Correlates of Functional Outcome among Stroke Survivors in a Developing Country–A Prospective Community-based Study from India

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Stroke survivors (SS) are rising with higher incidence of stroke in developing countries. In addition to physical impairment, other factors such as cognition, social interaction, and depression determine the functional outcome after stroke. Considering the paucity of data from developing countries, we planned to determine the change in various functional parameters among SS. This community-based prospective study was carried out in Kolkata, India among 283 SS between 2006 and 2010. Functional outcome was assessed at baseline and at 3 annual follow-up visits using validated tools. A stepwise regression analysis was performed with demographic and stroke-related covariates against various measures of functional outcome. Result showed that mean Barthel Index score at baseline was 76.4 ± 30.8. Bengali version of mental status examination and Geriatric Depression Scale scores trended down over time with a negative regression coefficient of −2.2061 (standard error [SE], .0937) and −2.4488 (SE, .2145). Other outcomes did not change. Female gender, depression, and cognitive dysfunction had an unfavorable impact, whereas education correlated positively. In conclusions female gender and neuropsychiatric disturbances showed poor functional outcome compared with education, which correlates with better outcome. This information will be helpful for patients in developing countries for planning stroke rehabilitation. **Key Words:** Developing country—stroke—physical disability—stroke survivor—cognition—depression.

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Introduction

The incidence of stroke is increasing in developing countries because of demographic and epidemiologic transitions. Conversely, advances in diagnosis and management of acute stroke have also improved survival in hospital settings, resulting in an increased number of individuals living with different physical, cognitive, or affective sequelae of stroke. Functional outcomes of stroke in physical, cognitive, and affective domains have been primarily studied in clinical settings of developed countries, but such studies are limited in developing nations. It is essential to understand the time line and the local factors associated with stroke outcome to identify the focus of rehabilitation services. Stroke survivor’s rehabilitation is essential to become economically active and participate in civil life. Considering the rising prevalence of stroke in developing countries and particularly in India, and yet remaining gap in our understanding of functional status of stroke survivors (SS) in the community, we sought to describe the nature of change in various functional parameters among survivors at different time points after stroke, determine whether these parameters are interrelated, and identify putative socioeconomic and clinical associations. It is essential to understand the time line and the local factors associated with stroke outcome to identify the focus of rehabilitation services.

Methods

We followed up a cohort of 353 SS between 2006 and 2010 in an urban community in Kolkata, the largest city in eastern India. The research was approved by the Institutional Ethical Committee of Institute of Post Graduate Medical Education & Research, Kolkata, and informed consent was taken from each participant.

Study Population

The study area, the municipal limit of Kolkata, is the third largest metropolitan city in eastern India. It has a socioeconomically diverse population and about 80% literacy rate. It has an area of 185 km² and population of 4.58 million (Indian Census 2001). Between 30% and 40% of the population live in slums and are socioeconomically deprived.

Randomly Stratified Selection of Sample Population

The city is divided into 5200 units referred to as National Sample Survey Organization blocks by the Government of India. The details of this survey have been published. Briefly, based on type of dwelling and location, blocks have been grouped into 6 sampling frames (strata). Stratum I includes blocks across the city with predominant slums, where socioeconomically weaker families live in unhygienic, overcrowded conditions. Strata II through V include blocks in southern and northern parts of the city with either predominantly consolidated housing complexes or individual houses. Stratum VI includes blocks from the central business district of Kolkata, primarily comprising high-rise building complexes.

Aiming to screen a population of at least 100,000, 282 blocks were selected randomly, so that they proportionately represented all 6 strata. Experienced field workers screened subjects with stroke symptoms, using a validated World Health Organization–based questionnaire by visiting 50% of the households of each selected block so that individuals from diverse socioeconomic and educational backgrounds would be included. Screened patients who were found to have either symptoms or history of stroke were further examined by field physicians and these findings were reviewed by senior neurologists. A neurologist evaluated a random 10% of the screen negative participants, to check for accuracy of the screening process. Based on survey of these participants, a community-based stroke cohort was obtained.

Functional status of each SS was assessed at baseline (2006) and at 3 annual follow-up visits (2007–2009), using standardized, validated tools under the combined supervision of a doctor and a neuropsychologist. Physical function was assessed by Barthel Index (BI) and Everyday Abilities Scale for India (EASI). EASI scale was used to assess activities of daily living (ADL) such as independence in feeding, dressing, toileting, social participation, and decision making in personal and familial issues. Cognitive impairment and depression were evaluated by Bengali versions of Mini Mental State Examination (BMSE) and Geriatric Depression Scale (GDS), respectively. Kolkata Cognitive Screening Battery was administered to assess cognitive function in detail, in subjects who scored 1.5 standard deviations below normative values on BMSE. Two subscales (namely, social participation (SP) and instrumental activities of daily living (IADL) of Stroke Impact Scale had been modified from an original questionnaire for precision, brevity, and applicability in an Indian community setting. SP was used to assess participation in recreational activities, role functioning in family, and friendship and social activities. IADL assessed performance in outdoor activities such as shopping, managing finances, telephone, and conveyance. Intrarater and inter-rater validation of the Stroke Impact Scale questionnaire showed good-to-very good intraclass correlation coefficient values between .76 and .90.

