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Managing the Stroke Rehabilitation Triage Process

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Abstract

The challenge of constructing an exemplary stroke rehabilitation system is balancing the attempt to maximize patient outcomes while controlling costs. This review, using findings from Modules 5 through 7 and from evidence based on consensus opinions, presents research on the stroke rehabilitation triage process. Evidence on patient screening, establishing assessment criteria, stroke severity, and unit location is reported. As well, a potential stroke rehabilitation triage system is proposed.

Key Points

- Screening assessments for rehabilitation should be performed as soon as possible.
- Stroke patients eligible for rehabilitation must be able to learn and have sufficient endurance to participate.
- Eligible stroke patients should be engaged in rehabilitation as soon as they are able; however, higher doses of mobilization therapy, in the first week can be harmful which in that initial week shorter more frequent rehabilitation therapy sessions can improve outcomes.
- The most powerful predictors of rehabilitation outcomes are initial stroke severity followed by age.
- Age can negatively impact stroke recovery; however, its overall contribution is small compared to stroke severity. Age is also not considered to be a strong predictor of functional recovery after stroke.
- Young stroke patients account for a small percentage of stroke survivors. As a rule, they do very well with rehabilitation, making significant functional gains and almost all are discharged home.
- Very elderly stroke patients should be considered candidates, regardless of stroke severity, and each case needs to be considered based on individual characteristics and potential. Factors such as premorbid fitness, cognitive functioning, family/community support and comorbidities are considered important in these cases.
- Mild stroke patients can be rehabilitated in an outpatient setting by an interdisciplinary stroke rehabilitation team. Thus far, evidence for superiority of home-based or hospital-based outpatient stroke rehabilitation is conflicting.
- Wherever possible, based on best evidence, patients with moderately severe strokes should receive rehabilitation on stroke specific rehabilitation units. However, in practice, rehabilitation on a stroke specialized unit does not guarantee better outcomes, as other factors may also be important, such as continuity of care.
- Patients with severe strokes may be better managed on long-term, less-intensive stroke rehabilitation units.

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4.1 Determining Stroke Rehabilitation Admission

4.1.1 Screening Assessment

A screening examination for rehabilitation should be performed as soon as the patient's medical and neurological condition permits, by a person experienced in rehabilitation ("Post-stroke rehabilitation: assessment, referral, and patient management. U.S. Department of Health and Human Services Public Health Service. Agency for Health Care Policy and Research" 1995). The screening examination should incorporate medical information, neurological examination, use of a well-standardized disability (e.g., activities of daily living) instrument and a mental status screening test. Asberg and Nydevik (1991) felt that the optimal timing for stroke rehab assessment was 5-7 days post-stroke onset, although more recent trends have seen assessments reduced to being done within the first 3-5 days. The importance of a proper screening assessment was understated in a study conducted by Edwards et al. (2006) who reported that screening measures detected significantly more impairments than that was documented in patient charts at discharge. The authors suggest that systematic screening and assessments are required even if specific deficits are not immediately noticeable upon observation. Screening for cognitive deficits has also been found to be of clinical value as Dong et al. (2013) revealed that assessment using the Montreal Cognitive Assessment (MocA) and Mini-Mental State Examination (MMSE) were both individually predictive of functional outcome at 3-6 months post-stroke according to the Modified Rankin Scale (mRS). In patients with a severe stroke (i.e. National Institute of Health Stroke Scale scores of greater than 2), the MoCA and MMSE demonstrated a larger predictive value for mRS scores at 3-6 months than mild or moderate stroke patients.

Conclusions Regarding Screening Assessment

> ***Screening assessment for rehabilitation should be performed as soon as possible.***

4.1.2 Threshold Admission Criteria

Threshold criteria for admission to a comprehensive rehabilitation program include medical stability, the presence of a functional deficit, the ability to learn, and enough physical endurance to sit unsupported for at least one hour and to participate actively in rehabilitation ("Post-stroke rehabilitation: assessment, referral, and patient management. U.S. Department of Health and Human Services Public Health Service. Agency for Health Care Policy and Research" 1995). Admission to an interdisciplinary program should be limited to patients who have more than one type of disability and who therefore require the services of two or more rehabilitation disciplines. Patients with a single disability can benefit from individual services, but generally, do not require an interdisciplinary program ("Post-stroke rehabilitation: assessment, referral, and patient management. U.S. Department of Health and Human Services Public Health Service. Agency for Health Care Policy and Research" 1995).

Conclusions Regarding Determinants of the Need for Rehabilitation

> ***Stroke patients eligible for rehabilitation must be able to learn and have sufficient endurance to participate.***

4.1.3 Timing of Admission to Stroke Rehabilitation Animal Models

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

Early Admission to Rehabilitation

Animal studies suggest that there is a time window where the brain is "primed" for maximal response to rehabilitation therapies, such that delays in initiating rehabilitation are detrimental to recovery (Biernaskie et al. 2004). The effects of post stroke training are generally greater when started early after a stroke, perhaps because of a "sensitive" period of enhanced neuroplasticity. Clinical studies have shown an association between early admission to rehab and better functional outcomes (Bai et al. 2012; Paolucci et al. 2000; Salter et al. 2006). One prospective comparative trail by Paolucci et al. (2000) looked at the outcomes of stroke patients admitted to rehabilitation at different times following stroke. They found that those stroke patients who received rehabilitation early did better functionally than those whose rehabilitation was delayed.

In an RCT conducted by Liu et al. (2014), it was suggested that patients who received early rehabilitation were less likely to experience mortality and obtained higher scores on the Barthel Index and the physical and mental components of the SF-36 compared with patients who received standard care only. Moreover, Askim et al. (2014) reported that patients who spent a greater length of time on bed rest exhibited significantly poorer outcome at 3 months post stroke compared to patients who participated in motor activity.

The concept of the benefit of early rehabilitation has been brought into question by the AVERT trial (Bernhardt et al. 2015). In this trial patients less than 24 hours post stroke were randomly assigned to standard care (SC) (n=1050) or SC + Very Early Mobilization (VEM) (n=1054) until discharge or 14 days later, which ever came first. This was a 56 site international trial conducted over 8 years. The VEM group started earlier (18.5 vs 22.4 hours post stroke), got more out of bed sessions (6.5 vs. 3.0) and received more therapy (31 minutes/day; total 201 minutes versus 10 minutes/da; total 70 minutes). More patients in the Usual Care (n=525) than VEM (n=480) (p=.001) had favourable outcome (modified Rankin Scale 0-2) at 3 months post stroke. Later analysis (Bernhardt et al. 2016) found improved odds of a favourable outcome with increased daily frequency of out-of-bed sessions. Overall, shorter more frequent early mobilization improves the chances of regaining independence; higher doses of long-term mobilization worsens outcomes.

