Post-stroke aphasia prognosis: a review of patient-related and stroke-related factors

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Abstract

Rationale, aims and objectives Recovery of language function in individuals with post-stroke aphasia is associated with a variety of patient and stroke-related indices. Amidst a complex interaction of a multitude of variables, clinicians are faced with the arduous challenge of predicting aphasia recovery patterns and subsequently, long-term outcomes in these individuals. Unfortunately, predictive factors are highly variable making prognosis of aphasia recovery difficult. Therefore, the objective of this review was to assess the influence of patient-related and stroke-related factors on language recovery in individuals with post-stroke aphasia.

Methods We completed a literature review to assess and identify evidence-based patient and stroke-related variables shown to be influential in aphasia recovery.

Results A range of patient-related (gender, handedness, age, education, socio-economic status and intelligence) and stroke-related indices (initial severity, lesion site and lesion size) were identified as potential influential factors to post-stroke aphasia recovery. Initial severity of aphasia emerged as the factor most predictive of long-term aphasia recovery. Other influential factors of post-stroke language recovery included lesion site and size.

Conclusions Stroke-related factors, including aphasia severity, lesion site and lesion size, appear most critical to post-stroke aphasia recovery. The findings presented in this review offer clinicians an evidenced-based framework to assist in prediction of post-stroke aphasia recovery patterns and subsequent long-term functional communication outcomes.

Introduction

Each year approximately 795 000 people experience a stroke and many are left with serious long-term disability [1]. Of those who experience a stroke, approximately 100 000 will acquire aphasia during the acute phase of recovery and an estimated one million Americans are currently living with aphasia [2]. Aphasia is defined as ‘an acquired communication disorder caused by brain damage that impairs a person’s ability to understand, produce and use language’ (p. 2) [3]. Aphasia can result from a variety of neurological disorders; however, stroke is the predominate neurological condition associated with aphasia and will therefore constitute the focus of this review.

There exists a comprehensive literature related to prognostic indicators for general stroke recovery. For example, the presence of prior stroke, old age, urinary and bowel incontinence, visuospatial deficits and initial Functional Independence Measure (FIM) scores below 60 have all been identified as negative prognostic indicators for general post-stroke function [4–6]. A clear understanding of the specific factors critical to the prediction of aphasia recovery patterns, however, is yet to emerge. Even in the absence of this much needed and critical prognostic information, clinicians are constantly challenged to predict aphasia recovery.

A prognosis is a prediction of the course of a disease or condition based upon experience, intuition and evidence-based information [7]. Determining a prognosis in aphasia requires consideration of a multitude of inter-related patient-specific and stroke-specific variables believed to influence functional outcomes for individuals with aphasia. Patient-related variables include: age, handedness, gender, educational level, intelligence, motivation, depression, family support, beliefs and attitude regarding health care, and access to medical treatment. In contrast, stroke-related indices include: site of lesion, size of lesion, aphasia type and pattern of recovery, and initial aphasia severity. Identifying the correct combination of factors critical to an accurate prognosis is a daunting task for the new and even experienced clinician. Clinicians are
now faced with new challenges due to the widespread distribution of misleading information available to the public on the internet that must be carefully considered when discussing and providing prognostic information to caregivers and family members. In this review we will examine a range of variables previously documented and that are believed to influence aphasia outcomes post stroke. Unfortunately, studies designed to examine aphasia prognosis have either examined the natural history of aphasia or primarily examined one aphasia outcome prognostic variable independently [8]. Consequently, few previous reports have attempted to consolidate the evidence to present a clear picture for clinicians. Therefore, it was our goal to systematically organize available evidence so as to provide clinicians the foundation for a more accurate and evidenced-based prognostic approach to aphasia recovery in post-stroke individuals.

Research design and methods

For this review, we considered all studies that recruited patients with a diagnosis of aphasia following stroke and reported standardized measures designed to predict aphasia outcomes. We used the Cochrane Collaboration Group search strategy as outlined in the Cochrane Handbook for Systematic Reviews of Interventions [9]. We searched: Medline (from 1966–2007), CINAHL (from 1982–2007), PsycINFO (1966–2007), REHABDATA (1966–2007) and the Cochrane Library. The following (MESH) terms were used in our search: ‘stroke, aphasia, prognosis and terms associated with the prediction of aphasia outcomes including: age; handedness; gender; educational level; intelligence; site of lesion; size of lesion; aphasia type and pattern of recovery; and initial aphasia severity’. We also considered all other variables that are known to influence general stroke outcomes such as: motivation; depression; family support; beliefs and attitude regarding health care; and access to medical treatment. From these terms, we attempted to identify other terms associated with aphasia prognosis.

