Rehabilitation of Severe Stroke

Shelialah Pereira MSc, Robert Teasell MD, Ross Graham MSc, Katherine Salter PhD (cand.), Norine Foley MSc, Sarah Donaldson BHSc

Last Updated: October 2013

Abstract

Severe strokes often result in multiple disabilities and constitute not only the most disabled group of stroke patients but also the greatest rehabilitation challenge. On a per-person basis, severe stroke patients incur the greatest costs to the healthcare system, primarily due to increased length of stay (LOS) in hospital and the frequent need for expensive long-term care or institutionalization (Navarrete-Navarro et al. 2003). Research relating to the definition, classification, neuro-recovery and rehabilitation of severe strokes is provided in this review. Clinical evidence for various severe stroke rehabilitation models are discussed (including slow-stream, intensive care unit (ICU), and specialized interdisciplinary stroke rehabilitation). Ethical dialogue pertaining to severe stroke is also presented.
Key Points

- Severe stroke rehabilitation poses a significant challenge to the current healthcare and rehabilitation system.

- Although there is no single definition for severe stroke, a commonly used indicator is early FIM® score <40.

- Rehabilitation funding models have a direct implication on the care of individuals recovering from severe strokes.

- Larger strokes have less potential for cortical reorganization to occur.

- Although it is rare for individuals with severe stroke to be admitted to an ICU, their outcomes suggest it may be beneficial in reducing mortality.

- Greater severity is associated with poorer outcomes in stroke patients.

- Persons with severe stroke admitted to specialized interdisciplinary stroke rehabilitation units show better health outcomes when compared to those who receive standard care.

- Specialized interdisciplinary stroke rehabilitation units do not necessarily result in better functional outcomes.

- Rehabilitation of individuals with severe stroke should emphasize discharge planning and reduction in complications.

- At present, there is insufficient evidence to suggest that slow-stream stroke rehabilitation is an effective intervention.

- Ethical decisions regarding care of individuals with severe stroke should be based on trial treatments, and collaboration between attending medical staff and the patient’s family.

---

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

Abstract ............................................................................................................................................. 1

Key Points .......................................................................................................................................... 2

Table of Contents .............................................................................................................................. 3

23. Rehabilitation of Severe Stroke .................................................................................................. 4

23.1 Issues in Severe Stroke Rehabilitation ...................................................................................... 4
  23.1.1 Defining Severe Strokes ........................................................................................................ 4
  23.1.2 Impact of Funding Models on Severe Stroke Rehabilitation ................................................. 6

23.2 Stroke Recovery and Severity .................................................................................................... 7
  23.2.1 Cortical Reorganization Following Stroke ............................................................................ 7
  23.2.2 Role of Reciprocal Motor Area Connectivity in Reorganization ......................................... 8
  23.2.3 Effect of Lesion Size on Recovery ......................................................................................... 8
  23.2.4 Summary of Stroke Severity and Recovery ......................................................................... 9

23.3 Care of Individuals with Severe Stroke ....................................................................................... 9
  23.3.1 Admission to Intensive Care Units ....................................................................................... 9
  23.3.2 Stroke Severity and Rehabilitation Outcomes ..................................................................... 11

23.4 The Outcomes of Severe Stroke Rehabilitation .......................................................................... 14
  23.5 Slow Stream Rehabilitation ....................................................................................................... 19
  23.6 The Ethical Issues in Severe Stroke Rehabilitation .................................................................... 21
  23.7 Summary .................................................................................................................................. 25

References .......................................................................................................................................... 27
23. Rehabilitation of Severe Stroke

23.1 Issues in Severe Stroke Rehabilitation

Severe strokes often result in a combination of significant motor, sensory and cognitive deficits. Individuals who have experienced a severe stroke constitute the most disabled group of stroke patients and present significant rehabilitation challenges. Although individuals with severe stroke have the greatest deficits, they may have limited access to rehabilitation. These individuals may be considered “poor candidates” for inpatient stroke rehabilitation because of perceived limitations to their rehabilitation potential (Gladman & Sackley 1998), because they do not make functional gains comparable to those made by individuals in the "middle band" of stroke severity (Alexander 1994; Ancheta et al. 2000; Asberg & Nydevik 1991; Carey et al. 1988) and because there are concerns about the cost effectiveness of rehabilitating these individuals (Gladman & Sackley 1998).

It is estimated that approximately 20% of stroke patients will experience such severe functional deficits that they may remain non-ambulatory and continue to require assistance with activities of daily living (ADLs), irrespective of rehabilitation efforts (Pfeffer & Reding 1998). Further, it has been demonstrated repeatedly that the most powerful predictors of both functional recovery and eventual discharge home are initial stroke severity and patient age; although, the effect of age is not nearly as significant as that of stroke severity (Alexander 1994; Stineman & Granger 1998).

There is some evidence suggesting that patients with severe stroke benefit from specialized inpatient rehabilitation. Although these patients appear to make limited functional gains in response to specialized interdisciplinary stroke rehabilitation, they may experience reduced mortality, reduced length of stay in hospital and a greater likelihood of discharge home (Jorgensen et al. 2000; Jorgensen et al. 1995).

Conclusions Regarding the Issues in Severe Stroke Rehabilitation

Despite having the greatest number of impairments and the most severe disabilities, these patients may have limited access to rehabilitation

Limited access to rehabilitation could be a result of many factors such as their reduced potential to make functional gains comparable to those individuals with moderately-severe stroke

Rehabilitation of individuals with severe stroke is associated with greater use of resources

Severe stroke rehabilitation can pose a significant challenge to the current healthcare and rehabilitation system.

23.1.1 Defining Severe Strokes

Globally, there are various scales used to assess and study stroke severity (see Table 23.1). Appelros et al. (2002) proposed that the amount of initial trauma or risk of mortality upon admission may serve as a measure of severity while other authors have classified severe stroke as functional outcome post-rehabilitation or level of morbidity post-discharge (Nolfe et al. 2003). Acute health measures used to study severe stroke include the Acute Physiology and Chronic Health Evaluation (APACHE) (Riachy et al. 2008) and the National Institutes of Health Stroke Scale (NIHSS). Disability is often measured using the...
Garraway et al. (1981) first proposed the concept of three bands of stroke severity (see Table 23.2). Individuals who were unconscious at onset and experiencing severe unilateral or bilateral paresis were described as having experienced a severe stroke. These patients may have also had serious medical comorbidities, which would have contributed to the severity of disability. Alexander (1994) and Nolfe et al. (2003) classify severe stroke as an early FIM® score <40. Individuals fulfilling this criterion were considered unlikely to achieve functional independence regardless of treatment, with the exception of the younger (<55 years) population (Nolfe et al. 2003).