Conclusions Regarding the Timing of Admission

Eligible stroke patients should be engaged in rehabilitation as soon as they are able; however, higher doses of mobilization therapy, in the first week can be harmful while in that initial week shorter more frequent rehabilitation therapy sessions can improve outcomes.

4.2 Triaging Stroke Patients

An effective triage system allows stroke patients to be quickly matched with the appropriate intensity of resources or easily moved to different levels of rehabilitation intensity according to their needs and is critical to any well-functioning stroke rehabilitation system. Before an objective and transparent triage system can be set up there must be consistent objective measures of functional abilities and outcomes.

All stroke survivors need caring, support, and education, but not all need formal rehabilitation. Approximately 20% of stroke survivors recover full functional independence by 2 weeks stroke (Kelly-Hayes et al. 1988). It is estimated that another 20% have such severe functional deficits that they are expected to remain nonambulatory and continue to require assistance with ADLs irrespective of rehabilitation efforts (Pfeffer & Reding 1998); in these cases of severe strokes, the age of the patient and the presence of a caregiver (Pereira et al. 2014; Pereira et al. 2012) dictates whether rehabilitation will alter the discharge destination or improve function of all all abilitites to a substantial degree. Between these extremes are individuals with varying degrees of disability. For these individuals, the goal should be to identify the best possible match between their needs and the capabilities of available rehabilitation facilities.

Alexander (1994) notes that the most powerful predictors of functional recovery are initial stroke severity and the patient's age. This finding has been confirmed by Stineman et al. (1998) and Stineman and Granger (1998) although the effect of age falls out for patients with less initial disability (FIM >60-65), leaving stroke severity the most powerful predictor. Discharge to inpatient rehabilitation was found to be more likely among patients of an older age, greater length of stay in ICU, higher therapy costs, and living in a country of lower poverty whereas the opposite was true for each of these factors for patients discharged home (Gregory & Han 2009). A cluster analysis by Buijck et al. (2012) revealed two clusters of patients who had received rehabilitation at a skilled nursing facility; those in fair condition and those in poor condition upon admission. These clusters were based on balance, arm motor function, ADL performance, gait, and neuropsychiatric complaints. Nearly half (46%) of patients in the poor condition cluster were able to be discharged to assisted-living or an independent living program, implying that these discharge destinations are attainable despite stroke severity. Pereira et al. (2014) in their study of 189 severe stroke patients admitted to a specialized interdisciplinary stroke rehabilitation unit, found that only one patient of the 123 discharged home did not have a caregiver, indicating a near zero likelihood of being discharged home if a caregiver was not present. Moreover, those patients with a caregiver achieved higher FIM gains during stroke rehabilitation than those without a caregiver.

Conclusions Regarding Predictors of Functional Outcome

The two most powerful predictors of functional recovery and eventual discharge status home are initial stroke severity and the patient's age, with initial stroke severity being by far the most important. These two alone can be used to determine appropriate stroke rehabilitation triage, although it does not preclude the use of additional factors.

The most powerful predictors of rehabilitation outcomes are initial stroke severity followed by age.

4.3 Levels of Stroke Severity

4.3.1 Levels of Severity of Stroke Rehabilitation Patients

Animal Studies

A number of research studies have demonstrated upper and lower limb motor impairment post stroke resolves within 6 months by **fixed proportion.** Fixed proportion states 70% of possible maximum improvement of motor impairment occurs regardless of the initial impairment, as measured by the Fugl-Meyer score, in those patients with relatively intact corticospinal (motor) tract function (Prabhakaran et al. 2008). Byblow et al. (2015) notes that this holds true for patients across all ages and countries with difference rehabilitation services. It is important to note that proportional resolution of upper extremity impairment is minimally affected b rehabilitation therapy.

As noted in module 3, animals with small strokes will experience functional and structural recovery occurring spontaneously (without rehabilitation therapy) for weeks to months post stroke. Irreversible structural damage to the corticospinal tract severely limits recovery of the upper limb movement (Stinear et al. 2012; Stinear et al. 2007). 3D kinematics in subacute and chronic stroke victims have shown motor recovery associated with rehabilitation is driven more by adaptive (or compensation) learning strategies. Most clinical test (i.e. Action Reaction Arm Test (ARAT) or walking speed (6 Minute Walk Test) only assess a patient's ability to accomplish a certain task or function; they do not measure impairment. Animals with larger lesions show much less return of function and function that does return may take weeks or months to stabilize. Compensatory movements play an important role with cortical activation and reorganization occurring in more distant cortical areas. In fact, rehabilitation promotes largely, likely entirely adaptive or compensatory motor recovery.

The Three Levels: Mild, Moderate and Severe

A paradigm for classifying early stroke-related disability was developed by Garraway in 1981. It is presented in Table 4.3.1.1.

Table 4.3.1.1 Levels of Severity of Stroke Rehabilitation Patients

Level of Severity (Garraway et al. 1981, 1985)	**Mild Strokes**	**Moderate Strokes**	**Severe Strokes**
Referred to as:	"Upper band"	"Middle-Band"	"Lower Band"
Early FIM Score (Ween et al. 1996)	> 80	40-80	< 40
Early Motor FIM (Stineman 1998)	> 62	38-62	< 38

The most powerful predictor of functional recovery is stroke severity (Garraway 1985; Garraway et al. 1981). The first concept stroke recovery during the acute phase was developed based on three bands of stroke severity: Mild, Moderate and Severe.

Mild Strokes

Patients with milder strokes have been defined as having an early (first 3-5 days post-onset) FIM score >80. Remember that FIM scores tend to increase over time with spontaneous recovery so the FIM score >80 refers to that very early initial phase post stroke onset. Stineman et al. (1998) have defined these milder stroke patients as having a motor FIM > 62 at the time of rehab admission. Mild stroke has also been classified on the National Institute of Health Stroke Scale (NIHSS) as less than a score of 16 points

(Askim et al. 2014). Given their deficits are less, these patients can generally be managed in the community if outpatient resources are available and there are no specific issues to be addressed on an inpatient stroke unit. These patients tend to recover well but their ability to benefit from rehab is limited by a "ceiling" effect.

Moderate Strokes

Garraway et al. (1985; 1981) defined moderately severe strokes as conscious acutely with a clinically significant hemiplegia/hemiparesis. Such patients have been defined as having an early (first 3-5 days post-stroke onset) FIM score of 40-80 and more specifically a motor FIM between 38-62 at the time of rehabilitation admission (Stineman et al. 1998). Moderate stroke has also been classified on the National Institute of Health Stroke Scale (NIHSS) as a score between 8-16 points (Askim et al. 2014). These patients frequently demonstrate marked improvements in all areas although they are often partially dependent in some areas at the time of discharge. Over 85% are discharged to the community (Stineman et al. 1998), a number that has stayed relatively constant, and it is these patients who appear to improve the most with rehabilitation. The moderately severe stroke patient is thought to be the main focus of most inpatient stroke rehabilitation units.