We identified studies that reported ‘aphasia outcomes’ even if the study’s primary purpose was not designed to identify aphasia prognosis. We completed hand searches of reference lists and a search of Google Scholar. We also searched for reviews of aphasia prognosis and websites that reported variables associated with aphasia prognosis. Given the heterogeneity of studies, we decided a priori not to use meta-analysis to pool the results of studies. Instead, the presentation of results provides a qualitative assessment of the studies.

Results

Patient-related factors

Gender

According to the National Institute of Neurological and Communication Disorders and Stroke (NINCDS) Stroke Data Bank, the incidence of aphasia post stroke is slightly higher among women compared with men in the USA [10]. Similarly, in an international study of 269 stroke patients, a higher incidence of aphasia was observed among women in 80 individuals with aphasia [11]. In contrast, other investigators have reported a higher incidence of post-stroke aphasia in men. Kertesz and Sheppard [12] reported a 1.6:1.0 ratio (male : female) in 204 patients with aphasia, while Basso et al. [13] observed a similar male to female ratio of 1.5:1.0 in 192 patients with aphasia.

Consequently, evidence regarding gender and prevalence of specific aphasia type is also mixed. For example, De Renzi and colleagues [14] reported a higher prevalence of males with non-fluent aphasia, and Hier et al. [10] documented that Wernicke’s and anomic aphasias were more common in women while Broca’s aphasia was somewhat more prevalent in men. Conversely, other studies have not reported any association between gender and type of aphasia. Specifically, Engelter and colleagues [11] observed no gender differences on measures of auditory comprehension, expressive language and ratings of everyday communication function, and Godefroy et al. [15] concluded that sex did not significantly influence aphasia type in 295 individuals. In addition, evidence has shown that gender does not appear to be related to aphasia recovery [16–18]. In summary, evidence is largely equivocal and gender does not appear to significantly impact incidence of aphasia, aphasia type or recovery patterns in post-stroke individuals.

Handedness

As early as the 19th century, Paul Broca proposed that the left hemisphere was dominant for language functions in right-handed individuals. Interestingly, in 1958, Surbirona noted that prognosis for aphasia recovery following stroke is better for those who are left-handed compared with right-handed individuals. A more recent study of handedness and language dominance among healthy adults, however, reported that left-handedness is not necessarily a consequence of right-hemisphere language dominance, but rather left-handedness increases the likelihood of right-hemisphere dominance [19]. Consequently, it appears that left-handed and ambidextrous individuals are more likely to have a bi-hemispheric representation of language and therefore the potential for greater recovery from aphasia [20]. While it appears that ambidextrous and left-handed individuals may have a greater neural capacity for recovery, handedness when studied as an independent factor has not been shown to influence aphasia recovery [21,22].

Age

Early studies of influential prognostic indicators of acute stroke ranked age as a primary variable [23,24]. Consequently, older individuals are more likely to have aphasia than younger ones [11]. Engelter and colleagues [11] studied 269 individuals following their first ischemic stroke, and reported the mean age of aphasic patients to be five years higher than their non-aphasic counterparts (80 vs. 75 years). In addition, Smith noted that aphasia severity increased with advancing age [25]. Further, studies of age and aphasia type demonstrate that individuals with fluent aphasia tend to be older than individuals with non-fluent aphasia. [21,26] De Renzi and colleagues [14] reported that individuals with Broca’s aphasia were significantly younger than individuals with Wernicke’s aphasia, and similarly, Kertesz and Sheppard [12] documented that individuals with Broca’s aphasia were younger than individuals with other aphasia types.
While age does appear to influence both the incidence and type of post-stroke aphasia, the impact of age on aphasia recovery is unclear. Younger patients have been reported to demonstrate a higher recovery rate than older patients [27]; however, conflicting reports have deemed age to be a poor prognostic indicator of aphasia recovery [16,17,22,28]. Thus, even though age has been identified as an important prognostic indicator for general stroke recovery, no consistent data have emerged regarding age and expressive or receptive language recovery patterns post stroke. In sum, incidence of aphasia is higher in older stroke patients, and of these patients a higher likelihood of fluent forms is seen in older adults and non-fluent forms in younger adults with no clear relationship between age and the ability for language recovery in post-stroke aphasia.

**Education, socio-economic status and intelligence**

Carl Wernicke (1874) proposed that aphasia in highly educated individuals would differ from those with less education; however, a clear relationship between educational level and aphasia recovery has yet to emerge [25]. This is likely due to the existence of a plethora of confounds, such as literacy levels, general intelligence, existence of learning disabilities, socio-economic status (SES) and cultural influences, that make this area particularly challenging to study. Indeed, the existence of these confounds requires adjustments and careful planning of experimental designs in order to draw any valid conclusions regarding the impact of education on aphasia.