Finally, individuals with severe stroke have also been described as those who are non-ambulatory and at high risk for failure to return home due to physical, cognitive, perceptual, and communication difficulties, but generally due to a combination of the above (Evans 1981). See also chapter 4: Managing the Stroke Rehabilitation Triage Process (4.3: Levels of Stroke Severity).

Table 23.2 Defining and Prognosticating Rehabilitation Potential Based on Stroke Severity  (Garraway 1985; Garraway et al. 1981)

<table>
<thead>
<tr>
<th>Upper Band</th>
<th>Middle Band</th>
<th>Lower Band</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal deficits Early (5-7 days) FIM®&gt;80 or motor FIM®&gt;62 Excellent recovery regardless of rehabilitation</td>
<td>Moderate deficits Conscious with significant hemiparesis Early FIM® 40-80 or motor FIM® 38-62 Marked improvements in rehabilitation and 85% discharged to community</td>
<td>Severe deficits Unconscious at onset with severe paresis or serious medical comorbidity Early FIM® score &lt;40 or motor FIM® &lt;37 Slower improvement, unlikely to achieve functional independence (unless young) and smallest likelihood of community discharge</td>
</tr>
</tbody>
</table>
Garraway et al. (1981, 1985) actually defined more severe strokes as the upper band and milder strokes as the lower band; however, we have changed that around to avoid confusion since over the years actual classification has changed to be more intuitive.

**Conclusions Regarding the Definition of Severe Stroke**

Stroke severity has been defined in a variety of ways. Common definitions are unconsciousness with severe unilateral or bilateral paresis at onset; early FIM® score <40 or motor FIM® score <37; high risk for failure to return home due to physical, cognitive, perceptual, and communication difficulties, or a combination of the above.

**Although there is no single definition for severe stroke, a commonly used indicator is early FIM® score <40.**

### 23.1.2 Impact of Funding Models on Severe Stroke Rehabilitation

Evidence has shown that individuals with severe stroke represent a greater burden in terms of health and economic resources than individuals with mild and moderate strokes (Brock et al. 2007; Gladman & Sackley 1998; Stineman 1997). That being said, stroke severity can also have an impact on resources within the stroke rehabilitation unit. With the use of case-mix funding models, admission processes could show favouritism towards certain stroke sub-groups (Ilett et al. 2010). There are concerns that a higher volume of severe stroke admissions could result in unfavorable publicly reported outcomes, such as mortality (Ali et al. 2013). There could be a bias toward selecting patients with less severe strokes for rehabilitation, as those with more severe disabilities could adversely affect the ‘bottom line’. “[Certain] funding models also have the potential to affect access to rehabilitation by providing financial incentives for admitting patients who are more likely to be profitable, rather than those who may receive significant benefits from the rehabilitation process” (page 827) (Brock et al. 2007). The severe stroke patient’s typically have longer LOS, poorer outcomes, discharge challenges, and a need for more nursing care which may place them at a significant disadvantage when being considered as rehabilitation candidates.

For rehabilitation hospitals in North America, a common funding model used is the FIM® Function-Related Groupings (FIM®-FRG). FIM®-FRGs is a type of case-mix funding model that uses a decision tree to distinguish one class of patients from another (Figure 23.1)(Tesio 2003). Principle impairment, severity of disability, and age are all factors included in the FIM®-FRG classification of stroke patients (Stineman 1997). This model is widely used in the United States and often as part of a larger case-mix system encompassing a variety of healthcare centers (Stineman 1997; Stineman et al. 1997). Stroke patients with the best measured gains post-rehabilitation are those of a young age with severe impairment(s) (FRG 1) (Bates & Stineman 2000). Midrange FRGs (4-7) typically experience significant positive functional gains, while older severe patients (FRG 2, 3) and those with mild impairment (FRG 8-9) often see less measured functional improvement at discharge (Bates & Stineman 2000; Han et al. 2002). Han et al. (2002) reported that stroke patients with multiple impairments often achieve less functional gains when compared to stroke patients with a single-impairment.

**Figure 23.1 FIM®-FRG Grouping Structure (Stineman et al. 1997)**
Research examining the introduction of similar systems has shown mixed benefits. For severe stroke patients, Brock et al. (2007) reported a FIM® grouping system reduced costs but increased level of disability at discharge. Dejong et al. (2005) found implementation of a FIM® classification system resulted in therapy resources being transferred from more severe stroke patients to those with moderate stroke. Further, Stineman (1997) echoes those results and states that both elderly and severe patients (classified using FIM®-FRGs) require additional considerations in a case-mix funding system.

**Conclusions Regarding Funding Models and Severe Strokes**

*Severe strokes may be the most negatively affected by the type of funding models employed.*

*Rehabilitation funding models have a direct implication on the care of individuals with severe stroke.*

**23.2 Stroke Recovery and Severity**

**23.2.1 Cortical Reorganization Following Stroke**

In animals, neurological and functional recovery after cortical injury is dependent upon reorganization of the remaining cortical circuitry, including increased dendritic arborisation and increased neuron spine density (Kolb et al. 2000). There is an abundance of evidence that structural changes occur in the uninjured cortical tissue surrounding a stroke. Nudo (2003) (page 8) suggested that the mechanisms which “underlie functional modifications in the motor cortex of normal animals during motor skill learning ... [are likely the] ... same mechanisms [that] play a role in recovery after damage to the motor cortex” and that this is particularly true for small focal lesions in the sensorimotor cortex hand area or the primary motor hand area. Further, when damage occurs to a portion of the cortex, as in stroke, much of the surrounding undamaged cortex will be impacted because of the loss of the intracortical
projections both to and from the area of injury (Nudo 2003). This applies to even remote areas of the brain, so long as they have some connection to the damaged area. Hence, a process of brain reorganization can be anticipated in adjacent and remote areas of the cortex that are connected to the damaged region.

23.2.2 Role of Reciprocal Motor Area Connectivity in Reorganization
Frost et al. (2003) studied infarcts in the primary motor cortex hand representation area of monkeys and reported that the amount of expansion in the hand area of the ventral premotor cortex was directly proportional to the amount of damage to the primary motor cortex. It appeared as though secondary motor areas were being called on to compensate for the lost function. Greater cortical damage resulted in more widespread attempts to reorganize the remaining cortical areas. However, this strategy has inherent issues since more distant and less well connected cortical regions are recruited, which results in continued impairment of functions represented by the damaged area of the brain. Frost et al. (2003) (page 3211) suggested two principles to explain this event: “reorganization of secondary cortical areas is a general feature of injury-induced plasticity,” and “remote reorganization is directly related to the reciprocal connectivity of the various motor areas.” With respect to the latter statement, there needs to be some form of connection to the damaged motor areas for functional reorganization to occur. This would mean that for much larger strokes, with both primary and secondary motor areas affected, there would be a reduced capacity for neurological reorganization. By injuring not only the primary area responsible for the lost function but also adjacent areas which normally would be called on to take over the lost function, more severe strokes have less capacity for neurological reorganization and recovery. Hence, the greater the damage to reciprocal intra-cortical pathways, the greater the plasticity seen in secondary intact areas; however, these secondary areas are less efficient and may not be preserved in more severe strokes, resulting in the reduced potential for recovery (Teasell et al. 2005a).