Severe Strokes

Garraway et al. (1985; 1981) defined severe stroke patients as unconscious at onset with severe unilateral or bilateral paresis. Alternatively, patients may be considered more severe if there is serious medical co-morbidity which adds to the overall stroke disability and makes rehabilitation more challenging. Ween et al. (1996) defined the severe stroke patients as having an early FIM score <40 while Stineman et al. (1998) defined it as Motor FIM score <38 at rehabilitation admission. These patients are less likely to achieve functional independence, regardless of treatment, unless they are younger (see below), and they have the longest rehab stays as well as a lesser likelihood of community discharge (Stineman et al. 1998). However, although the stroke is so severe they may not progress sufficiently to be discharged home, these patients do make significant gains and with strong family and community supports they often are discharged home. Although these patients do not improve as consistently as do the moderately severe stroke patients, improvement in this group appears to be more dependent on the availability of stroke rehabilitation.

Stroke Severity and Outcomes

Wang et al. (2015) revealed that patients with severe stroke at admission experienced significantly higher cognitive gains, were at lower risk of transfer to an acute hospital and were more likely to be discharged into the community when admitted to stroke rehabilitation with 7 days of stroke onset. Further, patients with severe stroke exhibited greater gains in motor ability when admitted within 14 days of onset whereas patients with stroke of a moderate severity demonstrated significantly greater motor gains when admitted within 7 days. However, there was no association between functional gain and post-onset among patients with mild stroke. Length of stay was also shorter for patients with severe stroke when admitted within 14 days, within 2 days for moderate strokes, and 7 days for mild strokes.

4.3.2 Severity of Stroke and Intensity of Rehabilitation

Carey and Seibert (1988), Asberg and Nydevik (1991), Alexander (1994) and Jorgenson et al. (2000) reported those with moderately severe stroke or in the middle severity range made the most functional gains whereas milder strokes are limited by a ceiling effect. Although sever stroke patients can make significant gains in rehabilitation, they are less consistent in their gains

Table 4.3.2.1 Severity of Stroke and Improvement on Rehabilitation

Author, Year	Methods	Outcomes

Country		
Ween et al. (1996) USA	Consecutive admissions to Braintree Hospital with a primary diagnosis of stroke were prospective followed. Patients with subarachnoid hemorrhages and strokes requiring cerebral surgical interventions were excluded. All patients included into the study received rehabilitation on general rehabilitation units in the standard, multi-disciplinary fashion. Independent measures suspected of influencing outcomes were assessed 2 or 3 days of admission (age, severity of deficit, lesion types, lesion site, existence of comorbidities, incontinence of bladder, socioeconomic constraints). Dependent measures were determined upon discharge (FIM).	Age had a strong influence on FIM change across the whole population while only the 55-64 vs. > 85 age group comparison reached statistical significance. FIM efficiency was found to be significantly different between the 65-74 and 75-85 group. Admission FIM influenced FIM change across the population with significant difference between <40 and 40-59 scores, <40 and 60-80 and <40 and <80 score groups. Large-vessel stroke did significantly worse than small-vessel stroke or hemorrhages. Lesion site influenced FIM change with bilateral and right-sided lesions doing worse than left-sided. Right-sided lesions also had less FIM efficiency than left-sided. No single comorbidity had an isolated effect on any dependent measure. Incontinence reflected severity of deficit. Continence on admission was associated with 84% rate of home discharge while incontinence on admission reduced rate to 55%. Dysphagia alone was associated with diminished FIM change, less FIM efficiency and less likelihood of home discharge.
Oczkowski & Barreca (1993) Canada	113 consecutive patients were observed from admission to discharge to determine the use of the FIM as a prognostic indicator of outcome in stroke. Rehabilitation was by a mutli-disciplinary team. After initial assessment, rehabilitation goals were set and reviewed and revised every 2 weeks for each patient.	Admission to rehabilitation unit occurred a median of 52 days after stroke onset. Rehabilitation was given on average of 64 days. Patients discharged home were younger than those who were institutionalized. Chedoke-McMaster Stroke Assessment and bladder and bowel incontinence on admission were predictive of discharge location. Patients discharged home had significantly higher FIM scores on admission and discharge. Patients discharged to await chronic care had the least change in FIM scores and those awaiting discharge to nursing home placement had similar change as home discharged patients. Patients with any degree of hemianopsia, sensory loss, parietal neglect, aphasia or cognitive impairment had significantly lower FIM scores than those patients without these impairments. Best predictor of location of discharge was FIM scores at admission, admission postural staging and age. FIM scores of 36 or less never get home, scores of 97 or more inevitably go home.

Ween et al. (1996) prospectively analyzed 536 consecutive stroke rehabilitation admissions to try and identify the influence of preselected factors on functional improvement and discharge destination. Patients with an admission FIM above 80 almost always went home after rehabilitation and so it was recommended that patients with early functional independence measure (FIM) scores greater than 80 (the mildly disabled) are best managed at home as long as appropriate supports are in place. Conversely, patients admitted to rehabilitation with a 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 or a decision not made at the time of initial assessment. An admission score of 60 or more was associated with a larger FIM improvement, but the absence of a committed caregiver at home increased the risk of nursing home discharge. Therefore, it was recommended that intensive rehabilitation units are most likely to be effective with moderately severe stroke patients with early FIM scores between 40-80. These patients are generally able to participate fully, show substantial improvement during rehabilitation and have a high probability of discharge home (Alexander 1994).

Oczkowski and Barreca (1993) explored the usefulness of the FIM as a prognostic indicator of outcome in 113 stroke survivors admitted to a Canadian rehabilitation unit. Patients were admitted into the

stroke rehabilitation unit a median of 52 days post stroke with average length of stay being 64 days. Oczkowski and Barreca (1993) observed 80 patients being discharged home; three patients died and the remaining 30 required long-term care in a nursing home or chronic care facility. The median FIM score was 80 on admission and 94 at discharge. Using multiple logistic regression, Oczkowski and Barreca (1993) determined that the best predictors of discharge location were FIM score at admission, admission postural staging, and age. The authors noted that admission FIM score was the most powerful predictor of discharge location. Three distinct groups of stroke survivors were identified. Patients with admission FIM scores of 36 or less showed minimal improvement, remaining severely disabled and typically requiring long-term institutionalization, particularly in the absence of an extremely supportive and healthy caregiver. Patients with admission FIM scores above 96 also tended to show relatively small FIM gains and almost invariably were able to return home. The relatively small change in scores seen in this group of patients could be in part attributed to the ceiling effect. Patients with admission FIM scores between 36 and 96 exhibited the greatest overall FIM gains, but discharge destination was difficult to predict because of others factors such as comorbidities, cognitive and perceptual impairments, and the presence or absence of a supportive caregiver. This study was limited by the almost 2 months median time to admission.

