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# The importance of cognition to quality of life after stroke

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ABSTRACT

*Objective:* Suffering a stroke typically has a negative impact on a person's quality of life. There is some evidence that post-stroke cognitive impairment is associated with poor quality of life, but the relative importance of deficits in different cognitive domains has not been established.

*Methods:* Patients with confirmed stroke were recruited in the acute hospital. A subgroup of patients completed 2 computerized cognitive tasks (simple and choice reaction time) within 2 weeks of stroke. The full cohort was followed up at 3 months with a comprehensive neuropsychological battery and then at 12 months with the Assessment of Quality of Life ('AQoL).

*Results:* Sixty patients participated in the study (mean age 72.1 years, SD 13.9), with a subgroup of 33 patients tested acutely (mean age 75.5 years, SD 11.9). Presence of cognitive impairment at 3 months was independently associated with lower quality of life at 12 months ($p = 0.021$). Attention and visuospatial ability were the cognitive domains most closely associated with quality of life. Faster choice reaction time in the acute stage (mean 5.4 days post-stroke) was significantly associated with better quality of life at 12 months ($p = 0.003$).

*Conclusion:* Cognition, particularly attention and visuospatial ability, is strongly associated with quality of life after stroke. It is possible that straightforward reaction time tasks are sensitive to the extent of brain damage, and might therefore be surrogate markers for quality of life.



## Introduction

Stroke can impact many aspects of a person's life, resulting in major adjustments and long-term challenges for the individual and their family. Groups of stroke survivors have been shown to have a lower average quality of life (QoL) than groups of age-matched people who have not experienced a stroke [1,2]. Defining QoL is complex, as it is determined by an individual's perception nested in the context of their values, expectations and cultural beliefs [3]. There is general consensus, however, that QoL is a multidimensional concept that incorporates physical, psychological and social domains of health and well-being [4,5]. As health care has moved from the traditional medical model (humans as biological organisms) to a more humane model (people as integrated, feeling beings), QoL has become viewed as the endpoint most relevant to the individual [6]. This move has been accelerated by treatment advances, particularly in cancer (i.e., ongoing chemotherapy will keep you alive, but is it a life worth living?).

Historically, the focus of rehabilitation after stroke has been on improving physical function. Such improvements clearly have a positive effect on QoL, but there are other important considerations. Results from the Australian stroke incidence study NEMESIS showed that handicap, physical impairment and disability were all independent predictors of health-related QoL, but so were dementia and mood disorder [7]. Hochstenbach et al. [8] found that several cognitive tasks—mostly in the attention domain—administered at 2 months post-stroke were predictive of QoL at 10 months. In multivariate analysis, the Trail-making part B task (requiring executive function, and also incorporating visuospatial scanning) emerged as an independent predictor of QoL. Similarly, Nys et al. [9] reported that cognitive impairment in the first month post-stroke was as an independent predictor of low QoL at 6–10 months. In this case, visuospatial ability was the cognitive domain with the strongest link to QoL. Given that the QoL life scales used in these two studies [8,9] included specific items on cognition, however, it might be argued that these associations are somewhat circular.

Although the evidence base is limited, these studies give some indication that attention and visuospatial ability are particularly closely related to QoL after stroke. This is interesting because, unlike tasks used to assess the cognitive domains of memory and language, the tasks used to assess attention and visuospatial ability are typically speed-dependent. This raises the prospect that the association with QoL is not with these cognitive domains per se, but is mediated by a more generalized speed of processing capability. Recent findings from two large ($n > 300$), longitudinal (>3 years follow-up) studies have demonstrated that long-term functional outcome after stroke can be

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independently predicted by processing speed [10] and visuomotor speed [11]. Whether long-term QoL can also be predicted by processing speed remains an open question. One of the advantages of using processing speed as a cognitive marker is that reaction time tasks are more straightforward than standard, time-consuming paper-and-pencil neuropsychological tasks. Computerized reaction time tasks have been used in stroke samples to test attention, processing speed and working memory [12,13], and our group has established their feasibility in acute stroke patients [14].

In light of this previous research, we formulated 3 hypotheses. First, that cognitive impairment at 3 months post-stroke would be independently associated with QoL at 12 months (evaluated on a QoL scale without specific cognitive items). Second, that the cognitive domains of attention and visuospatial ability would be the strongest correlates of long-term QoL. Third, that speed of processing (simple and choice reaction time) in the acute stage would be independently related to QoL at 12 months. This is not because we believe that reaction time per se is important for life satisfaction, but that speed of processing might be an important foundation for other cognitive processes and a useful marker for the extent of brain damage after stroke.

