Can stroke survivors with severe upper arm disability achieve a clinically important change in arm function during inpatient rehabilitation? A multicentre, prospective, observational study

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Abstract

BACKGROUND: Severe arm disability is considered to indicate poor potential to recover arm function.

OBJECTIVE: Determine if stroke survivors with severe upper arm disability can achieve a clinically important change in arm function on discharge from inpatient rehabilitation.

METHODS: 618 stroke survivors from 16 inpatient rehabilitation units were assessed on admission and discharge using the Motor Assessment Scale Item 6 Upper Arm Function (MAS6). Admission scores defined participants with severe (MAS6 ≤ 2) and mild/moderate (MAS6 > 2) upper arm disability. A clinically important change was evaluated according to: 1) statistical significance; 2) minimal clinical importance difference (MCID); and 3) shift in disability status i.e., severe to mild/moderate. Achievers of a MCID and shift were compared to non-achievers.

RESULTS: Stroke survivors with severe upper arm disability (n = 226) demonstrated a significant improvement in arm function (p < 0.001) at discharge. A MCID was achieved by 68% (n = 155) and a shift from severe to mild/moderate upper arm disability on discharge by 45% (n = 102) of participants. Achievers had a significantly shorter interval from stroke onset to inpatient rehabilitation admission (p < 0.002).

CONCLUSION: Stroke survivors with severe upper arm disability can achieve a clinically important change during inpatient rehabilitation.

Keywords: Stroke, inpatient rehabilitation, functional recovery, severe, motor
1. Introduction

Around 25% of stroke survivors have severe upper limb disability initially after stroke and have been found to show little functional recovery (Basmajian, Gowland, Brandstater, Swanson, & Trotter, 1982; Kwakkel, Kollen, Van der Grond, & Prevo, 2003; Nakayama, Jorgensen, Rasschou, & Olsen, 1994; Van der Lee et al., 1999; Wade, Langton Hewer, Wood, Skilbeck, & Ismail, 1983). Findings from a number of longitudinal studies report that during the first six months after stroke some functional recovery is evident in around 20% of cases and full recovery occurs in as few as 5% to 10% of cases (Basmajian et al., 1982; Kwakkel et al., 2003). This would suggest that there is little prospect of some to full functional upper limb recovery after stroke. Therefore, while full and even some recovery may be functionally meaningful, in considering the severity of disability to overcome and the complexity of arm-hand unit movements, is it an unrealistic expectation? In the context of severe arm disability, a small change may be realistic and represent a meaningful change during inpatient rehabilitation for this severely affected group. For example, an improvement in shoulder abduction may be enough to enable independent underarm showering. Therefore, evaluation of the stroke survivor’s potential to achieve a clinically important change in function rather than full function warrants further investigation.

A clinically important change in function can be explored through several methods. The traditional approach to determine efficacy is to identify a significant improvement on a functional scale. However, this does not always equate with a clinically important change (Hays & Woolley, 2000). An alternative approach is to investigate a minimal clinical important difference (MCID), that is the smallest change that is meaningful to the stroke survivor, their carer or the multidisciplinary team (Beaton, 2000; Hays & Woolley, 2000). Additionally, the proportion who shift from one disability category (e.g., severe) to another disability category (e.g., moderate) during inpatient rehabilitation may also be determined (Nadeau et al., 2013). Both the MCID and a shift in disability category provide a real world interpretation of a change in function. Evidence that stroke survivors with severe upper limb disability can achieve a clinically important change may provide the impetus for a more optimistic interpretation of their rehabilitation potential and could set the tempo for subsequent rehabilitation efforts from stroke onset.

To date, few studies have explored the potential of stroke survivors with upper limb disability, let alone severe disability, to achieve a clinically important change in function (Arya, Verma, & Garg, 2011; Hseih, Wang, Sheu, Hsueh, & Hseih, 2008; Van der Lee et al., 1999). Further, there is limited evidence as to what constitutes a MCID from the perspective of the stroke survivor, their carer or the multidisciplinary team (Arya et al., 2011; Lang, Edwards, Birkenmeier, & Dromerick, 2008). It is therefore pertinent to build the evidence base to support the use and development of approaches that investigate clinically important changes in upper limb outcomes after stroke. Thus, the aim of this study was to determine if stroke survivors with severe upper arm disability can achieve a clinically important change in arm function during inpatient rehabilitation.