23.2.3 Effect of Lesion Size on Recovery
Neuroplasticity in the damaged hemisphere, particularly those in areas with peri-infarct activity, are associated with the best recovery (Cramer et al. 2002; Hallett 2001). Research examining the impact of smaller strokes, in which the damaged area of the brain is partially preserved and adjacent or connecting areas have remained intact, has demonstrated that both patients and animals display an almost full and timely recovery (Whishaw 2000). Although recovery following a small stroke is often complete, the overall benefit of rehabilitation for patients with a small stroke is much less than that for patients with more severe strokes due to a “ceiling” effect. Recovery after a small stroke is often spontaneous and involves intact areas that already serve the affected function; therefore, rehabilitation therapies are not deemed to be critical to recovery.

As one example, Whishaw (2000) found that rats with small motor cortical lesions resulting in severe impairment initially performed poorly on skilled forelimb reaching tasks but demonstrated significant improvements over a 15-day period. Eventually, these rats were able to perform reaching tasks almost normally and demonstrated only mild impairments in lifting, aiming, and advancing the limb. In contrast, rats with larger lesions had a less complete return of function over a protracted period of time, generally weeks or months (Kolb 1995). Kolb (1995) noted that the larger lesions resulted in chronic loss of certain forelimb movements; even though the animals learned to compensate by using manoeuvres that involved the whole-body, in the end they were less successful in grasping food. Similarly in both animal and clinical studies, compensatory changes extended for up to 6 months in cases of more severe stroke (Green 2003).
23.2.4 Summary of Stroke Severity and Recovery
Cortical recovery following stroke depends on the reorganization of remaining cortical tissue. Any cortical tissue in contact with the stroke is affected via projections to and from the damaged tissue. Thus, plastic changes occur within the damaged ipsilateral hemisphere and in more remote regions of the cortex (Nudo 2003). Changes occurring in the ipsilateral hemisphere, particularly those in areas with peri-infarct activity, are associated with the best recovery (Cramer et al. 2002; Hallett 2001). Further, evidence suggests that compensation in remaining cortical areas associated with motor function is proportional to the amount of stroke-induced damage (Frost et al. 2003). This principle of reorganization appears to be true for secondary cortical areas that are adjacent to the stroke, as well as those in more remote regions of the cortex, so long as they are connected to the damaged tissue. Finally, evidence suggests that with larger lesions, compensatory changes within the cortex do in fact occur; however, such changes occur over a longer period of time when compared with changes resulting from smaller lesions (Kolb 1995, 2003; Kolb et al. 2000). The implication of this finding is that individuals with more severe stroke benefit from rehabilitation, although it will take longer for them to do so and recovery will be less complete.

Conclusions Regarding Stroke Severity and Recovery in Animal Studies
Animal studies, combined with human neuroimaging, demonstrate that recovery post-stroke is largely dependent on peri-lesional intact cortical areas which subsume a similar function and can take over the lost function. Larger strokes have reduced potential for this to occur.

Larger strokes have less potential for cortical reorganization to occur.

23.3 Care of Individuals with Severe Stroke
Individuals with severe stroke experience the greatest number of impairments and limitations and are therefore at the greatest risk for expensive, long-term institutionalization (Gladman & Sackley 1998). However, despite this risk, severe stroke patients are often denied formal access to inpatient rehabilitation. See also chapter 4: Managing the Stroke Rehabilitation Triage Process (4.4, Age as a Modifier in Rehabilitation Triage).

23.3.1 Admission to Intensive Care Units
Evidence shows that severe stroke patients can benefit from admission to an ICU or a neuro-intensive care unit (NICU) (Jeng et al. 2008; Nguyen & Koroshetz 2003). However, very few severe strokes (5-7%) are admitted to ICUs (Navarrete-Navarro et al. 2003; Riachy et al. 2008). Riachy et al. (2008) demonstrated that, compared with other types of patients, ICUs admission rates have been reported lower or non-existent for stroke.

Jeng et al. (2008) found a reduced 1-year mortality rate in those severe stroke patients treated in an ICU. However, the authors note that more research is required in order to establish the definitive benefits of intensive care for persons with severe stroke. The benefit of ICU care has been reported to be greatest for patients requiring continuous monitoring (Nguyen & Koroshetz 2003). This may include individuals with mechanical ventilation, post-stroke decompressive surgery, augmentation of cerebral perfusion, or induced hypothermia. As well, patients at risk for brain hemorrhage because of post-thrombolysis, candidates for endovascular angioplasty, stenting, clot retrieval, or those with severe neurological impairment may also derive significant benefit from admission to intensive care (Jeng et al.
2008; Nguyen & Koroshetz 2003). Given that intensive care can play a critical role in the reduction of early stroke mortality and improved short-term and long-term outcomes, the tendency not to admit severe stroke patients is somewhat disconcerting. This may be a combination of the significant resource expenditure associated with ICU care and a prevailing nihilistic attitude towards treatment of severe strokes. See also chapter 4: Managing the Stroke Rehabilitation Triage Process (4.2, Triaging Stroke Patients).

**Conclusions Regarding Severe Stroke Admission to ICUs**

*Severe strokes are seldom admitted to intensive care units as compared with other types of critically ill or injured patients.*

*Severe stroke patients with critical health issues appear to have lower mortality rates when admitted to intensive care. Further research is needed to establish other specific outcome gains.*

**Though it is rare for severe stroke patients to be admitted to an ICU, their outcomes suggest it may be beneficial in reducing mortality.**

### Table 23.3 Intensive Care Units and Severe Stroke Patients

<table>
<thead>
<tr>
<th>Author, Year Country PEDro Score</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navarrete-Navarro <em>et al.</em> (2003) Spain</td>
<td>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.</td>
<td>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 &lt;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.</td>
</tr>
<tr>
<td>Jeng <em>et al.</em> (2008) Taiwan</td>
<td>850 acute stroke patients (60% Ischemic) admitted &lt;12hrs to an ICU were examined for predictive value of early severity on 3 month post-discharge outcomes.</td>
<td>Old age, previous stroke, and total anterior circulatory infarct were associated with poor outcomes in ischemic stroke patients. Old age, low BMI, and presence of intraventricular haemorrhage were associated with poor outcomes. Poor functional outcome was defined as a Barthel Index score &lt;80 or a modified-Rankin Scale score &gt;2. NIHSS score ≥20 was consistently associated with death at 3 months, discharge to institutionalized care, and high levels of dependency post-stroke.</td>
</tr>
<tr>
<td>Riachy <em>et al.</em> (2008)</td>
<td>62 severe stroke patients (50% males, 62.2% Ischemic, mean age 65.8±12.3) admitted to an ICU</td>
<td>Severe stroke accounted for 7% of the ICU admissions. 16 patients died during the ICU admission.</td>
</tr>
</tbody>
</table>
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.