Operational Definitions

Stroke was defined as “rapidly developing clinical sign of focal (or global) disturbance of cerebral function, with symptoms lasting 24 hours or more or leading to death, with no apparent cause other than vascular origin” (stroke subtypes). Dementia was defined based on...
Diagnostic and Statistical manual of Mental Disorders–3rd edition, revised (DSM-III-TR) criteria using scores and norms of Kolkata Cognitive Screening Battery and EASI. GDS score of greater than or equal to 21 indicated depression. BI scores were interpreted as follows: 80-100 = independent; 60-79 = needs minimal help for ADL; 40-59 = partially dependent; 20-39 = very dependent; and < 20 totally dependent. EASI was found to have a sensitivity of 80.3% and specificity of 90%. Diffuse shrinkage of cerebral cortex reported in computed tomography (CT) or magnetic resonance imaging scans was interpreted as cortical atrophy.

**Statistical Analysis**

Preliminary analysis was performed using MINITAB 16 software (Minitab, State College, PA), on each of the responses of BI, EASI, IADL, SP, BMSE, and GDS, to determine if the response changed over time from the baseline observation to the fourth year. Covariates included age, sex, education, stratum, income, occupation; habits such as tea and nicotine consumption, and clinical and radiological details of stroke. The response variable in this set of analyses was individual measures of physical, mood, and cognitive function (BI, EASI, IADL, SP, BMSE, and GDS), and the purpose of this set of analyses was to individually compare the response variables over each year, and thus determine whether the responses were progressively decreasing or remained invariant over successive periods of time. Progressive reduction in the scores over 4 years would indicate a decreasing trend. However, in each case the variable “time” was forced to stay in the model during the stepwise procedure. Many covariates were chosen in the final model for each case.

**Results**

The screened population of 100,802 matched with that of the city population, based on 2001 census data. In the stroke registry, 1041 cases (inclusive of prevalent and incident cases) were registered. There were 763 incident cases. Of the total cases, 527 subjects died. Among the causes of incident death (n = 467), which were followed over 7 years within the study period because of various reasons, 70.45% cases were due to first ever stroke, 19.27% due to recurrent stroke, 7% due to coronary artery disease, 64% due to epilepsy, and 2.56% due to other causes. A total of 160 cases were excluded because of various reasons such as absence (20), refusal (25), aphasia (20), dementia (39), ongoing psychosis (1), unclassifiable (1), and incomplete data (54) before commencement of survey by the baseline year. Among the incident cases (n = 763) who were followed up over 7 years, the cumulative percentage of death in different time interval was 33% in 7 days, 42% in 30 days, 48% in 1 year, 53% in 2 years, 56% in 3 years, 58% in 4 years, 60% in 5 years, 60.81% in 6 years, and 61% in 7 years.

Thus, a total of 353 samples with stroke were screened at baseline year (2006-2007) initially. Seventy individuals were excluded from this study due to presence of aphasia, other communication difficulties, attrition due to non-participation, and past psychiatric problems. Thus, our study sample consisted of 283 subjects who could be assessed at baseline. Subsequently, less subjects were assessed on annual follow-ups over 3 consecutive years (average interval, 8-12 months; Fig 1).

The demographic and clinical information has been described in Table 1. BI scores were available in 277 individuals at baseline, of whom 180 (64.98%) were totally independent, 35 (12.64%) needed minimal help for ADL, 21 (7.58%) were partially dependent, 17 (6.14%) were very dependent, and 24 (8.66%) were totally dependent. Mean scores of various functional outcomes at baseline have been mentioned in Table 2.

In linear models, no statistically significant change in the slope for mean scores of BI, EASI, IADL, and SP were observed over the follow-up period of 3 years (Table 2). In linear models, BMSE and GDS scores tended to decrease over time. Negative regression coefficients were –2061 (standard error, .0937) and –4488 (standard error, 2145) whereas \( R^2 \) (adjusted \( R^2 \)) were 50.05 (49.25) and 53.01 (51.29), respectively. These data indicated progressive gradual deteriorating cognitive function and improvement in depressive features. EASI scores increased over time, which suggests worsening of ability to carry out daily activities. Although clinically important, it was not statistically significant. Other outcome measures such as BI, IADL, and SP showed no change over time.