2. Methodology

A prospective observational study was undertaken in accordance with the STROBE guidelines. Patients were recruited from 16 Rehabilitation Units (mean 24 beds, range 8 to 78) throughout Queensland, Australia. Units were predominantly located in a metropolitan region (n = 13) and publically funded (n = 12). Data collection occurred prospectively at three time-points: 1) September 2001 to February 2002, 2) March 2004 to March 2005; and 3) June 2010 through to April 2011. The number of cases admitted during each time-point determined the sample size. Individual sites were able to opt in or out at each time-point. Ethical approval was received from affiliated university and hospital ethics committees and conformed to the Declaration of Helsinki.

Eligibility criteria were consistent across time-points and sites. All people with a primary diagnosis of stroke who were medically stable, receiving physiotherapy, able to understand instructions and provide written informed consent were eligible. Ability to understand instructions was determined by the medical officer in consultation with the treating speech pathologist. Usual therapy across sites consisted of an individualised rehabilitation program provided by a multidisciplinary team including speech pathology, occupational therapy and physiotherapy.

The primary outcome measure was the Motor Assessment Scale. This is an 8-item measure used to assess functional performance post stroke and has demonstrated inter- and intra-tester reliability (Kendall, Jahnsen, & Aarnodt, 2005; Loewen & Anderson, 1988; Poole & Whitney, 1988). Item 6, upper arm function (MAS6) was the item of interest for this study.
This measure rates performance on a 6-point scale, where 0 represents no function and 6 represents highest function. The participants treating physiotherapist completed the measure within 72 hours of admission to and discharge from the unit. To minimise assessor bias and ensure consistency across physiotherapists and time-points, all staff attended common training sessions via teleconferencing at the commencement of each time-point, had access to a CD-ROM resource for ongoing training and a central contact person was nominated in each unit to address queries and ensure all staff maintained competency. Demographic and clinical information collected on admission included age, gender, time from stroke onset to rehabilitation admission and total hospital length of stay.

2.1. Statistical analysis

Participants with admission and discharge MAS6 data were included in the analysis, performed using SPSS v 18.0. Significance was set at $p < 0.05$. Participants were grouped on the basis of their MAS6 admission score. A score of $\leq 2$ defined severe upper arm disability (Loewen & Anderson, 1990) and equates to an inability (in supine) to hold the arm in 90 degrees of shoulder flexion, and flex and extend the elbow to take the palm to forehead (Carr, Shepherd, Nordholm, & Lynne, 1985). A score of $> 2$ defined mild/moderate upper arm disability.

To evaluate for differences in demographic characteristics, participants with severe disability were compared to those with mild/moderate disability using descriptive statistics and non-parametric, Mann-Whitney U Tests. A clinically important change on MAS6 was evaluated according to three statistical approaches based on severity of upper arm function on admission. Firstly, to determine the significance of the change on MAS6 from admission to discharge, non-parametric repeated measure Wilcoxon Signed Rank Test and effect sizes were calculated. Secondly, to determine how often a MCID on MAS6 was achieved during inpatient rehabilitation, the proportion of participants who demonstrated a 1-point change from admission to discharge was calculated. The MCID was set at 1-point based on available studies that have indicated a MCID on upper limb outcome measures can range between 10% to 30% (Lang et al., 2008; Van der Lee et al., 1999) of the scale. Based on this information, a 1-point (15%) change was thus adopted. Lastly, the proportion of participants who shifted from severe upper arm function on admission (MAS6 $\leq 2$) to mild/moderate upper arm function on discharge (MAS6 $> 2$) was calculated. Secondary analysis to explore for differences between those did or did not achieve a MCID or shift in disability with regards to age, gender, time to rehabilitation admission and length of hospital stay were performed using a Mann-Whitney U test.