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.

23.3.2 Stroke Severity and Rehabilitation Outcomes
There is clinical evidence that patients with severe stroke demonstrate poorer outcomes in a variety of domains relative to those with less severe stroke (Jeng et al. 2008; Kammersgaard et al. 2004; McKenna et al. 2002; Oczkowski & Barreca 1993; Ween et al. 1996; Ween et al. 2000). The research presented in Table 23.4 demonstrates that more severe strokes are associated with negative outcomes such as longer LOS, higher rates of mortality, dependence, or institutionalization, and lower functional ability.

Table 23.4 Stroke Severity and Rehabilitation Outcomes

<table>
<thead>
<tr>
<th>Author, Year Country PEDro Score</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ween et al. (1996) USA</td>
<td>536 consecutive admissions with a primary diagnosis of stroke were prospectively followed. Patients with subarachnoid haemorrhages and strokes requiring cerebral surgical interventions 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®).</td>
<td>Admission FIM® influenced FIM® change across the population. Significant differences were seen between the group with admission FIM® &lt;40 and those with admission FIM® of 40-59, 60-80 and &gt;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.</td>
</tr>
<tr>
<td>Source</td>
<td>Study Description</td>
<td>Outcomes</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ween et al. (2000) USA</td>
<td>244 consecutive admissions to a rehabilitation hospital with a diagnosis of ischemic or hemorrhagic stroke were prospectively followed. Patients were excluded if they had extraxial hemorrhages, a lag from stroke onset to rehabilitation admission of &gt;30 days, or if they required readmission back to acute care from the rehabilitation hospital. Independent measures suspected of influencing outcomes were assessed.</td>
<td>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® (&lt;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®&lt;50 remained dependent on discharge, whereas 77 of 90 (85%) patients with an AFIM®&gt;70 were nondependent on discharge. 42 of the 74 (55%) patients with an AFIM® &gt;50 and &lt;70 remained dependent. The lowest AFIM® groups (&lt;30-60) had significantly longer LOS compared with the 60-69 group.</td>
</tr>
<tr>
<td>McKenna et al. (2002) Australia</td>
<td>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 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.</td>
<td>More severe strokes, defined by lower admission converted motor FIM® (FIM<em>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</em>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<em>MOT1 group (13-46) (OR 8.02; 95% CI 2.40-26.79; p=0.001) compared with the highest FIM</em>MOT1 group (63-91). Further, of those with low (13-46), moderate (47-62) and high (63-91) FIM*MOT1 scores, 42.6, 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 (&gt;75 years) was associated with more severe strokes and poorer functional status on discharge.</td>
</tr>
<tr>
<td>Appelros et al. (2002) Sweden</td>
<td>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.</td>
<td>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</td>
</tr>
</tbody>
</table>
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 Investigators’ Collaboration registry.

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 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).

Discussion

Evidence suggests that in addition to having a higher mortality rate, patients with severe stroke are more likely to experience a longer LOS (in comparison with age-related peers), and to remain severely disabled when compared to those with less severe stroke (Kammersgaard et al. 2004; McKenna et al. 2002; Oczkowski & Barreca 1993; Ween et al. 1996; Ween et al. 2000). They are also less likely to show functional improvement during their rehabilitation (Jeng et al. 2008). Overall, severity of stroke has been identified as a predictor of: discharge destination, change in living situation, LOS, functional ability, and mortality.

Conclusions regarding Stroke Severity and Rehabilitation Outcomes.
More severe strokes, as determined upon admission, are associated with poorer outcomes after rehabilitation when compared with less severe strokes.

Greater stroke severity is associated with poorer rehabilitation outcomes when compared to less severe strokes.

23.4 The Outcomes of Severe Stroke Rehabilitation

There is a growing body of evidence suggesting that patients with severe stroke benefit substantially from rehabilitation. Several authors have reported that, in response to specialized rehabilitation, these patients experience reduced mortality, increased likelihood of discharge home, and a shorter length of stay in hospital when compared to those treated in other settings (Jorgensen et al. 2000; Jorgensen et al. 1995; Kalra & Eade 1995; Ronning & Gulvdog 1998; Stineman & Granger 1998; Teasell et al. 2005b; Yagura et al. 2005).

Table 23.5 The Impact of Inpatient Rehabilitation on Individuals with Severe Stroke

<table>
<thead>
<tr>
<th>Author, Year Country PEDro Score</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kalra et al. (1993)</strong>&lt;br&gt;UK&lt;br&gt;5 (RCT)</td>
<td>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.</td>
<td>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. 123.2 days, p&lt;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&lt;0.05).</td>
</tr>
<tr>
<td><strong>Kalra &amp; Eade (1995)</strong>&lt;br&gt;UK&lt;br&gt;5 (RCT)</td>
<td>76 stroke patients with a poor prognosis (Orpington Prognostic Score of &lt;5) resulting from severe stroke were randomized to care on a stroke unit or a general medical unit.</td>
<td>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.</td>
</tr>
<tr>
<td><strong>Jorgensen et al. (1995)</strong>&lt;br&gt;Jorgensen et al. (2000)&lt;br&gt;Denmark No Score</td>
<td>A comparison of 1241 stroke patients who received care in two different medical districts of Copenhagen. One community had a single stroke unit (n=936), while patients in the other community were treated on general neurological and medical wards (n=305). The clinical characteristics of patients in each group were similar.</td>
<td>At discharge, stroke unit patients experienced significantly lower mortality, better functional outcome, shorter LOS, and a higher discharge home rate. The relative risk of a poor outcome (defined as mortality during hospital stay or discharge to a nursing home) was reduced by 47%, on average, for stroke patients treated on the stroke unit when compared to those treated on the general neurological and medical wards. Persons with the most severe strokes (lower consciousness on admission) were the ones who benefited most from the stroke unit. The relative risk of a poor outcome was reduced by 86% in</td>
</tr>
</tbody>
</table>
this group. The relative risk of one and five-year mortality was reduced by 40% and 70%, respectively, in this group. Those who benefited the least were the patients with mild to moderate (fully conscious on admission) stroke. The authors noted that the marked improvement in outcome was a result of the interdisciplinary coordinated rehabilitation approach with early mobilization, as opposed to acute intensive monitoring.