Educational achievement is frequently linked to SES, a variable involving the complex interaction of a wide range of associated factors including: income, insurance status, access to health care and health-related beliefs that are associated with stroke-related outcomes [11,29–33]. Thus, one might hypothesize that SES represents a related variable critical to aphasia prognosis. Two studies have examined the relationship between SES and education with aphasia. Connor and colleagues examined 39 individuals with aphasia at both 4 and 103 months post onset to determine the degree to which educational achievement and SES influenced initial aphasia severity and recovery [34]. These authors noted that both educational achievement and SES did not impact aphasia recovery rate; however, initial aphasia severity was worse in those with less education then in those with a higher level of education. In contrast to this later finding, Lazar and colleagues reported no relationship between education level, initial aphasia severity or recovery [35]. While data regarding the influence of educational levels on aphasia outcomes remain limited, data to date suggest no consistent relationship between education level and aphasia severity or recovery.

Closely associated with educational achievement level, higher pre-morbid intelligence has been examined as a potential positive prognostic factor for individuals with aphasia. Kertesz and McCabe measured non-verbal intelligence in 111 individuals with aphasia and 52 control patients taken from the same hospital with a range of medical diagnoses [36]. The authors observed that while non-verbal intelligence was impaired in the former, overall there were no significant differences between the two groups. In a similar study, David and Skilbeck investigated the impact of intelligence on aphasia severity and recovery of language function post-stroke in 148 patients [37]. These authors reported a correlation between intelligence level and initial aphasia severity but not with recovery of language function following stroke. In an early review of prognostic indicators of aphasia recovery, Ferro et al. concluded that intelligence did not appear to influence aphasia recovery [20]. Thus, there is some data to suggest that intelligence may impact initial aphasia severity; however, it appears that this variable does not influence aphasia recovery patterns post stroke.

**Stroke-related factors**

**Initial stroke and aphasia severity**

Recent studies indicate that initial stroke severity is associated with initial aphasia severity, which in turn, is associated with poorer outcomes [27,28,38]. For example, Laska et al. documented that individuals with milder aphasia tended to have a higher degree of aphasia recovery [27]. Similar findings were reported by Pedersen and colleagues, who studied 270 aphasia patients post-stroke using the Western Aphasia Battery Aphasia Quotient (WAB AQ) [28]. These authors observed that language outcomes could be predicted by initial stroke and aphasia severity but not by other factors such as age, gender or aphasia type. At 1-year post-neurological insult, aphasic symptoms still remained for 61% of these individuals; however, the majority demonstrated a reduction in the severity of language deficits with some degree of functional improvement [28]. While a strong relationship existed between initial aphasia severity and language outcomes, the relationship was most predictive of long-term language outcomes during the 2- to 4-week post-stroke period, suggesting an optimal prognostic time window. Thus, clinicians are encouraged to consider initial stroke, and subsequently initial aphasia severity, as predictive factors when determining aphasia prognosis.

**Site and size of lesion**

A wealth of literature supports the notion that lesion size and location constitute important clinical predictors of aphasia type. For example, certain semantic deficits are correlated with damage to the left posterior temporal and inferior parietal region [39]. Similarly, large lesions to the third frontal gyrus involving Broca’s area and the lower part of the precentral gyrus, in conjunction with lesions in the opercular and insular regions, are associated with more severe naming difficulties and overall expressive language deficits in individuals with Broca’s aphasia [40]. Likewise, lesions localized to the left superior temporal gyrus are common in patients with significant and persisting global aphasia and generally associated with poor language recovery [41].

Lesion location and size have also been documented to influence aphasia recovery patterns in post-stroke individuals. Mazzoni and colleagues documented different recovery patterns based on lesion size in 45 patients with aphasia [42]. Specifically, patients with small lesions exhibited significant improvement in auditory comprehension, verbal expression and written expression; patients with medium sized lesions improved in both auditory comprehension and verbal expression; while patients with large lesions improved in only auditory comprehension. Goldenberg and Spratt examined lesion size specific to Wernicke’s area in 18 individuals with aphasia over an 8-week recovery period [43]. Size of lesion negatively influenced overall recovery, with larger lesions to the...
temporobasal area associated with lower improvement and less total recovery. Likewise, Knopman and colleagues noted that persistent non-fluency was associated with large lesions located in the Rolandic cortical regions extending into underlying white matter [44]. Finally, a recent study of 669 patients with aphasia by Maas and colleagues indicated that better outcomes were associated with clinically and radiographically smaller strokes as well as lower prestrike disability [8].