Table 3 lists the predictors of different domains having regression coefficient of \( P \) values less than .01. BMSE showed negative regression coefficient with cognitive dysfunction, depression, age of onset of stroke, female gender, nicotine, and number of CT lesions. GDS showed negative regression coefficient with education level and ischemic infarct and positive regression coefficient with cognitive dysfunction and female gender. Physical function as measured by BI, IADL, and EASI showed negative coefficient with education, cognitive dysfunction, depression, mixed type of stroke, cortical atrophy, and bilateral cerebral lesion. Social participation showed negative regression coefficient with education and cardiac pathology.

**Discussion**

We have longitudinally evaluated changes in physical functional status, social relationships, affective and cognitive domains over a period of 3 years in an urban sample of SS living in a developing country. The merits of the study are the following: community based, prospective, stratified random sampling, and use of validated scales in evaluation of functional parameters. Mean scores of functioning in basic and instrumental ADL remained stable over the
study period. Cognitive functions deteriorated, although depressive symptoms gradually improved. We did not find a statistically significant deterioration in physical functioning in our sample, possibly because of the heterogeneity of the sample or because assessments were done at different time intervals after index stroke. However all the cases have been assessed by the field doctors.19 As studies have shown that long-term recovery after stroke is possible,20,21 subjects were analyzed with different time latency after stroke, including after the initial 6 months22 of overt improvement. Decrease in GDS scores with passage of time can be explained by actual resolution of depressive thoughts due to better coping or due to cognitive dysfunction making it difficult to evaluate underlying depression.

Gender studies in SS have shown that women have poorer functional outcome after stroke with significantly more depression, limitations in ADL, physical and cognitive impairment.23,24 A recent study found that functional outcome, as measured by modified Rankin Scale, was worse at 3 months and at 1 year after stroke in women, although there was no difference in mortality.25 In another study of 108 ischemic SS from the Framingham Study, 34% of women were disabled at 6 months (BI < 60) compared with only 16% of men.26 Our study showed comparable results. Causes of gender differences in functional outcomes are not clear, although various explanations have been offered, such as comparatively higher age, poor prestroke function, more comorbidities such as depression, less social support, and more likelihood to be widowed.24 In our social setting, caregivers are invariably women.27 Thus, women have a higher chance of being neglected regarding proper physical, medical, emotional, or rehabilitative care and economical support when they themselves are afflicted with stroke.

There is a close yet complex relationship between depression and cognitive dysfunction. Depression may be a risk factor for dementia, coexist with it, be a clinical presentation of dementia,28 or an early manifestation because of a common neuropathologic correlate.29 Depression may afflict up to half of SS,30,31 and has a negative effect on functional independence after stroke.12 Similarly, depression has adversely affected EASI, IADL, and cognitive functions in our study. However, reasons for poor

Figure 1. Flowchart depicting number of stroke survivors (SS) assessed for functional status in different visits.
functioning in other domains may be multifactorial. Depressed SS are less likely to take part in active rehabilitation measures or adhere to treatment, which may contribute to the less favorable outcome in this group.32

We observed that cognitive dysfunction was more common in females and was also associated with higher age of onset of stroke and depression scores. Many previous studies have shown similar results, citing relationship with increased age33 and depression.34 In our study, cognitive dysfunction was associated with negative outcome regarding mood state affecting ADL both basic and instrumental.

Education was inversely related with many outcome parameters, namely cognitive status, mood state, and disability. Education increases cognitive reserve, and hence also predicts positive functional outcome.35 Paradoxically, social participation was lower with higher educational status. The more educated SS may have more options to pass leisure time in isolation, or they may be more conscious about their deficits and avoid socializing because of perceived stigma. Thus low and middle income countries having poor socioeconomic condition may be benefitted from better education.

SS with single CT lesion had better cognitive status and functional independence compared with those with multiple lesions. Bilateral involvement was related to worse scores in BI, which is expected, as multiple lesions in the brain will naturally have a larger volume of tissue loss, with a more deleterious effect on outcome. Presence of cortical atrophy was associated with higher EASI scores and greater impairment in ADL, whereas those without cortical atrophy had higher BMSE scores. Lesions in basal ganglia and thalamus may interfere with...
performance of frontal–subcortical circuits and consequently executive functions, thus explaining our finding of association of these lesions with worse social participation. Mixed stroke type, defined as having evidence of both hemorrhagic as well as ischemic in the same patient, carried a poorer prognosis as shown by BI, IADL, and EASI scores. Hemorrhagic stroke had a negative correlation with IADL scores only. Infarction had a negative regression coefficient with GDS scores indicating that those patients were less likely to have depressive symptoms.