Jorgenson et al. (2000) conducted the Copenhagen Stroke Study, a prospective analysis of 1,197 consecutive patients admitted to a stroke unit. The initial stroke severity was measured by the Scandinavian Neurological Stroke Scale (SSS) at the time of acute admission (Scandinavian Stroke Study Group 1985). The scale's score ranges from 0-58 points with very severe (0-14), severe (15-29), moderate (30-44) and mild (45-58) classification. At the time of acute admission 41% of the patients were of mild severity, 26% moderate, 14% severe and 19% of very severe severity. Almost all patients with a mild stroke were discharged to their own home. The proportion of patients discharge to their homes occurred in 75% of patients with a moderate stroke, 33% of severe strokes while only 14% of the most severe strokes returned to their home at discharge. For those patients who had suffered a severe stroke, one third died, one third were discharged back to their own homes and one-third had to be discharged to a nursing home despite rehabilitation (Jorgensen et al. 2000).

Interestingly, Jorgensen et al. (2000) noted that the mean gain in Barthel Index (BI) score from admission to discharge was 16 points. However, the gain in BI score varied widely and was related to the level of initial disability. In patients with very severe initial stroke disability, the average gain was 24 points; 41 points for patients with severe stroke; 27 points for those with moderate stroke and 8 points for those with mild stroke. The small gain in points seen in the patients with mild strokes likely reflects a "ceiling" effect.

Sung et al. (2016) reported that a predictive model of 30-day and 1-year mortality rates using the Stroke Severity Index (SSI) significantly outperformed two other models with one that used length of stay, and another that noted ventilation, surgical procedure, hemiplegia, and neurological deficits. The findings indicated that stroke severity can be predictive of future outcomes and allowed for risk adjustment. Sung et al. (2016) note that the SSI has not only demonstrated a strong correlation with the NIHSS, components of the tool are easy to use which can be taken upon admission or when the patient exhibits a change in clinical condition.

Conclusions Regarding the Levels of Severity of Stroke Rehab Patients

Severity of stroke is the most powerful predictor of ability to participate and benefit from stroke rehabilitation. Mild strokes benefit the least because of a "ceiling effect". Moderate to severe

stroke improve the most on stroke rehab although the most severe strokes appear to benefit the most when compared to controls.

4.4 Age as a Modifier in Rehabilitation Triage

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

4.4.1 Impact of Age on Recovery/Rehabilitation

Animal Studies

As noted in Module 3, the impact of stroke and recovery with age in animals is not entirely clear. Older animals do exhibit recovery post stroke, although generally recovery is more rapid and extensive, the younger the animal. This observation correlates with a decline in the rate of formation of new neuronal connections or synaptogenesis. Therefore, older animals do improve post stroke but the process takes longer and is less complete. For this reason age may not be a consistent predictor of functional recovery after stroke.

Clinical Studies

Studies support the concept that age is a critical prognostic factor with an established association between increasing age and poorer outcomes (Table 4.4.1.1).

Table 4.4.1.1 Age as a Modifier in Rehabilitation Triage

Author, Year Country	Methods	Outcomes
Kotila et al. (1984) Finland	Analyzed the profile of recovery of 154 stroke survivors on discharge from hospital, ADL and return to work. Patients were evaluated at time of admission and then 3 and 12 months post stroke onset. Previous medical, social and occupational history and neurological signs and symptoms were registered.	1. Patients under 65 had significantly better outcomes than those over 65 years and were more often at home, more independent in ADL after 3 months and this difference increased at 1 year.
Bogousslavsky & Pierre (1992) Switzerland	From the Lausanne Stroke Registry, young stroke patients that made up 12.3% of first ever ischemic strokes were divided into two group: group 1 encompassing patients aged 16 to 30 years of age and group 2 encompassing patients aged 31 to 45 years old. Computed tomography, ECG, standard hematologic and other blood tests and extracranial and transcranial Doppler ultrasounds were performed on each patient.	1. Early mortality was not negligible. No disability of minor sequele was present in 60% of group 1 and 52% of group 2 patients. Severe sequlae were found in 7% and 14% of group 1 and 2 respectively. Prognosis was better for younger patients with at least 75% of patients improving markedly or completely and able to return to previous activities. The annual incidence of recurrent stroke seems to be less than 1%.
Borucki et al. (1992) USA	Inpatients on a stroke rehabilitation unit with no prior history of stroke and who were admitted directly from acute care hospital were randomly assigned for serial follow up and then were divided into 2 age groups: 69 years or less and 70 years or more.	1. Greater proportion of older patients were discharged to a skilled nursing facility or were placed in one between discharge and 24 months. Albeit non-significant, survival tended to be worse for older patients. While age was related to death and skilled nursing facility placement, it had no clinically significant effect on maintenance of rehabilitation gains following ischemic stroke.