Studies by Naeser and colleagues have generally concluded that aphasia recovery is associated with both the specific location and the size of lesion, rather than just the later [45–48]. Specifically, a significant correlation was present between comprehension skills and the amount of temporal lobe involvement in Wernicke’s area, however not between comprehension abilities and total temporoparietal lesion size. Furthermore, patients with lesions that encompassed more than half of Wernicke’s area generally had poor comprehension skills, even 1 year post stroke [46]. Finally, these authors reported that anterior–inferior temporal lobe lesions that extended into the middle temporal gyrus were associated with the worst language recovery. A later study by this group did not identify a single neuroanatomical area where extent of lesion could discriminate outcomes for spontaneous speech fluency; however, Naeser et al. concluded that spontaneous speech fluency was significantly influenced by lesion size in two subcortical white matter areas when combined [48]. These two areas consisted of the most medial and rostral portion of the subcallosal fasciculus and the periventricular white matter area near the body of the lateral ventricle and deep to the lower motor/sensory cortex area of the mouth.

Alexander and colleagues also noted that size of lesion in critical language areas was highly predictive of aphasia severity and recovery patterns [49]. While shallow lesions of the frontal operculum resulted in transient disorders of language output with normal articulation and repetition, lesions that extended into the deep white matter of the frontal isthmus and anterior periventricular white matter resulted in more severe and prolonged non-fluent verbal output. Alexander et al. concluded that a more severely impaired expressive language profile resulted from disruption of the limbic-frontal projections and cingulated–striatal–frontal connections critical to expressive language output [49]. Similarly, Kertesz et al. reported that poor recovery in comprehension abilities was associated with larger lesions involving the supramarginal gyrus, angular gyri and superior temporal area, while sparing of the superior temporal and middle temporal gyri was associated with good recovery of auditory comprehension in 22 individuals with Wernicke’s aphasia [50]. Finally, Selness and colleagues examined 39 individuals with aphasia to determine the relationship between lesion localization, lesion volume and auditory comprehension outcomes [51]. In this study, poorer outcomes were associated with lesions to the posterior superior temporal and infrasylvian supramarginal region and lesion volume was generally not associated with auditory comprehension abilities unless extremely large or small.

Metabolic factors, not typically measured by clinicians, have also been noted to influence short- and long-term aphasia prognosis. Evidence suggests that cerebral metabolic rates of glucose in language regions, and cerebral blood flow adjacent to lesions during the early post-stroke period, are critical to aphasia recovery. [52,53] Furthermore, the proposed mechanism by which adequate cerebral blood flow returns to the damaged brain is a dynamic and complex process occurring bilaterally and might therefore influence aphasia recovery because the right hemisphere appears to have a definitive role in the early recovery of language function [53–57]. For example, Karbe and colleagues reported that while the left superior temporal cortex was critical in determining long-term prognosis in aphasia, the right hemisphere was important for speech processing when the left hemisphere areas were permanently damaged [56]. This has led to the hypothesis that long-term aphasia recovery is linked to the right hemisphere’s slow and gradual compensatory role in language function, particularly during the early post-stroke time period [53].

Finally, the continuous advent of more sophisticated neuroimaging techniques has significantly advanced our current understanding of the neural mechanisms by which aphasia recovers [58]. Recent neuroimaging studies have provided compelling evidence to support the notion that the brain has the ability to engage in structural and functional plasticity that supports language recovery in individuals with aphasia [58]. For example, Schlaug et al., using diffusion tensor imaging, reported increases in the number and volume of fibres in the right arcuate fasciculus (AF), a large white matter tract with reciprocal connections between Broca’s and Wernicke’s area, in six individuals with moderate to severe expressive aphasia [59]. Schlaug et al. observed increases in the number and volume of AF fibres that were accompanied by improvements in verbal expression following 75 sessions of melodic intonation therapy [59]. Furthermore, a significant trend emerged between the relative improvement in conversational information units (elicited from a picture description task and during conversational speech) and the absolute change in the number of AF fibres. In this small sample, it appears that structural brain plasticity may have facilitated functional improvement in expressive language function following an intensive and salient rehabilitation program.

**Conclusions**

A multitude of inter-related variables must be considered when determining a prognosis for aphasia (see Table 1). While a prognosis may only represent a clinician’s ‘best guess’, the current literature offers evidence, that when integrated, could offer clinicians a framework to facilitate a more accurate evidence-based approach.

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<th>Variable</th>
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<td><strong>Patient-related variables</strong></td>
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<td><strong>Stroke-related variables</strong></td>
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+, positive evidence; *, mixed/unclear evidence; –, no significant evidence.
assessing a patient’s potential for recovery [7]. This paper highlights evidence that can serve as a guide for such evidence-based prognostic statements. Specifically, we report that while patient-related variables (age, gender, handedness, education and intelligence) do not appear to significantly influence aphasia prognosis; stroke-related variables such as initial stroke and aphasia impairment level, lesion size and lesion location, do influence recovery patterns. Clinicians are encouraged to consider these stroke-related prognostic indicators when faced with the arduous task of predicting an individual’s potential for functional recovery in post-stroke aphasia.

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