**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 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.
live in their homes and were interviewed regarding their psychological wellness using the Philadelphia Geriatric Center Morale Scale (PGCMS).

Depression was shown to have the largest negative association (-0.78 correlation with the PGCMS score, p<0.01) with a patient’s 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.

<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>Country</th>
<th>Score</th>
<th>Participants</th>
<th>Intervention</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fagerberg et al. (2000)</td>
<td>Sweden</td>
<td>8 (RCT)</td>
<td>249 elderly patients (&gt;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.</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Nolfe et al. (2003)</td>
<td>Italy</td>
<td>No Score</td>
<td>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.</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Teasell et al. (2005b)</td>
<td>Canada</td>
<td>No Score</td>
<td>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 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.</td>
<td>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 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</td>
<td></td>
</tr>
</tbody>
</table>
importance were: admission FIM® score, age, male sex and no history of previous stroke.

<table>
<thead>
<tr>
<th>Study</th>
<th>Description</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yagura et al.</strong></td>
<td>Reported on the efficacy of an interdisciplinary stroke rehabilitation unit</td>
<td>Significantly more patients with severe disability were discharged home in the SRU group</td>
</tr>
<tr>
<td>(2005)</td>
<td>(SRU; defined as having regular team conferences) compared to a general</td>
<td>compared with the GRW group (47.4% vs. 0%, p&lt;0.0001). There were no significant differences</td>
</tr>
<tr>
<td>Japan</td>
<td>rehabilitation ward (GRW; without such conferences) within the same</td>
<td>between the groups with respect to increase in FIM® score, Stroke Impairment Assessment Set</td>
</tr>
<tr>
<td>No Score</td>
<td>rehabilitation hospital. 178 patients were admitted within 3 months of</td>
<td>score, length of hospital stay, or cost. The authors concluded that patients with severe</td>
</tr>
<tr>
<td></td>
<td>stroke onset and were allocated to either the SRU or the GRW, depending on</td>
<td>stroke appeared to benefit most from regular interdisciplinary stroke team conferences in</td>
</tr>
<tr>
<td></td>
<td>bed availability.</td>
<td>the SRU and had an improved discharge disposition.</td>
</tr>
<tr>
<td><strong>Deutsch et al.</strong></td>
<td>Compared the outcomes and reimbursement of care provided to sub groups of</td>
<td>IRF patients were more likely to be discharged to the community. Significant difference</td>
</tr>
<tr>
<td>(2006)</td>
<td>stroke patients in 2 sub-acute rehabilitation settings [i.e. inpatient</td>
<td>between the 2 groups was seen for severe stroke patients &lt;82 years among other subgroups.</td>
</tr>
<tr>
<td>US</td>
<td>rehabilitation facilities (IRFs) and skilled nursing facilities (SNFs)].</td>
<td>Motor FIM® gains were higher by an average of 2.4 points (95% CI: 1.56 to 3.24) in IRF</td>
</tr>
<tr>
<td>No Score</td>
<td>Data was included from 58724 patient records. Case-mix grouping was used</td>
<td>patients with severe motor disabilities, 2.39 points (95% CI: 1.45 to 3.32) for individuals</td>
</tr>
<tr>
<td></td>
<td>to develop sub groups based on severity. The most severe strokes (CMG</td>
<td>with severe motor disabilities and ≥82 years of age, and 4.24 (95% CI: 3.45 to 5.03) for</td>
</tr>
<tr>
<td></td>
<td>108-114) consisted of individuals with motor FIM® scores 12-38.</td>
<td>individuals with severe motor disabilities and &lt;82 years of age. Median IRF LOS was</td>
</tr>
<tr>
<td></td>
<td></td>
<td>significantly shorter than median LOS in SNFs across most subgroups. Cost of rehabilitation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>was higher in IRFs when compared to SNFs.</td>
</tr>
</tbody>
</table>

**Discussion**

Various researchers investigating a number of different outcomes have highlighted the benefits of specialized stroke rehabilitation for individuals with severe stroke. The most consistent benefits of specialized interdisciplinary rehabilitation for severe stroke patients are a reduced mortality rate (Jorgensen et al. 1995; Ronning & Guldvog 1998) and an increased likelihood of discharge home (McKenna et al. 2002; Ween et al. 1996).

Jorgensen et al. (2000) reported that persons with the most severe strokes appeared to benefit the most initially, from rehabilitation in a dedicated stroke rehabilitation unit in terms of mortality when compared to other stroke patients. A similar finding was also reported by Ronning and Guldvog (1998), who demonstrated that patients with moderate and severe impairments received the most benefit from inpatient rehabilitation in terms of combined death and dependency.

It was reported that 47.4% of individuals with severe stroke admitted to an inpatient stroke unit were able to return home; in contrast, none of those admitted to a general rehabilitation ward were discharged home (Yagura et al. 2005). This number is similar to the 43% of severe stroke patients who were able to return home after undergoing a specialised stroke rehabilitation program (Teasell et al. 2005b). Deutsch et al. (2006) conducted a retrospective review of stroke patients admitted to 631 Inpatient Rehabilitation Facilities (IRFs) and 239 Skilled Nursing Facilities (SNFs) across the United States. It was found that individuals with severe stroke admitted to IRFs were significantly more likely to be discharged to the community than those admitted to SNFs (Deutsch et al. 2006). Shorter lengths of
hospital stay were reported for persons with severe stroke admitted to stroke rehabilitation units in 2 RCTs (Kalra et al. 1993; Kalra & Eade 1995). Median LOS of severe stroke patients in IRFs was shorter than those undergoing rehabilitation in SNFs (Deutsch et al. 2006). Finally, Jorgensen et al. (2000) and Yagura et al. (2005) concluded that there was no significant difference in LOS for patients with severe strokes admitted to rehabilitation units when compared to general medical wards.

The benefits of rehabilitation for severe stroke patients, in terms of functional gains, are less clear. Nolfe et al. (2003) found a significant improvement in median FIM® scores among severe stroke patients admitted to inpatient rehabilitation during the 6 month follow up; this trend has been observed in additional studies (Deutsch et al. 2006; Teasell et al. 2005b). Ronning and Gulvog (1998) reported that moderate and severe stroke patients benefitted the most in terms of dependency. However, other authors have reported no significant functional gains (as measured by the Barthel Index) in the severe stroke study population (Kalra et al. 1993; Kalra & Eade 1995).