3. Results

A total of 739 stroke survivors were recruited, of which 618 (84%) had complete admission and discharge MAS6 data. There were no differences between those with compared to without complete MAS6 data with regards to age, gender or hospital location ($p > 0.05$). Included participants were on average female (56%) and 71 (SD 13) years old (Table 1). A total of 226 (37%) had severe upper arm paresis (MAS6 $\leq 2$) at admission and were more likely to be male, younger, and have a longer time from stroke onset to admission to inpatient rehabilitation and a longer LOS in rehabilitation as compared to those with mild/moderate upper arm disability (MAS6 $> 2$) (Table 1).

Both disability groups demonstrated a significant improvement in MAS6 from admission to discharge from inpatient rehabilitation (Table 2). Specifically, those with severe upper arm disability (MAS6 $\leq 2$) demonstrated a 2-point change following inpatient rehabilitation (mean admission MAS6 1 (SD1), mean discharge MAS6 3 (SD2), $p < 0.001$).

On discharge a MCID (1-point change) was achieved by 68% ($n = 155$) of participants with severe upper arm disability at admission (Table 3). Those who achieved a MCID had a shorter interval from stroke onset to
admission to inpatient rehabilitation when compared to those who did not achieve a MCID ($p = 0.001$) (Table 3). There were no differences with regards to age or length of stay.

At discharge, 45% ($n = 102$) of participants had shifted from severe upper arm disability (MAS6 $\leq 2$) to mild/moderate upper arm disability (MAS6 $>2$) (Table 4). Those who achieved a shift in disability had a shorter interval from stroke onset to admission to inpatient rehabilitation ($p = 0.002$) and shorter overall hospital length of stay ($p = 0.013$) when compared to those who did not shift (Table 4). There was no difference with regards to age.

4. Discussion

This study found that participants with severe upper arm disability demonstrated a significant improvement in function during inpatient rehabilitation. This equated to 68% achieving a MCID and 45% demonstrating a shift in disability from severe to mild/moderate upper arm disability. This illustrates that a clinically important change in upper arm function is possible during inpatient rehabilitation even in those with severe disability.

From the large cohort investigated, a significant proportion of stroke survivors with severe upper arm disability achieved a MCID and shift in arm function during inpatient rehabilitation. As such, it appears that these measures offer a realistic reflection of the potential to recover function after stroke in the presence of severe arm disability. The findings of the current study were comparable to extrapolated raw data presented by Dean and Mackey (1992) who investigated rehabilitation outcomes following stroke using the MAS over 20 years ago. In the current study 68% achieved a MCID of 1-point, which is comparable to 66% who achieved a MCID in the comparison study (Dean & Mackey, 1992). Similarly, in the current study, 45% of participants shifted out of severe upper arm disability...
into mild/moderate disability, which is comparable to 52% who shifted in the study by Dean and Mackay (1992). While the current study had a much larger severe cohort $(n = 226$ vs. $n = 29$ severe stroke survivors), it is disappointing that the potential to recover arm function after severe stroke has not changed over the last 20 years. This is also consistent with reports of the dose of activity-related upper limb therapy provided during inpatient rehabilitation. In the late 90’s, Ada et al. (1999) reported as few as 7-minutes of activity-related upper limb therapy was performed during inpatient rehab. This remained consistent in more recent reports by Kuys et al. (2006) (4-minutes) and Hayward et al. (2013) (11-minutes). While it is unclear in the current study if the clinically important changes were spontaneous or therapy-induced, it would appear that current rehabilitation practices, whereby up to 11 minutes per day is spent on the upper limb, may not sufficiently exploit the recovery potential of stroke survivors with severe motor disability. This indicates a clear need to direct greater attention to practices that can drive upper limb recovery after stroke.