## Methods

### *Participants*

Patients who were admitted to the acute stroke unit at the Austin Hospital with confirmed stroke (ischemic or intracerebral hemorrhage) were eligible. Patients were excluded if they: (a) were younger than 18 years old, (b) were unconscious on admission to hospital, (c) required an interpreter, or (d) had major visual, hearing or language impairments which would be likely to prevent completion of the cognitive assessments. Patients were recruited from 2009 to early 2011. In February 2010 (approximately half way through recruitment), computerized cognitive testing in the acute stage was added to the protocol, and the additional exclusion criterion of having suffered the stroke more than 2 weeks previously was introduced. All patients provided informed consent prior to inclusion in the study. Ethical approval for this study was obtained from the Austin Health Human Research Ethics Committee.

### *Procedure*

Relevant demographic and clinical characteristics, including age, stroke severity using the National Institutes of Health Stroke Scale (NIHSS) [15], Oxfordshire classification [16] and lesion side, were extracted from the patient's medical record. For the subgroup of patients who were tested acutely, the first testing session took place on the stroke ward immediately following recruitment. The cognitive tasks were presented on a laptop computer that had 2 large (approximately 6 cm in diameter) external response keys (the ‘yes’ and ‘no’ buttons) attached. Each patient was either sitting up in bed or sitting in a chair next to their bed for the testing (wherever they were originally situated). Curtains were drawn to minimize interruptions and to encourage the patient to focus on the task. The follow-up visits at 3 and 12 months post-stroke were completed by all patients. At 3 months, 2 visits were made to the patient's residence approximately 1 week apart. During the first visit, a screening tool for mood disorder was completed. At the second visit, a comprehensive neuropsychological battery consisting of paper-and-pencil tests was administered. The researcher (TBC) who conducted the neuropsychological testing is experienced in administering cognitive batteries. At 12 months, a final follow-up visit was made to the patient's residence. During this visit, assessments were made of the patient's QoL and their level of disability.

### *Outcome measures*

#### *Acute stage*

The 2 computerized tasks administered to the acute subgroup were the simple and choice reaction time tasks from the CogState battery (CogState Ltd, Melbourne, Australia). Each task took approximately 3 minutes to complete. The tasks are not reliant on expressive language; they require button press responses to the presentation of playing cards on a computer screen. Research has shown the CogState tasks to be valid and reliable [17], free of practice effects in serial testing [18] and sensitive to change [19]. Both tasks were preceded by instructions read aloud by the experimenter and a series of practice items for task familiarization. A playing card was presented face down in the center of the screen and, after an interval that varied randomly between 2.5 and 3.5 seconds, instantly turned face up. The detection task is a simple reaction time test of psychomotor function and speed of processing; the participant was instructed to press the ‘yes’ button as soon as possible after the card on screen flipped over. The card was always the same joker card. The task ended after 35 correct trials were completed. The identification task is a choice reaction time test of visual attention; the participant was instructed to press the ‘yes’ button if the card is red and the ‘no’ button if the card is not red as soon as possible after it flipped over. The card was either a red or a black joker. The task ended after 30 correct trials were completed. Visual and auditory feedback differentiated correct and incorrect responses, and anticipatory responses (button press before card flips over) triggered a distinctive error sound. Accuracy and reaction times for correct responses were recorded. A base 10 logarithmic transformation was applied to normalize the distributions of reaction time data. If a patient made an error on 50% or more of the trials, their reaction time data for that task were excluded from analysis. For the simple reaction time task, errors could be anticipatory responses (button press before card flips) or non-responses (timed out). For the choice reaction time task, errors could also be an incorrect button press, with a chance level of 50%.

#### *3 months*

At the first 3-month visit, the Hospital Anxiety and Depression Scale (HADS) [20] was completed to screen for mood disorder. This scale features 7 items assessing anxiety and 7 items assessing depression and has documented validity in stroke [21]. The neuropsychological battery administered in the second 3-month session was designed to be similar to those used in previous studies requiring a criterion standard for cognitive impairment [22]. Our battery included widely used cognitive tests that have established age-specific norms: the Rey Complex Figure, WAIS-R subtests of block design, digit span and digit symbol, the Hopkins Verbal Learning Test-Revised, the Trail-Making Test, letter and animal fluency, Star Cancellation, the Token Test and the Boston Naming Test. These tasks were grouped into the separate but interdependent domains of visuospatial, memory, executive, language and attention (see Table 1 for full details of the battery). The battery took 60–90 minutes to complete. Our classification of cognitive impairment was determined on the basis of the neuropsychological battery. Scores on each test were translated to z-scores using age- and education-specific normative data. These z-scores were then averaged across the contributing tests within each domain to yield an overall domain z-score. A patient was classified as cognitively impaired if they had domain z-scores of less than −1 (i.e., greater than 1 standard deviation below the mean) in 2 or more domains. Patients who had domain z-scores of less than −2 (i.e., greater than 2 standard deviation below the mean) in 2 or more domains were classified as moderate-severely cognitively impaired. This domain-based z-score approach to classification has strong endorsement [23].

#### *12 months*

At the 12-month visit, the assessment of quality of life (AQoL) [24] was completed. This generic health-related utility instrument consists