There are differing views about the role of comorbidities in functional outcome of stroke. 36-38 In our study, cardiac dysfunction was the only comorbidity to have significant negative association with social participation. Cardiac problems may separately limit individual outdoor activities or may impose medical restriction on physical activities resulting in lower social participation.

In the present study, use of nicotine was associated with poorer scores in BMSE but better scores in BI. Consumption of tea expectedly resulted in improved social participation. Relationship between nicotine use and cognition is ambiguous. Nicotine is a protective agent against Alzheimer disease, and most studies have shown improved cognition with nicotine use, but some studies concluded that continued smoking correlates with lower BMSE scores in nondemented elderly individuals. 39

To the best of our knowledge, there is no community-based longitudinal prospective study from other developing countries including India focusing on the functional outcome with validated instruments after stroke. Ideally, predictive models of stroke outcomes should be based on population-based studies in which various potential predictors of stroke outcomes are described and adjusted for adequately and where standard diagnostic criteria and validated standardized measures of outcomes are used. 40

Our study suffers from a common limitation of high attrition rate. Not all patients could be assessed in the initial poststroke period as they were either hospitalized or still not well enough to participate in the study. Patients with aphasia or difficulty in communication were excluded because they could not be assessed properly. Ours is a heterogeneous stroke sample with varied age of presentations, different comorbidities, risk factors, different types, and levels of complications with differing disease durations. We could not take into account rehabilitative measures started in the hospital or undertaken by the caregivers during the early poststroke period, which may have important predictive values. India is a multiethnic country and only 30% of the population lives in urban area. Additionally because of large attrition of the sample, the result of this study could not be generalized.

In conclusion, our study suggests that measurement of functional outcome in SS living in the community in a developing country such as India, and their follow-up over time is feasible. Neuropsychiatric (depression and cognition), socioeconomic (lower educational level), demographic (female gender), and cultural factors can adversely affect outcome in SS. Avoidance and correction of those factors may improve the outcome. These findings will help in policy framing of health rehabilitation centers, whereas community-based day-to-day interventions may play a major role in improving the overall functioning and quality of life of the SS. Apart from physical rehabilitation, psychiatric consultation and cognitive rehabilitation are equally important.

### Table 3. Predictors of different functional outcome measures

<table>
<thead>
<tr>
<th>Response</th>
<th>Negative regression coefficient</th>
<th>Positive regression coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMSE</td>
<td>Cognitive dysfunction, depression, age of onset, female gender, and nicotine</td>
<td>Single lesion in CT and absent cortical atrophy</td>
</tr>
<tr>
<td>EASI</td>
<td>Education</td>
<td>Cognitive dysfunction, depression, age of onset, female gender, neurologic history, family history, mixed stroke type, multiple lesions on CT, and presence of cortical atrophy</td>
</tr>
<tr>
<td>GDS</td>
<td>Education and infarction</td>
<td>Cognitive dysfunction and female gender</td>
</tr>
<tr>
<td>BI</td>
<td>Cognitive dysfunction, neurologic history, family history, female sex, mixed type of pathology, bilateral affection, multiple lesion on CT, and cortical atrophy</td>
<td>Education, nicotine, and cortical lesion</td>
</tr>
<tr>
<td>IADL</td>
<td>Cognitive dysfunction, depression, female sex, hemorrhagic stroke, mixed stroke, and cortical atrophy</td>
<td>Cortical lesion, migraine, and duration</td>
</tr>
<tr>
<td>SP</td>
<td>Education, cardiac problem, lesion in thalamus, and basal ganglia</td>
<td>Tea and neurologic history</td>
</tr>
</tbody>
</table>

**Abbreviations:** BI, Barthel Index; BMSE, Bengali Mini Mental Status Examination; CT, computed tomography; EASI, Everyday Abilities Scale for India; GDS, Geriatric Depression Scale; IADL, Instrumental Activities of Daily Living; SP, social participation.
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Author contribution: Dr Malay Ghosal conceptualized the project, conducted field visits, monitored the progress of the project, and wrote the first draft. Dr Prabir Burman undertook detailed statistical analysis. Dr Vineeta Singh reviewed and significantly contributed to the article. Dr Sujata Das collected data in the field (related to cognition). Dr Neelanjana Paul collected data in the field (related to depression). Dr Biman Kanti Ray undertook field visits and monitored the study. Dr Avijit Hazra monitored the study and revised the article. Dr Tapas Kumar Banerjee conceptualized and monitored the study. Dr Arindam Basu overall reviewed the article and contributed suggestion regarding statistical contribution. Dr Arijit Chaudhuri made the sampling strategy. Dr Shyamal Kumar Das conceptualized, monitored the study, exercised overall supervision, and finalized the draft.

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