mo (13.9% vs 26.0%) (p=0.007) and at 1yr (16.1% vs 31.4%) (p=0.001).
		In patients with a BI score of 0-9 (n=151), 27.5% were deceased at 3mo and 39.5% were deceased at 1yr.
		In patients with a BI score of 10-20 (n=187), 1.1% were deceased at 3mo and 3.3% were deceased at 1yr.
		In patients with a NIHSS score >6 (n=153), 32.0% were deceased at 3mo 41.2% were deceased at 1yr, 41.2% were dead or dependent at 3mo, 60.5% were dead or dependent at 1yr, 41.1% were dead of institutionalized at 3mo and 43.9% were institutionalized at 1yr.
		In patients with a NIHSS score ≤6 (n=186), 2.2% were deceased at 3mo, 5.6% were deceased at 1yr, 4.9% were dead or dependent at 3mo, 11.7% were dead or dependent at 1yr, 2.7% were dead of institutionalized at 3mo and 6.7% were institutionalized at 1yr.
Peters et al. (2014) Canada Retrospective No Score $TPS_{Overall}$=53.6±32.0d N_{Start}=10 N_{End}=10	**Population**: This was a severe stroke population Mean age=58.3 ±15.1yr; Gender: Males=5, Females=5. **Intervention**: Stroke patients were evaluated monthly in a stroke rehab unit and functional and physiological recovery of standing balance during inpatient rehab was examined in people with severe impairments after stroke. **Outcomes**: Berg Balance Scale (BBS); Clinical Outcome Variables Scale (COVS); Chedoke, McMaster Stroke Assessment (CMSA).	Participants demonstrated statistically significant improvements in all functional measures. Mean BBS scores improved by 22.1 points and the mean COVS improved by 20.9 points (p'0.05). However, physiological measures did not reach statistical significance for change over the course of rehabilitation (p>0.05). COP velocity decreased by 60.1% on the paretic leg, though this finding was not statistically significant (p>0.05). There was a statistically significant correlation

		between the CMSA and the COVS with Area 200 Post and WB% on the paretic side (p<0.05). The BBS was also moderately correlated with the paretic WB%. There was no correlation between the first total FIM or motor FIM and the functional or physiological scores.
Arling et al. (2015) USA Observational TPS$_{Mean}$=NA N$_{Start}$=3811 N$_{End}$=3811	**Population**: Mean Age=NA; Gender: Male=3735, Female=76. **Intervention**: Patients hospitalized for an ischemic stroke were followed for 12mo post discharge. **Outcomes**: National Institute of Health Stroke Scale (NIHSS); Functional Independence Measure (FIM): total, motor, cognitive; Rehabilitation outcomes <90d and 12mo post stroke; Morality; Care trajectories.	NIHSS scores showed mild strokes (NIHSS 0-2) in 50% of patients, moderate strokes (NIHSS 3-9) in 40% and sever strokes (NIHSS≥10) in 10%. LOS was a mean of 6.8d. Total FIM scores showed complete independence (FIM 6-7) in 37% of patients, modified dependence (FIM 3-5) in 45% and complete dependence (FIM 0-2) in 18%. Cognitive FIM scores showed complete independence (FIM 6-7) in 59% of patients, modified dependence (FIM 3-5) in 27% and complete dependence (FIM 0-2) in 14%. Motor FIM scores showed complete independence (FIM 6-7) in 32% of patients, modified dependence (FIM 3-5) in 42% and complete dependence (FIM 0-2) in 26%. Rehabilitation <90d post discharge was administered to 49% of patients with 20% receiving rehabilitation in a nursing home, 8% in an inpatient rehabilitation facility, 4% in a home care setting and 29% as an outpatient. Mortality was 4% <30d post stroke and 16% 12mo post stroke. Rehabilitation outcomes 12mo post stroke showed ≥1 re-hospitalization in 50% of patients and patients spent a mean of 8.5m at home without home care. Care trajectories showed rapid recovery with little to no use of care in 49% of patients, steady recovery with high initial use of nursing or home care decreasing over 1-3m in 15%, long term home or nursing care with high levels of care over 12mo in 21% and an unstable trajectory in 14%. Severe strokes (NIHSS≥10) were significantly more prevalent in steady recovery (8.5%), long term home or nursing care (21%) and unstable trajectories (11.6%) compared to the rapid recovery trajectory (4.8%) (p<0.05).

References

Appelros, P., Nydevik, I., Seiger, A., & Terent, A. (2002). Predictors of severe stroke: influence of preexisting dementia and cardiac disorders. *Stroke, 33*(10), 2357-2362.

Arling, G., Ofner, S., Reeves, M. J., Myers, L. J., Williams, L. S., Daggy, J. K., Phipps, M. S., Chumbler, N., & Bravata, D. M. (2015). Care trajectories of veterans in the 12 months after hospitalization for acute ischemic stroke. *Circulation: Cardiovascular Quality and Outcomes, 8*(6_suppl_3), S131-S140.

Chung, D. M., Niewczyk, P., DiVita, M., Markello, S., & Granger, C. (2012). Predictors of discharge to acute care after inpatient rehabilitation in severely affected stroke patients. *Am J Phys Med Rehabil, 91*(5), 387-392.