Kalra (1994) UK	245 stroke survivors who remained in hospital on general or geriatric wards 2 weeks after stroke were randomized to a stroke unit or to a general medical ward and then were divided into on older (75 years and over) and younger (under 75 years) age group. Younger and older stroke patients were comparable for neurological and functional deficits and were distributed equally between the stroke unit and the general wards.	1. Older patients received more occupational therapy in both settings and more physiotherapy. Younger patients on the stroke unit showed better outcome on discharge to home, median Barthel score, median length of hospital stay, compared with those on the general wards. Older patients on stroke unit had better outcome on discharge to home and median Barthel score than those on general wards. Outcomes in older stroke patients were similar in both settings except for a shorter median length of hospital say on the stroke unit. Outcomes in younger patients managed on general ward were worse than that in older patients with similar prognosis.
Nakayama et al. (1994) Denmark	363 consecutive acute stroke patients were prospectively followed. Upper extremity function and paresis were assessed weekly using the Barthel Index subscores for feeding and grooming and the Scandinavian Stroke Scale (SSS) subscore for arm and hand. Rehabilitation was performed according to the Bobath technique.	1. Patients who gained upper extremity function by compensation were younger, had less severe stroke, smaller and subcortically located lesions and less affection of higher cortical function.
Bagg et al. (2002) Canada Observational No Score TPS_{Mean}=NA N_{Start}=561 N_{End}=561	**Population:** Mean age=71±11.6yr; Gender: Males=302, Females=259. **Intervention:** To examine the relationship between age and functional recovery after stroke. **Outcomes:** Functional Independence Measure (FIM).	1. Correlations between age and FIM score at admission were significant for the FIM full scale (r=-0.16, p<0.001) and, and for the motor (r=-0.14, p<0.001) and cognitive (r=-0.16, p<0.001) domains. 2. Female sex, hemorrhagic stroke was significantly associated with discharge FIM scores in the positive direction. 3. Impaired problem solving was significantly associated with FIM score at discharge and a change in FIM score in the negative direction. 4. Presence of dysphagia was significantly associated with motor FIM score at discharge. 5. Adjusting for A-FIM score at admission (A-FIM) and other clinical, age was not found to be associated with a change in FIM scores. 6. There was a weak relationship found between age and functional outcome when other factors (such as clinical variables and FIM score at admission) are accounted for. 7. Results showed that A-FIM explained most of the variation in the statistical model, suggesting that functional status at admission may have an important role for assessing how patients will cope in a rehabilitation setting.
Kugler et al. (2003) Germany Observational No Score TPS_{Mean}=NA N_{Start}=2219 N_{End}=2219	**Population**: Primary study group: Mean age Males=65±12yr, Mean age Females=69±13yr. Gender: Males=55.9%, Females=44.1%. Secondary study group: Mean age Males=66±12yr, Mean age Females=70±13yr; Gender: Males=55.7%, Female=44.3%. **Intervention**: To explore the factors and predictors of functional recovery during the	1. Age was significantly associated with stroke mortality rate as indicated by chi-square test for differences between age groups in hospital fatality rate. 2. Weak negative association between age and mean length of stay (LOS) when younger to older patients were compared. 3. Adults between ages 65-74 and 75-84 had lower

	very early phase of stroke. **Outcomes**: Relative functional recovery/relative improvement in functional status; Speed of functional recovery over time; Barthel Index (BI); Length of stay (LOS). *this article suggests that age is a poor predictor of functional recovery during the very early phase after stroke and that a more powerful predictor is on an individual's initial disability status; don't be limited by age	functional status at T1, T2, and T3 compared to all other age groups, as indicated by a comparison of the mean Barthel Index scores. 4. Results showed that there was a mean relative improvement in functional status of approximately 54% in all patients, over the period of analysis. A larger mean relative improvement in functional status was found for patients less than 55yr of age, compared to those above 55yr of age. (67% v. 50%). 5. Statistically significant inverse association between age and functional status (Bage=–0.130, p<0.001) 6. After considering LOS in the regression model, there was a significant association between LOS and extent of recovery (βLOS=–0.295, p<0.001) and initial ADL status was shown to have more of an effect on the outcome than without LOS in the model. 7. Considering the entire period of analysis, age had a very small effect on the recovery outcome (βage=–0.080, p<0.001).
Kammersgaard et al. (2004) Denmark	1,197 patients were studied in the community-based Copenhagen Stroke Study and stratified according to age. Age was evaluated as a predictor of both short-term and long-term outcomes. The very old were classified as being ≥ 85 years.	1. 191 patients were 85 years or older. Very old age was associated with more severe strokes,, being female, having atrial fibrillation and pre-existing disability. Very old age predicted short-term mortality (OR 2.5; 95% CI 1.5-4.2), and discharge to nursing home or in-hospital mortality (OR 2.7; 95% CI 1.7-4.4). Five years after stroke very old age predicted mortality or nursing home placement (OR 3.9; 95% CI 2.1-7.3), and long-term mortality (HR 2.0; 95% CI 1.6-2.5). However, other factors such as onset stroke severity, pre-existing disability and atrial fibrillation were also significant independent predictors of prognosis after stroke.

In a cohort study of 2,219 patients, Kugler et al.(2003) studied the effect of patient age on early stroke recovery. The authors found that relative improvement decreased with increasing age: patients younger than 55 years achieved 67% of the maximum possible improvement compared with only 50% for patients above 55 years (p< 0.001). Similar results were found in a recent study by Alonso et al. (2015) where functional outcome after rehabilitation was associated with age as younger patients were found to achieve better outcomes compared to the older cohort (p=0.008). Further, Kugler et al. (2003) also found that age had a significant but relatively small impact on the speed of recovery with younger patients demonstrating a slightly faster functional recovery (p< 0.001).

Bagg et al. (2002) in a prospective study of 561 patients admitted to an inpatient stroke rehabilitation program found that age alone was a significant predictor of total FIM score and Motor FIM score at discharge, but not of FIM change. At two and six months post-stroke, age was found to negatively influence the level of functional independence along with lower limb motor (Meyer et al. 2015). Similarly, Kwah et al. (2013) found that age was a significantly predictor of independent ambulation and upper limb motor function recovery at six months. At twelve months, age remained a significant predictors of functional independence, suggesting that older patients were less likely to gain functional independence than younger patients (Kong & Lee 2014). At 5 years post-stroke, the negative association

between age and functional independence together with lower limb motor recovery remained significant (Meyer et al. 2015).

Despite the indication that age may be strongly associated with poorer outcomes, its impact on recovery can be overestimated. For both total FIM score and Motor FIM score at discharge, in one study age alone accounted for only 3% of the variance in outcome (Bagg et al. 2002). Furthermore, patients attaining a "good" post-rehabilitation outcome (mRS≤3) were not significantly younger than those attaining a poorer functional outcome (p=0.16) (Alonso et al. 2015). Thus, advanced age alone is not a justifiable reason to deny patients access to rehabilitation given the questionable clinical relevance of that factor (Bagg et al. 2002). The authors conclude that although age had a significant impact on recovery it nevertheless was a poor predictor of functional outcome after stroke and could not be regarded as a limiting factor in the rehabilitation of stroke patients (Bagg et al. 2002). Age may be associated with greater comorbidity which may account for some of the challenges associated with rehabilitation of older patients.

Conclusions Regarding the Impact of Age on Recovery

Age can negatively impact stroke recovery; however, its overall contribution is small when compared to stroke severity. Age is also not considered to be a strong predictor of functional recovery after stroke.

4.4.2 Younger Stroke Patients

The odds of discharge home are 18 times greater if the stroke patient is under 65 than if they are over 85 (Herman et al. 1984). Kotila et al. (1984) compared 77 stroke patients 65 or older versus 77 patients younger than 65. Younger stroke patients had a better outcome in terms of return to home and ADLs. Bogousslavsky and Pierre (1992) found that 202 of 1638 (12.3%) patients from the Lausanne stroke registry with first ever ischemic stroke were 45 years or younger. They were divided into two groups: 1) Group 1 – age 16-30, n=56 (28%); 2) Group 2 – age 21-45, n=146 (72%). Prognosis was better for the Group 1 patients.