It was reported that severe stroke patients admitted to a specialized geriatric stroke unit had improved psychological wellness at a 6 month follow-up (Lofgren et al. 1999). Finally, specialized care appears to be beneficial for patients with severe stroke who suffer from concomitant cardiac disease (Fagerberg et al. 2000). Evidence from clinical trials suggests that patients with severe stroke benefit substantially from the provision of interdisciplinary specialized stroke rehabilitation and that these benefits may be relatively greater than those seen for moderately severe strokes.

Pereira et al. (2012) conducted a systematic review of 14 studies (including 4 RCTs) that looked at outcomes of severe stroke admitted to various inpatient rehabilitation programs. Although persons with severe strokes make slower and fewer functional gains during inpatient rehabilitation, there is evidence to support significant benefits for this population in terms of decreased mortality, reduced LOS and increased likelihood of discharge to the community. The authors believe that this is sufficient to justify admission of persons with severe stroke to specialized inpatient rehabilitation facilities.

The results of studies examining severe stroke rehabilitation are described in Table 23.6.

**Table 23.6 Summary of Studies Comparing different forms of Rehabilitation in Severe Stroke**

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>N</th>
<th>Study Type</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kalra et al. (1993)</td>
<td>36</td>
<td>RCT – stroke unit vs. general medical unit</td>
<td>- Barthel Index Scores + LOS + Mortality - Discharge home</td>
</tr>
<tr>
<td>Kalra &amp; Eade (1995)</td>
<td>76</td>
<td>RCT – stroke unit vs. general medical unit</td>
<td>- Barthel Index Scores + LOS + Mortality + Discharge home</td>
</tr>
<tr>
<td>Jorgensen et al. (2000; 1995)</td>
<td>1241</td>
<td>Cohort controlled – stroke unit vs. general neurological unit</td>
<td>+ Initial and 1 year mortality + Poor Outcome (Death or LTC) - LOS</td>
</tr>
<tr>
<td>Ronning &amp; Gulvog (1998)</td>
<td>251, 115 severe or moderate (BI&lt;50) patients</td>
<td>RCT – stroke rehabilitation unit vs. ad hoc care at home</td>
<td>+ Combined Death and dependence (at 7 months) + Barthel Index Scores</td>
</tr>
<tr>
<td>Fagerberg et al. (2000)</td>
<td>249,75 severe (BI 0-15) patients</td>
<td>RCT – stroke unit vs. conventional care</td>
<td>- Combined death and dependency</td>
</tr>
<tr>
<td>Yagura et al. (2005)</td>
<td>178, 27 severe (FIM® ≥53)</td>
<td>Cohort controlled – stroke rehabilitation unit vs. general</td>
<td>+ Discharge home - FIM® scores</td>
</tr>
</tbody>
</table>
Conclusions Regarding the Benefits of Rehabilitation for Severe Strokes

There is evidence that patients with severe stroke benefit from specialized interdisciplinary stroke rehabilitation. This results in reduced length of hospital stay, institutionalization and mortality, and to a lesser extent, functional improvement.

There is strong (Level 1a) evidence that specialized interdisciplinary stroke rehabilitation reduces mortality in severe stroke patients when compared to general rehabilitation programs.

There is moderate (Level 1b) evidence that severe stroke patients who are admitted to specialized interdisciplinary stroke rehabilitation programs are more likely to be discharged home.

There is strong (Level 1a) evidence that specialized interdisciplinary stroke rehabilitation programs result in shorter LOS.

There is conflicting (Level 4) evidence regarding functional gains of persons with severe stroke following specialised interdisciplinary inpatient stroke rehabilitation.

Functional outcomes suggest that rehabilitation of severe stroke patients should emphasize discharge planning and reduction of post-stroke complications.

Severe stroke patients admitted to specialized interdisciplinary stroke rehabilitation units have better health outcomes as compared to standard care.

Specialized interdisciplinary stroke rehabilitation units do not necessarily result in better functional outcomes.

Rehabilitation of individuals with severe stroke should emphasize discharge planning and reduction in complications.

23.5 Slow Stream Rehabilitation

Slow-stream rehabilitation has been suggested as an alternative for individuals with a severe stroke who may not be able to tolerate intensive therapy but could benefit from low intensity rehabilitation (Tourangeau et al. 2011). It aims to provide specialized stroke rehabilitation services over longer periods of time to individuals with more severe deficits who may not traditionally be considered good candidates for inpatient rehabilitation (O'Neill et al. 1987). O'Neill et al. (1987) studied 52 individuals with mixed diagnoses admitted to a slow-stream rehabilitation unit and reported that this form of rehabilitation could result in both social and economic benefits. However, (Richmond et al. 1988) raised some interesting questions about these conclusions. Although 36% (n=19/52) returned home following slow-stream rehabilitation, only 9 remained home 6 to 30 months later. Moreover, they attempted to
compare costs of slow-stream rehabilitation to nursing home care and suggested that the former may be the more expensive of the two. In Canada, the majority of costs associated with the delivery of inpatient stroke rehabilitation are associated with nursing and accommodation rather than the provision of core therapies (physiotherapy, occupational therapy and speech language pathology). In fact, less than 20% of costs are attributable to core therapies. Therefore, it is important to ensure that patients receive as much of the core therapies as is tolerable to them within a short period of time. All of the research that demonstrated significant improvements over conventional care in the rehabilitation of patients with severe stroke (refer to Tables 23.3 and 23.4) involved interdisciplinary, relatively intense stroke rehabilitation units, and not less intensive versions. Hence, the intensity of therapy received should be dictated by the tolerance of the individual patient and not by preconceived notions about the amount of therapy that severe stroke patients can successfully tolerate (Teasell et al. 2005b).

At present, the concept of slow-stream stroke rehabilitation for individuals with severe stroke remains relatively untested. Torangeau et al. (2011) described the outcomes of 81 individuals admitted to “low intensity, long duration” units across 6 facilities in Ontario. They reported that 48% of these individuals (who would have not been considered as candidates for traditional intensive rehabilitation) were able to return home, 35% were discharged to setting that needed lower levels of care (e.g nursing homes) and 17% were discharged to more costly setting where higher levels of care were provided (Tourangeau et al. 2011).