Claesson, L., Gosman-Hedstrom, G., Fagerberg, B., & Blomstrand, C. (2003). Hospital re-admissions in relation to acute stroke unit care versus conventional care in elderly patients the first year after stroke: the Goteborg 70+ Stroke study. *Age Ageing, 32*(1), 109-113.

Claesson, L., Gosman-Hedstrom, G., Johannesson, M., Fagerberg, B., & Blomstrand, C. (2000). Resource utilization and costs of stroke unit care integrated in a care continuum: A 1-year controlled, prospective, randomized study in elderly patients: the Goteborg 70+ Stroke Study. *Stroke, 31*(11), 2569-2577.

de Villiers, L., Badri, M., Ferreira, M., & Bryer, A. (2011). Stroke outcomes in a socio-economically disadvantaged urban community. *Samj South African Medical Journal, 101*(5), 345-348.

Deutsch, A., Granger, C. V., Heinemann, A. W., Fiedler, R. C., DeJong, G., Kane, R. L., Ottenbacher, K. J., Naughton, J. P., & Trevisan, M. (2006). Poststroke rehabilitation: outcomes and reimbursement of inpatient rehabilitation facilities and subacute rehabilitation programs. *Stroke, 37*(6), 1477-1482.

Di Carlo, A., Lamassa, M., Wellwood, I., Bovis, F., Baldereschi, M., Nencini, P., Poggesi, A., Cramaro, A., Pescini, F., Lucente, G., Wolfe, C. D. A., & Inzitari, D. (2011). Stroke unit care in clinical practice: An observational study in the Florence center of the European Registers of Stroke (EROS) Project. *European Journal of Neurology, 18*(5), 686-694.

Hayward, K. S., Kuys, S. S., Barker, R. N., & Brauer, S. G. (2014). Clinically important improvements in motor function are achievable during inpatient rehabilitation by stroke patients with severe motor disability: a prospective observational study. *NeuroRehabilitation, 34*(4), 773-779.

Hu, M. H., Hsu, S. S., Yip, P. K., Jeng, J. S., & Wang, Y. H. (2010). Early and intensive rehabilitation predicts good functional outcomes in patients admitted to the stroke intensive care unit. *Disabil Rehabil, 32*(15), 1251-1259.

Jammali-Blasi, A., McInnes, E., Markus, R., Faux, S., O'Loughlin, G., Dale, S., & Middleton, S. (2011). A study of 90-day outcomes for a cohort of patients admitted to an Australian metropolitan acute stroke unit. *Journal of Vascular Nursing, 29*(1), 3-10 18p.

Jeng, J. S., Huang, S. J., Tang, S. C., & Yip, P. K. (2008). Predictors of survival and functional outcome in acute stroke patients admitted to the stroke intensive care unit. *J.Neurol.Sci., 270*(1-2), 60-66.

Jorgensen, H. S., Kammersgaard, L. P., Houth, J., Nakayama, H., Raaschou, H. O., Larsen, K., Hubbe, P., & Olsen, T. S. (2000). Who benefits from treatment and rehabilitation in a stroke Unit? A community-based study. *Stroke, 31*(2), 434-439.

Jorgensen, H. S., Nakayama, H., Raaschou, H. O., Larsen, K., Hubbe, P., & Olsen, T. S. (1995). The effect of a stroke unit: reductions in mortality, discharge rate to nursing home, length of hospital stay, and cost. A community-based study. *Stroke, 26*(7), 1178-1182.

Kalra, L., Dale, P., & Crome, P. (1993). Improving stroke rehabilitation. A controlled study. *Stroke, 24*(10), 1462-1467.

Kalra, L., & Eade, J. (1995). Role of stroke rehabilitation units in managing severe disability after stroke. *Stroke, 26*(11), 2031-2034.

Kammersgaard, L. P., Jorgensen, H. S., Reith, J., Nakayama, H., Pedersen, P. M., & Olsen, T. S. (2004). Short- and long-term prognosis for very old stroke patients. The Copenhagen Stroke Study. *Age Ageing, 33*(2), 149-154.

Kashihara, M., Nakao, S., Kawasaki, J., Takata, S., Nagahiro, S., Kaji, R., & Yasui, N. (2011). Long-term outcome of severe stroke patients: Is the ADL status at discharge from a stroke center indicative of the long-term outcome? *Journal of Medical Investigation, 58*(3-4), 227-234.

Kimura, K., Minematsu, K., & Yamaguchi, T. (2005). Atrial fibrillation as a predictive factor for severe stroke and early death in 15,831 patients with acute ischaemic stroke. *J.Neurol.Neurosurg.Psychiatry, 76*(5), 679-683.

Lofgren, B., Gustafson, Y., & Nyberg, L. (1999). Psychological well-being 3 years after severe stroke. *Stroke, 30*(3), 567-572.

Maulden, S. A., Gassaway, J., Horn, S. D., Smout, R. J., & DeJong, G. (2005). Timing of initiation of rehabilitation after stroke. *Archives of Physical Medicine & Rehabilitation, 86*, S34-40 31p.