The interval from stroke onset to inpatient rehabilitation admission appears important for a stroke survivor to achieve a clinically important change (MCID and shift). Stroke survivors who achieved a MCID and a shift in disability level had a significantly shorter interval from stroke onset to inpatient rehabilitation admission. Further, when a shift to reduced arm disability occurred, overall length of stay was significantly shorter. This indicates a pressing need to direct greater attention to explore how this interval can be used to drive functional recovery. Spontaneous recovery, which occurs in the first month post stroke (Nudo, 2011), has been suggested to be one of the most neglected features of recovery after stroke (Krakauer, Carmichael, Corbett, & Wittenberg, 2012; Kwakkel, Kollen, & Lindeman, 2004). Furthermore, a substantial proportion of the stroke survivors’ day during acute hospitalisation is spent inactive (Bernhardt, Chan, Nicola, & Collier, 2007; Van Wijk, Cumming, Churilov, Donnan, & Bernhardt, 2012), with very limited use of the affected arm (Bernhardt et al., 2007). A therapeutic process that could exploit the interval is an early intensive upper limb therapy program. A Very Early Mobilisation Trial has been commenced to investigate if early mobilisation after stroke could reduce the level of disability experienced, reduce the number and severity of complications experienced and result in better quality of life after stroke (Bernhardt et al., 2006). To date this trial has found early mobilisation is safe and feasible (Bernhardt, Dewey, Thrift, Collier, & Donnan, 2008) and can enhance the dose and frequency of therapy sessions (Van Wijk et al., 2012). Application of this approach to the upper limb requires investigation.

Recognising the heterogeneity of the stroke population and current lack of clinically useful prediction models, (Counsell, Dennis, & McDowall, 2004; Moons et al., 2012; Schulz, 2004) it remains to be seen if it is possible to reliably characterise those patients with severe upper arm disability who will achieve a clinically important change during inpatient rehabilitation from those who will not. At present it appears that use of a clinical outcome measure alone (e.g., MAS) may not consistently recognise recovery potential and may lead to adoption of compensatory rather than retraining approaches to therapy (Kwakkel et al., 2003; Stinear, Barber, Petoe, Anwar, & Byblow, 2012). Exploration of predictive factors beyond clinical measures, such as the presence of a motor-evoked potential or corticospinal tract integrity, may ensure that the rehabilitation potential of stroke survivors who have no peripheral movement early after stroke, but central capacity for movement (Stinear et al., 2012) is realised and exploited.

This study has several strengths. It is a large study that used a three-pronged approach to evaluate the clinical importance of arm recovery specific to the context of severe disability. While a large number of sites were included and the findings were comparable to previous reports, the study does have its limitations. It was not possible to compare the results of participants with severe upper arm disability in this cohort to those with severe upper arm disability who were not offered inpatient rehabilitation. This study also lacked independent assessors and recording of therapy dose and content. While the MCID adopted was a conservative distribution-based rating from a clinician perspective, it was not anchored to the stroke survivor or carer (de Vet et al., 2006). To confirm the adoption of the current rating and subsequent outcomes, future studies need to develop anchored-based ratings for the MAS. Generalisability of the current findings may be limited by acute hospital and inpatient rehabilitation structure (e.g., collocation of the services), dose and content of upper limb therapy available and length of inpatient rehabilitation stay.

5. Conclusion

This study demonstrates that stroke survivors with severe upper arm disability can achieve a clinically
important change during inpatient rehabilitation. While it remains unclear if the functional gains achieved were spontaneous or therapy-induced, it is likely that current practices may not sufficiently exploit the interval from stroke onset to inpatient rehabilitation admission.

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Ethical approval

This study was approved by university and hospital ethics committees as detailed below: University of Queensland Medical Research Ethics Committee 20100000478 and 2003000520 was for all sites; E/08/2003 was for multiple Queensland Health sites and some private sites; additional site specific approvals obtained include Princess Alexandra Hospital Human Research Ethics Committee HREC/10/QPAH/003; The Prince Charles Hospital Human Research Ethics Committee HREC/10/QPCH/21; Ipswich Base Hospital Review Board 11-10, 6-03N; St Andrews Hospital Review Board 1012; Toowoomba Base Hospital Review Board 2010/8. All participants provided informed consent prior to study participation.

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Conflict of interest

We declare that KH, RB, SB are involved in a company developing a medical device to improve arm function after stroke (SMART Arm). SK has no non-financial interests that may be relevant to the submitted work.

References