Alexander (1994) reported that all patients under 55 years old in his study group were discharged home. More importantly there was a significantly greater FIM change in those patients aged <55 years than for patients >55 years and even a significantly greater FIM change for groups aged 55 to 74 years than for the group >75 years (Alexander 1994). Nakayama et al. (1994) reported that older stroke patients made the same degree of neurological recovery as younger patients but had a much lower degree of functional gain. It was suggested that younger patients had more compensatory abilities than older stroke patients with comparable neurologic impairments. Kalra (1994) also reported that younger patients enjoyed greater functional recovery and higher rates of home discharge than elderly stroke survivors. These findings parallel the results from Kes et al. (2016) which also demonstrated that younger stroke patients attained considerably better outcomes at discharge when compared to older patients. Younger patients often do well no matter how impaired they are initially and even with severe strokes (early FIM <40) should be considered appropriate for a comprehensive intensive rehab unit (Alexander 1994).

Of the 43 163 patients admitted in the Austrian Stroke Unit Registry, only 14.1% were less than 55 years of age (Knoflach et al. 2012). Of those younger patients, 88.2% obtained good outcomes (mRS ≤2) at 3 months post-stroke (Knoflach et al. 2012). The study suggested that regression-adjusted probability of

good outcome was highest among patients in the 18-35 age group, and gradually decreased by 3.1-4.2% every 10 years, followed by a steep decline after the age of 75 (Knoflach et al. 2012).

Conclusions Regarding Younger Stroke Patients

> ***Young Stroke patients account for a small percentage of stroke survivors. As a rule, they do very well with rehabilitation, making significant functional gains and almost all are discharged home.***

4.4.3 Elderly Stroke Patients

It is important to recognize that elderly patients do make significant gains in terms of FIM changes (Alexander 1994; Borucki et al. 1992) but such gains tend to be slower with longer rehabilitation stays and a greater likelihood of discharge to an institution (Alexander 1994). Very elderly patients tend to be more cognitively impaired and have greater disease comorbidity and poorer social supports which can add to the challenge of rehabilitation of this population. Elderly patients often don't do as well with more aggressive intensive therapy approaches and such an approach may not be the best utilization of resources. Alexander (1994) has shown that elderly patients (defined as greater than 75 years) with early FIM scores between 40-60 don't appear to be able to benefit as much from intensive rehab and should be considered for less intensive rehab although with the high level of fitness and health maintained by many seniors today, the definition of elderly is more fluid and needs to be considered more on a case by case basis. Borucki et al. (1992) showed that those elderly patients with the ability to function independently outside their homes had a functional outcome not significantly different than younger patients. Similarly, Lieberman and Lieberman (2005) found that stroke patients over the age of 85 with an admission FIM score of 64 did not differ with respect to the change in FIM scores during rehabilitation, and at discharge from rehabilitation compared to those between the ages of 75 and 84 averaging a score of 66 on FIM at admission. Additionally, the length of hospital stay and the length of rehabilitation were not statistically different between the two groups.

Conclusions Regarding Elderly Stroke Patients

> ***Very elderly stroke patients should be considered candidates, regardless of stroke severity, and each case needs to be considered based on individual characteristics and potential. Factors such as premorbid fitness, cognitive functioning, family/community support and comorbidities are considered important in these cases.***

4.5 A Triage System

There is a fundamental need for an integrated system of care that spans acute care, inpatient rehabilitation, outpatient and home care service and supported living options that permit disabled individuals to move among levels of care in response to changed needs. Continuity of care and efforts to maximize functional independence of both patients and caregivers are essential. The goal is to provide a seamless flow of patients across the continuum of care.

One of the most important elements of systematic approach is an appropriate triage system based on the previous evidence discussed in this section (see Figure 4.5.1). The two most important predictors of functional recovery and eventual discharge home are initial stroke severity and the patient's age. Initial stroke severity for purpose of stroke rehabilitation triage is best measured using a functional outcome

measure such as FIM. Patients with early FIM scores of >80 can generally be managed in the community if the outpatient rehabilitation therapies are available. Early FIM scores of 40 – 80 are the traditional moderately severe stroke rehabilitation patients, making marked improvement more rapidly and hence benefiting from intensive rehabilitation. Those patients with early FIM scores of < 40 are less likely to achieve functional independence and make a slower recovery; they still benefit from specialized interdisciplinary stroke rehabilitation, of similar intensity seen for moderately severe stroke patients. However, for these more severe stroke patients, particularly those that are older, the lack of a committed caregiver is associated not only with lesser gains when compared to those patients with caregivers but also with virtually no chance of being discharged home.

Age is a significant prognostic factor with increasing age leading to poorer outcomes. Younger stroke patients (< 55 years of age) often do well no matter how impaired they are initially and even with severe strokes (FIM < 40). Such patients should be considered appropriate for a more intensive stroke rehabilitation program regardless of severity and the presence or absence of a caregiver.

The combination of stroke severity and age allows an objective triage system to slot patients into community-based stroke rehab or more intensive intersdisciplinary in hospital stroke rehabilitation. In reality, an optimal stroke rehabilitation program would provide an individualized rehabilitation therapy program based upon the individual stroke patient's specific needs.