McKenna, K., Tooth, L., Strong, J., Ottenbacher, K., Connell, J., & Cleary, M. (2002). Predicting discharge outcomes for stroke patients in Australia. *Am.J.Phys.Med.Rehabil., 81*(1), 47-56.

Mutai, H., Furukawa, T., Araki, K., Misawa, K., & Hanihara, T. (2013). Long-term outcome in stroke survivors after discharge from a convalescent rehabilitation ward. *Psychiatry and Clinical Neurosciences, 67*(6), 434-440.

Navarrete-Navarro, P., Rivera-Fernandez, R., Lopez-Mutuberria, M. T., Galindo, I., Murillo, F., Dominguez, J. M., Munoz, A., Jimenez-Moragas, J. M., Nacle, B., & Vazquez-Mata, G. (2003). Outcome prediction in terms of functional disability and mortality at 1 year among ICU-admitted severe stroke patients: a prospective epidemiological study in the south of the European Union (Evascan Project, Andalusia, Spain). *Intensive Care Med., 29*(8), 1237-1244.

Niewada, M., Jezierska-Ostapczuk, A., Skowronska, M., Sarzynska-Dlugosz, I., & Czlonkowska, A. (2012). Weekend versus weekday admissions in Polish stroke centres - could admission day affect prognosis in polish ischaemic stroke patients? [Przyje{ogonek}cia w dni robocze i w weekend na polskich oddzialach udarowych - czy dzien przyje{ogonek}cia wplywa na rokowanie chorych na udar niedokrwienny mozgu w polsce?.]. *Neurologia i Neurochirurgia Polska, 46*(1), 15-21.

Nolfe, G., D'Aniello, A. M., Muschera, R., & Giaquinto, S. (2003). The aftermath of rehabilitation for patients with severe stroke. *Acta Neurol.Scand., 107*(4), 281-284.

Peters, S., Ivanova, T. D., Teasell, R., & Garland, S. J. (2014). Is the recovery of functional balance and mobility accompanied by physiological recovery in people with severe impairments after stroke? *Neurorehabil Neural Repair, 28*(9), 847-855.

Rabadi, M. H., Rabadi, F. M., Edelstein, L., & Peterson, M. (2008). Cognitively Impaired Stroke Patients Do Benefit From Admission to an Acute Rehabilitation Unit. *Archives of Physical Medicine and Rehabilitation, 89*(3), 441-448.

Riachy, M., Sfeir, F., Sleilaty, G., Hage-Chahine, S., Dabar, G., Bazerbachi, T., Aoun-Bacha, Z., Khayat, G., & Koussa, S. (2008). Prediction of the survival and functional ability of severe stroke patients after ICU therapeutic intervention. *BMC.Neurol., 8*, 24.

Ronning, O. M., & Guldvog, B. (1998). Outcome of subacute stroke rehabilitation: a randomized controlled trial. *Stroke, 29*(4), 779-784.

Sandstrom, R., Mokler, P. J., & Hoppe, K. M. (1998). Discharge destination and motor function outcome in severe stroke as measured by the functional independence measure/function-related group classification system. *Arch.Phys.Med.Rehabil., 79*(7), 762-765.

Saposnik, G., Black, S. E., Hakim, A., Fang, J., Tu, J. V., Kapral, M. K., Investigators of the Registry of the Canadian Stroke, N., & Stroke Outcomes Research Canada Working, G. (2009). Age disparities in stroke quality of care and delivery of health services. *Stroke, 40*(10), 3328-3335.

Smith, E. E., Hassan, K. A., Fang, J., Selchen, D., Kapral, M. K., & Saposnik, G. (2010). Do all ischemic stroke subtypes benefit from organized inpatient stroke care? *Neurology, 75*(5), 456-462 457p.

Somerford, P. J., Lee, A. H., & Yau, K. K. (2004). Ischemic stroke hospital stay and discharge destination. *Annals of Epidemiology, 14*(10), 773-777 775p.

Sulter, G., Elting, J. W., Langedijk, M., Maurits, N. M., & De Keyser, J. (2003). Admitting acute ischemic stroke patients to a stroke care monitoring unit versus a conventional stroke unit: a randomized pilot study. *Stroke, 34*(1), 101-104.

Teasell, R. W., Foley, N. C., Bhogal, S. K., Chakravertty, R., & Bluvol, A. (2005). A rehabilitation program for patients recovering from severe stroke. *Can.J.Neurol.Sci., 32*(4), 512-517.

Ween, J. E., Alexander, M. P., D'Esposito, M., & Roberts, M. (1996). Factors predictive of stroke outcome in a rehabilitation setting. *Neurology, 47*(2), 388-392.

Ween, J. E., Mernoff, S. T., & Alexander, M. P. (2000). Recovery rates after stroke and their impact on outcome prediction. *Neurorehabil.Neural Repair, 14*(3), 229-235.

Yagura, H., Miyai, I., Suzuki, T., & Yanagihara, T. (2005). Patients with severe stroke benefit most by interdisciplinary rehabilitation team approach. *Cerebrovasc.Dis., 20*(4), 258-263.