In the United States, a large comparative study examined stroke rehabilitation outcomes at 3 and 6 months with regard to long-term placement, functional status and cost (Kramer et al. 1997). This study included case mix-adjusted populations treated in rehabilitation hospitals, specialized rehabilitation nursing homes and traditional nursing homes. Findings indicated that patients in the rehabilitation hospital experienced significantly greater functional recovery when compared to those who received specialized rehabilitation in the nursing home or those treated in a traditional nursing home. Medicare costs associated with services provided in the rehabilitation hospital setting were 1.5 times greater than those in sub-acute rehabilitation and twice that of traditional nursing home rehabilitation. The odds of returning to the community doubled for rehabilitation hospital patients in comparison to the other two groups. Additionally, rehabilitation patients who received specialized nursing home rehabilitation were more likely than those in a traditional nursing home to be discharged to the community, though this trend did not reach significance (Kramer et al. 1997). This study demonstrated that the more intensive and specialized the stroke rehabilitation, the more likely the stroke patient was to be discharged home (Teasell et al. 2005b). See also chapter 4 (Managing the Stroke Rehabilitation Triage Process: 4.6 A Potential Triage System).

**Conclusions Regarding Slow-Stream Rehabilitation**

*Some data suggest that slow-stream stroke rehabilitation may result in less favourable outcomes when compared to the more intensive stroke rehabilitation program.*

*The utilization of slow stream rehabilitation should be dictated by the tolerance of the individual patient for therapy and not by preconceived notions about the amount of therapy that patients can successfully tolerate.*

At present, there is insufficient evidence to suggest that slow-stream stroke rehabilitation is an effective intervention.
23.6 The Ethical Issues in Severe Stroke Rehabilitation

The severe stroke patient is likely to have a worse prognosis, require more resources, and be a larger financial burden than a moderate or mild stroke patient (Gladman & Sackley 1998). This being said, recovery from a severe stroke can be quite significant and time spent in hospital can be relatively short because of discharge to a nursing home, long-term care, or family home (Kalra et al. 1993; Kalra & Eade 1995). These statements constitute the basis for an ethical dilemma surrounding the amount, and quality of services provided to those with severe stroke.

“When a patient has suffered a severe stroke, investigations and treatments should be terminated when they no longer are useful,” (page 1107) (Asplund & Britton 1989). In a multi-study review Asplund and Britton (1989) (page 1111) present and deconstruct this traditional view on severe stroke ethics, and present guidelines to be considered in ethical decision-making:

“...patients with impaired consciousness 1 week after the stroke, the total inability to communicate in a meaningful manner combined with no self-care ability, life-prolonging and preventive measures (except for symptomatic treatment, nursing care, and perhaps fluid support) might be withdrawn. We also proposed that additional factors such as the patient’s expressed wishes, previous permanent morbidity, family attitudes, ethical principles and experiences of the attending physician and medical staff, and different cross-cultural ethical standards should be considered in ethical decision-making.”

However, they later note that these considerations may be too provocative. A decision based on a severe stroke patient’s prognosis may not always be accurate (Asplund & Britton 1989). They recommend that more definitive data is required in order to establish ethical decision-making criteria. In a more recent review, extensive guidelines have been generated to assist with ethical decision-making in severe stroke patients (see Table 23.8) (Holloway et al. 2005).

<table>
<thead>
<tr>
<th>Table 23.7 Summary of Studies Comparing different forms of Rehabilitation in Severe Stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rankin (1957)</td>
</tr>
<tr>
<td>Oxbury et al. (1975)</td>
</tr>
<tr>
<td>Bates et al. (1977)</td>
</tr>
<tr>
<td>Hier et al. (1977)</td>
</tr>
<tr>
<td>Abu-Zeid et al. (1978)</td>
</tr>
<tr>
<td>Mayr et al. (1983)</td>
</tr>
<tr>
<td>Miah et al. (1983)</td>
</tr>
</tbody>
</table>
Table 23.8 Decision Making in Severe Stroke: A Suggested Approach (Holloway et al. 2005)

<table>
<thead>
<tr>
<th>Provide structured interactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health care proxy and advance directive clarification</td>
</tr>
<tr>
<td>Identify key decision makers and meet in quiet</td>
</tr>
<tr>
<td>Build partnership with patient and family</td>
</tr>
<tr>
<td>Identify decision points in advance: feeding tubes, tracheotomy, post-hospital care</td>
</tr>
<tr>
<td>Establish clear follow-up plans/communication times</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Be mindful of potential decision-making biases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimistic or pessimistic prognoses</td>
</tr>
<tr>
<td>Inadequate communication of treatment evidence</td>
</tr>
<tr>
<td>Selective presentation of information (ex. framing effects)</td>
</tr>
<tr>
<td>Misunderstanding patients values and expectations</td>
</tr>
<tr>
<td>Undervaluing future patient health states</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expect and manage conflicts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agonizing with families is part of the process</td>
</tr>
<tr>
<td>Physician vs. family, physician vs. physician, physician vs. other team members</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communicate prognosis with continued treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>If mechanically ventilated, approximate 1-year mortality is 70%</td>
</tr>
<tr>
<td>Among survivors, no/slight disability may be possible</td>
</tr>
<tr>
<td>Modify estimate based on patient details</td>
</tr>
<tr>
<td>Provide range and avoid being vague</td>
</tr>
<tr>
<td>Include elements of treatment burden</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elicit patient’s valued life activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time with family and friends, autonomy, recreation, other</td>
</tr>
<tr>
<td>Probe positions on “life worth living” and states considered “worse than death”</td>
</tr>
<tr>
<td>Include spiritual and ethical dimensions of these values</td>
</tr>
<tr>
<td>Will deficits and treatment burdens interfere with future valued life activities?</td>
</tr>
<tr>
<td>If yes, estimate probability and ranges</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>If appropriate, explain alternatives to continued treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Withholding from further escalation of treatment (ex. CPR)</td>
</tr>
<tr>
<td>Withdrawal of life-sustaining therapies</td>
</tr>
<tr>
<td>Explain process of withdrawal, estimated survival and comfort measures</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Consider use of time-limited trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>To improve estimates of prognosis</td>
</tr>
<tr>
<td>To better understand the benefits and burdens of therapies</td>
</tr>
<tr>
<td>To provide time to achieve consensus about the goals of care</td>
</tr>
<tr>
<td>To allow families to work through grief and let go of loved ones</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Be familiar with state laws and institutional policies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particularly with regard to artificial nutrition and hydration</td>
</tr>
</tbody>
</table>

Another ethical and legal issue is the distribution of authority regarding withholding or withdrawal of services, including vital supports (Asplund & Britton, 1989; Holloway et al., 2005). Often the physician or medical team is the surrogate decision-maker, though this varies by country (Asplund & Britton, 1989). While not documented, it is assumed that patient’s families have always played an important role in this process. Increasingly this collaboration on vital decisions is being advocated (Aita et al. 2008; Holloway...
et al. 2005). In a study examining withholding and withdrawal of vital services from severe stroke patients, 27 Japanese physicians were interviewed about ethical decision-making (Aita et al. 2008). They found that participants relied most on their intuition and subjective interpretation of the law when making decisions. Overall, physicians were more reluctant to withdraw nutrition and hydration services than mechanical ventilation. The use of trial treatments to ascertain a specific short-term prognosis has been recommended (Aita et al. 2008; Holloway et al. 2005). This method will hopefully allow for a more accurate basis on which to conduct ethical decision-making regarding the care of severe stroke patients.