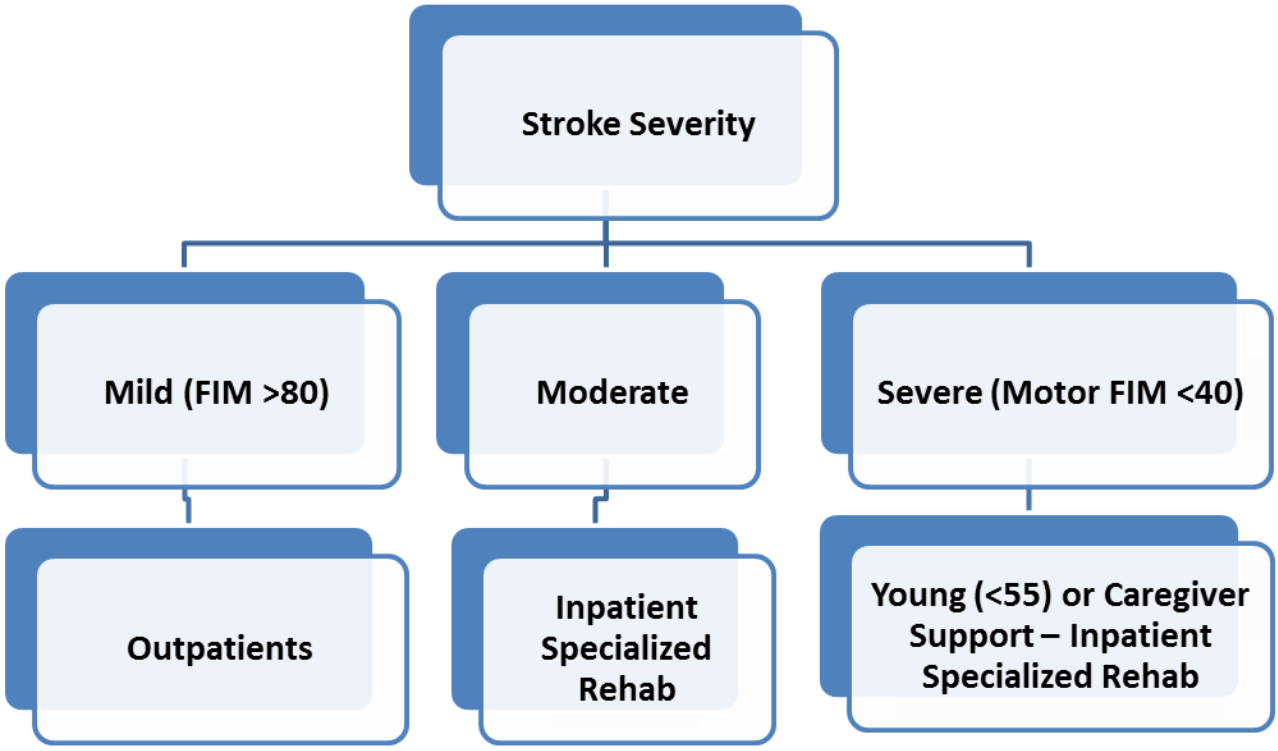

Figure 4.5.1 A triage system based on stroke severity.

4.6 Where Should Stroke Rehabilitation Be Conducted?

Stroke rehabilitation can be conducted in rehabilitation hospitals or rehabilitation units in acute care or rehabilitation hospitals, in nursing facilities with rehabilitation programs, in outpatient facilities, or in the home.

4.6.1 Mild Stroke Patients/ Outpatient/Home Care Rehabilitation

Patients with early FIM scores of >80 can generally be managed directly in the community if the outpatient rehabilitation therapies are available. There is a trend, where feasible, to move rehabilitation out of the hospital and into the community, sooner and to a greater extent than previously. This alternative approach to rehabilitation has been advocated by Edmonds and Peat (1997). The approach is multidisciplinary in nature and takes place where the stroke patient lives. This approach purportedly makes use of existing community resources, including Home Care, and outpatient stroke rehabilitation program and full involvement of family members or caregivers. The stroke patient and their family can be potentially more involved in their health care and have a greater say, and more responsibility, for their own rehabilitation.

The benefits of this devolution are obvious; it is potentially less costly, is arguably more patient-centered and involves the family/caregivers to a greater extent. However, where similar therapy services have been provided to the home as are provided in the hospital, the cost savings have proven elusive.

The characteristics of the home environment and availability of social support may determine the feasibility of home or outpatient therapy; for outpatient rehabilitation provided at the institution, transportation is often an issue. Studies that have looked at conducting rehabilitation in the home have found little difference in functional outcomes for higher level stroke patients when offered organized rehabilitation care at home (Widen Holmqvist et al. 1998) but poorer care for moderate or severe stroke sent back to their communities when compared to in-patient rehabilitation programs (Ronning & Guldvog 1998). The danger with the moderate to severe stroke group is that the skill set, present in hospital rehabilitation units, will not be as high in the community, and that patients and their families are not prepared to be discharged home without undergoing a course of inpatient rehabilitation. An integrated system, whereby the hospital-based rehab program serves as an educational and clinical resource, is important, both for the community support and the rehab program.

Conclusions Regarding Home/Outpatient Rehabilitation of Mild Strokes

> ***Mild stroke patients can be rehabilitated in an outpatient setting by an interdisciplinary stroke rehabilitation team.***
>
> ***Thus far, evidence of the superiority of home-based or hospital-based outpatient stroke rehabilitation is conflicting.***

4.6.2 Moderately Severe Strokes/ Hospital Based Inpatient Programs

Hospital programs are usually the most comprehensive, provide the greatest intensity of therapy and generally have optimal medical coverage. Expertise in stroke rehabilitation varies with the greatest concentration in formal hospital-based stroke rehabilitation units. Patients with moderate or severe disabilities and sufficient physical endurance to tolerate intense rehabilitation (often at least 3 hours of

physically demanding activities per day) are candidates for these more intense hospital programs. The benefits of such specialized stroke rehabilitation units are discussed in Module 5.

As noted in Module 5, there is strong evidence that specialized interdisciplinary stroke rehabilitation, as provided by an interdisciplinary stroke-specific team, results in improved functional outcomes when compared to "usual" care as provided on a general medical unit. There is also strong evidence that patients with more severe strokes benefit from stroke rehabilitation to a much greater extent. The evidence in this regard is overwhelming that moderate to severe stroke patients should be rehabilitated in stroke-specific inpatients units. There is moderate evidence that enhanced outpatient rehabilitation and discharge services, when provided in conjunction with stroke specific inpatient care, results in improvements in functional outcomes and the number of patients discharged home as well as reduced length of hospital stay. Again, enhanced rehabilitation/discharge services have the greatest impact on moderate to severe strokes.

There is currently an abundance of studies that compare and contrast the rehabilitation efficiency in a variety of locations; however, few studies have looked at whether different hospital types provide the same level of rehabilitation outcomes. This question was investigated by Asplund et al. (2015) whom compared a university hospital, a specialized non-university hospital, and a community hospital to determine significant differences among rehabilitation outcomes. The results demonstrate that mortality and ADL dependency were not significantly different in patients that rehabilitated in a university hospital compared to those obtained from patients discharged from a non-university hospital (Asplund et al. 2015). Furthermore, the odds of having a poor outcome was similar across sites. Foley et al. (2013) found similar evidence that in Ontario, being rehabilitated in free standing stroke specialized rehabilitation units did not produce better outcomes than patients rehabilitated in smaller general rehabilitation units, often located in acute care hospitals. This requires further study but one potential explanation is that rehabilitation in the same hospital as acute care is provided offers the opportunity for greater continuity of care, thereby balancing out the benefit seen in transferring patients to a freestanding specialized stroke rehabilitation unit.