Seeber et al. (2012) conducted a systematic review of studies that looked at treatment restrictions in chronic neurologic diseases. The objective of this review was to determine when discussions around treatment restrictions were initiated, and by whom. Ten studies including a stroke population were identified. The authors found that in all studies (2 actual practice, 8 interview studies) pertaining to stroke, the physician was identified as the final decision maker regarding treatment restrictions such as artificial nutrition and hydration services, do not resuscitate orders, invasive mechanical services, and so forth. Physicians’ decisions are often influenced by institutional requirements, personal and professional biases, and perceptions of prognosis (Creutzfeld 2012). Seeber et al. (2012) noted that interviews looking at the involvement of family members provided conflicting results and often patients’ previously expressed preferences were overlooked.

Another ethical concern in rehabilitation is the decision as to whether a severe stroke patient who has survived the acute phase should be admitted to a specialized interdisciplinary stroke rehabilitation unit, especially in the face of limited resources. In other words, stroke rehabilitation specialists are often called upon to decide between a moderately severe stroke and a more severe stroke patient. With limited resources it is important to ensure that persons most likely to benefit receive rehabilitation. Kennedy et al. (2012) examined the key factors, from a physician’s perspective, involved in the decision making process regarding the admission of persons with severe stroke to rehabilitation. The authors noted that the key patient factors considered included prognosis, social factors, anticipated discharge destination, and age. Some sites also considered anticipated length of stay. The authors indicated that variability in selection practices is common and extensive investigation into various factors influencing outcome is needed to optimize the use of resources.

**Conclusions Regarding Severe Stroke Rehabilitation Ethics**

*There is consensus (Level 3 evidence) that more research needs to be conducted in the area of severe stroke prognosis.*

*The attending medical team should collaborate with the patient’s family in ethical decision-making regarding the well-being of the patient.*

*Trial treatments may assist in creating a more accurate basis for ethical decision-making.*

*Ethical decisions regarding care of severe stroke patients should be based on trial treatments, and collaboration between attending medical staff and the patient’s family.*

**Summary**

In spite of the fact that they are the most impaired and disabled of all stroke patients, those with severe stroke have limited access to rehabilitation due to lesser potential for functional gains, longer lengths of stay and greater resource challenges. Research has indicated that these patients benefit significantly from specialized interdisciplinary stroke rehabilitation units in terms of reduced mortality and combined death and dependency. Stroke units are also associated with shorter lengths of stay in hospital and
improved likelihood of discharge home in severe stroke populations, although functional outcomes generally do not show corresponding improvements. In Canada, patients with severe stroke are often denied access to rehabilitation units in spite of the clear benefits associated with this type of care (Teasell et al. 2005b). As well, there is Ontario data which suggests this problem may be getting worse (Services 2005). Moreover, there are potential cost-benefits to be realized through the admission of severe stroke patients to rehabilitation (Gladman & Sackley 1998). These benefits are, however, dependent upon careful selection processes, as the goals of rehabilitation shift from improving functional outcomes towards discharge planning and reducing complications. Finally, at this point there is insufficient evidence to suggest that slow-stream stroke rehabilitation is an effective intervention but there is some data to suggest it may be a less effective intervention.
23.7 Summary

1. Despite having the greatest number of impairments and the most severe disabilities, these patients may have limited access to rehabilitation.

2. Limited access to rehabilitation could be a result of many factors such as their reduced potential to make functional gains comparable to those individuals with moderately-severe stroke.

3. Rehabilitation of individuals with severe stroke is associated with greater use of resources.

4. Stroke and outcome severity have been defined in a variety of ways. Common definitions are unconsciousness with severe unilateral or bilateral paresis at onset; early FIM® score <40 or motor FIM® <37; high risk for failure to return home due to physical, cognitive, perceptual and communication difficulties, or a combination of the above.

5. Severe strokes may be most negatively affected by the type of funding model employed.

6. Animal studies, combined with human neuroimaging, demonstrate that recovery post-stroke is largely dependent on peri-lesional intact cortical areas which subsume a similar function and can take over the lost function. Larger strokes have reduced potential for this to occur.

7. Severe strokes are seldom admitted to intensive care units as compared with other types of critically ill or injured patients.

8. Severe stroke patients with critical health issues appear to have lower mortality rates when admitted to intensive care. Further research is needed to establish other specific outcome gains.

9. More severe strokes, as determined upon admission, are associated with poorer outcomes after rehabilitation when compared with less severe strokes.

10. There is evidence that patients with severe stroke benefit from specialized interdisciplinary stroke rehabilitation. This results in reduced length of hospital stay, institutionalization and mortality, and to a lesser extent functional improvement.

11. There is strong (Level 1a) evidence that specialized interdisciplinary stroke rehabilitation reduces mortality in severe stroke patients when compared to general rehabilitation programs.

12. There is moderate (Level 1b) evidence that severe stroke patients who are admitted to specialized interdisciplinary stroke rehabilitation programs are more likely to be discharged home.
13. There is strong (Level 1a) evidence that specialized interdisciplinary stroke rehabilitation programs result in shorter lengths of hospital stay (LOS).

14. There is conflicting (Level 4) evidence regarding functional gains of persons with severe stroke following specialised interdisciplinary inpatient stroke.

15. Functional outcomes suggest that rehabilitation of severe stroke patients should emphasize discharge planning and reduction of post-stroke complications.

16. Rehabilitation of severe stroke patients should emphasize discharge planning and reduction of post-stroke complications.

17. Some data suggest that slow-stream stroke rehabilitation may result in less favourable outcomes when compared to the more intensive stroke rehabilitation program.

18. The utilization of slow stream rehabilitation should be dictated by the tolerance of the individual patient for therapy and not by preconceived notions about the amount of therapy that patients can successfully tolerate.

19. There is consensus (Level 3 evidence) that more research needs to be conducted in the area of severe stroke prognosis.

20. The attending medical team should collaborate with the patient’s family in ethical decision-making regarding the well-being of the patient.

21. Trial treatments may assist with more accurate basis for ethical decision-making.
References