Conclusions Regarding Hospital Based Inpatient Rehabilitation for Moderately Severe Stroke Patients

> ***Wherever possible, based on best evidence, patients with moderately severe strokes should receive rehabilitation on stroke specific rehabilitation units. However, in practice, rehabilitation on a stroke specialized unit does not guarantee better outcomes, as other factors may also be important, such as continuity of care.***

4.6.3 Severe Stroke Patients

Patients with severe strokes have been shown to benefit from the same intensive stroke specific interdisciplinary care that moderately severe stroke patients benefit from; hence even severe stroke patients (Early FIM <40) should be considered as candidates for in-hospital intensive interdisciplinary stroke rehabilitation. Pereira et al. (under review) reported that more severe stroke patients with committed caregivers made a better functional improvement than those without a committed caregiver. Pereira et al. (2014) demonstrated that the lack of a committed caregiver almost guaranteed that the patient would not be discharged home, calling into question the need to rehabilitate those severe stroke patients without a caregiver. One exception to this rule is the younger stroke patient (<55 years old) who seem to do better in stroke rehabilitation and may still achieve significant enough gains to achieve greater discharge independence than an older cohort with stroke of similar severity.

Severe stroke patients can achieve impressive rehabilitation goals. A group of 196 non-ambulatory patients, most with FIM scores below 40, were admitted to a specialized, enriched multidisciplinary rehabilitation program designed for severe stroke patients for a period of close to three months. Upon completion of the program, 43% of patients were able to return home and 28% were no longer wheelchair dependent (Teasell et al. 2005).

There has been a great deal of talk about less intensive stroke rehabilitation units to better deal with the more severe, and in many cases elderly stroke survivor, who are not likely to make as substantial gains and when they do they are at a much slower rate. This was studied in Toronto stroke rehabilitation facilities as shown below (See Figure 4.6.3.1 for study results). In this study of stroke rehabilitation units in Toronto admitting similar severe stroke patients as defined by Rehabilitation Patient Groups in Ontario, patients admitted to the slow stream stroke rehabilitation unit ended up staying twice as long and actually made lesser gains.

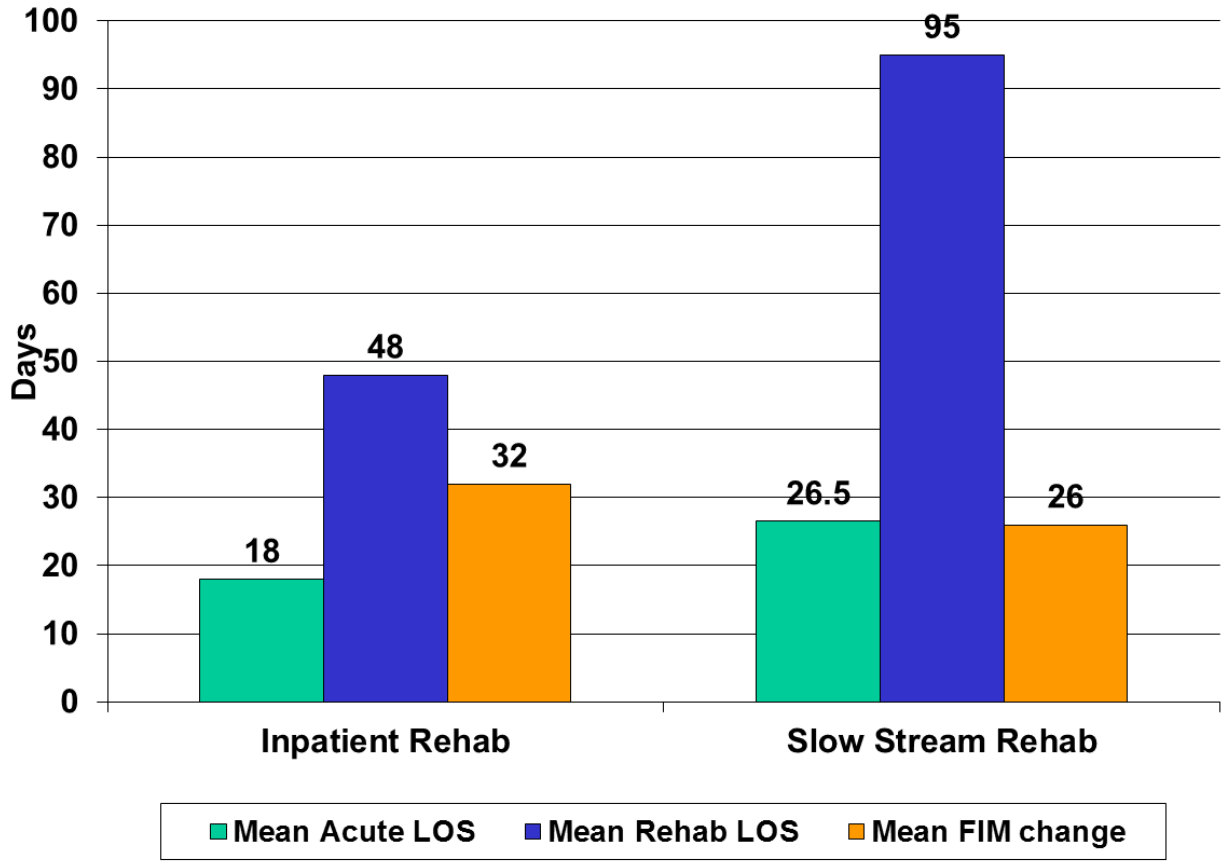

Figure 4.6.3.1 Days in hospital for patients admitted to inpatient rehab versus slow stream rehab. Data provide from rehabilitation units in Toronto, Canada.

As cited by Flick (1999), in the United States "*There is a trend for Medicare managed-care patients to be sent to subacute rehabilitation programs (Retchin et al. 1997). A recent large cooperative study compared stroke rehabilitation outcomes at 3 and 6 months for long-term placement, functional status, and cost in case mix-adjusted populations treated in rehabilitation hospitals, subacute nursing homes, and traditional nursing homes (Kramer et al. 1997). The study found significantly greater functional recovery in the rehabilitation hospital patients compared with the subacute and traditional nursing home patients. The total Medicare cost was 1.5 times greater than subacute and 2 times greater than*

traditional nursing home rehabilitation, but the odds of returning to the community doubled for rehab hospital patients in comparison with subacute patients. Subacute patients were more likely to return to the community than traditional nursing home patients, but there was no significant difference in function (Kosasih et al. 1998)."

Conclusions Regarding Lower Intensity Programs

> ***Patients with severe strokes may be better managed on long-term, less-intensive stroke rehabilitation units.***

Summary

1. ***The two most powerful predictors of functional recovery and eventual discharge status home are initial stroke severity and the patient's age, with initial stroke severity being by far the most important. These two alone can be used to determine appropriate stroke rehabilitation triage, although it does not preclude the use of additional factors.***

2. ***Severity of stroke is the most powerful predictor of ability to participate and benefit from stroke rehabilitation. Mild strokes benefit the least because of a "ceiling effect". Moderate to severe stroke improve the most on stroke rehab although the most severe strokes appear to benefit the most when compared to controls.***

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