



Trends in stroke outcomes at hospital discharge in first-ever stroke patients: Observations from the Malaysia National Stroke Registry (2009–2017)



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ARTICLE INFO

Keywords:

Stroke outcomes
Functional dependence
Independence
Death

ABSTRACT

Background: Stroke outcomes could be a quality indicator across the continuum of care and inform stroke management policymaking. However, this topic has rarely to date been studied directly.

Aims: We sought to investigate recent trends in stroke outcomes at hospital discharge among first-ever stroke patients.

Methods: This was an analysis of data from the Malaysia National Stroke Registry. Patients aged 18 years or older documented as having a first episode of stroke in the registry were recruited. Subsequently, the comparison of proportions for overall and sex-specific stroke outcomes between years (from 2009 to 2017) was conducted. The primary outcome was modified Rankin Scale score, which was assessed at hospital discharge, and each patient was categorized as follows: 1) functional independence, 2) functional dependence, or 3) death for analysis.

Results: This study included 9361 first-ever stroke patients. Approximately 36.2% (3369) were discharged in an independence state, 53.1% (4945) experienced functional dependence, and 10.8% (1006) patients died at the time of hospital discharge. The percentage of patients who were discharged independently increased from 23.3% in 2009 to 46.5% in 2017, while that of patients discharged in a disabled state fell from 56.0% in 2009 to 45.6% in 2017. The percentage of death at discharge was reduced from 20.7% in 2009 to 7.8% in 2017. These findings suggest that the proportions of stroke outcomes at hospital discharge have changed significantly over time ($p < 0.001$), and there was a significant sex-related difference in stroke outcomes at hospital discharge following first stroke episode ($p < 0.001$).

Conclusions: Our data indicate there has been a significant change in stroke outcomes over the past nine years in Malaysia. This information ought to be considered in ongoing efforts of tertiary stroke prevention.

1. Introduction

Cardiovascular and circulatory diseases, including cerebrovascular diseases (stroke), are the leading cause of death in Malaysians, contributing to 22.62% of deaths in Ministry of Health hospitals and 26.4% in private hospitals in 2017 [1]. Further, cerebrovascular diseases were the largest contributor toward deaths in Malaysia, as evidenced by the World Health Organization (WHO) data reporting a prevalence of 11.3% [2] and local data reporting that of 15.2 to 15.6% for such between 2009 and 2014 [3]. The age-adjusted death rate for stroke was indicated to be 71.50 per 100,000 people, with Malaysia ranking 113 in the world [2]. With regard to sex, the local statistics have consistently

(from 2009 to 2014) highlighted that stroke was the second highest contributor of deaths among males and the leading cause of death among females [3].

Disability, over and above death, is a devastating clinical endpoint in stroke. A comprehensive Malaysia burden of disease report revealed that stroke was the third leading cause of total disability-adjusted life years, making up 7.9%, in 2014 [3]. Even worst, the foremost longitudinal Malaysia stroke statistics have reported the existence of an escalating stroke incidence over the years [4]. Apart from its impact on survivors, stroke exerts a financial and emotional burden on their families and imposes a negative effect on the health care system [5,6]. Stroke appears largely to be a disease that kills and cripples mankind.

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<https://doi.org/10.1016/j.jns.2019.04.015>

Received 18 February 2019; Received in revised form 19 March 2019; Accepted 9 April 2019

Available online 11 April 2019

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Studies published using the Malaysia National Stroke Registry data have previously described the incidence and prevalence rates and reported on the demographics of stroke patients, their risk factors, and the stroke management protocols used; however, the trends in stroke outcomes at hospital discharge were not included [4,7–12]. There have been several local hospital-based (single-center) investigations that reported stroke outcomes at hospital discharge: one reported 37 out of 158 (23.42%) first-ever stroke patients died in the ward [13], while another revealed none were completely independent and seven out of 51 (13%) ambulated with gait aids [14]. A more recent study additionally showed 23.4% first-ever stroke patients died during admission [15]. However, to our knowledge, no study in Malaysia has adequately elucidated the statistics trend of stroke outcomes at hospital discharge, particularly following the first-stroke event.

Stroke outcomes are ordinarily mortality and disability or dependency. The examination of the stroke outcomes in Malaysians could potentially provide an estimation of the magnitude of death and dependency in the population poststroke. It is interesting to explore the up-to-date trends in stroke outcomes at hospital discharge; which either appear to be improving with the advancement of medical technology and the introduction of the stroke management guidelines or deteriorating with the unhealthy lifestyle and ballooning of health risk behaviors [16,17]. This is needed especially in the contemporary scenario of the growing prevalence of diabetes, hypertension, and hypercholesterolemia, together with the fact that at least two-thirds of Malaysian adults have at least one cardiovascular risk factor [16].

By examining the trends in stroke outcomes at hospital discharge in first-ever stroke populations in Malaysia, we will be able to gather important information for health care authorities to use in formulating an effective strategy for addressing the aftermath of the stroke event. In addition, stroke presented a higher burden in females versus males [3], and this finding motivated us to investigate the sex differences in stroke outcomes. Thus, the objectives of this study were to describe the trends in stroke outcomes at hospital discharge in first-ever stroke patients in Malaysia and to compare the proportions of stroke outcomes between years overall and according to sex for the period of 2009 to 2017.

2. Material and methods

Data were retrieved from the Malaysia National Stroke Registry. This registry is a national system established for the non-mandatory notification of stroke admissions in Malaysia public hospitals since July 2009 [18]. The target population consisted of first-ever stroke patients aged 18 years or older in Malaysia. The inclusion criteria were clinical diagnosis of stroke, age 18 years or older, notification provided to the registry between July 2009 and December 2017, and documentation of the first episode of stroke occurring in a certain individual in the registry. Principal hospital discharge diagnoses of ischemic stroke, intracerebral hemorrhage, and subarachnoid hemorrhage based on the WHO classifications [19] were included, whereas those with transient ischemic attack or unknown or unclassified stroke type were excluded from this study. Information used in the present analysis included age, sex, ethnicity, presence of comorbidities, family history of stroke, WHO stroke classification, length of hospital stay, and outcomes at hospital discharge.

Stroke outcomes were assessed using the modified Rankin Scale (mRS) at hospital discharge. This is a seven-grade scale, ranging from the least to most severe outcome, as follows: (0) no symptoms, (1) no significant disability despite symptoms, (2) slight disability, (3) moderate disability, (4) moderately severe disability, (5) severe disability, and (6) dead [20]. The outcomes collected were categorized into the three groups of functional independence (FI, mRS scores = 0–2), functional dependence (FD, mRS scores = 3–5) and death (mRS score 6) [5,21]. Data from the Malaysia National Stroke Registry were downloaded in a comma-separated values format and were read and analyzed using RStudio IDE version 1.1.456 [22] and R software

version 3.5.1 [23].

The proportion for each stroke outcome, p , was calculated as the number of patients who experienced the stroke outcome at discharge for the year among the total number of patients discharged for the year. The 95% confidence interval (CI) was calculated as follows: proportion $\pm z^* \sqrt{[p(1-p)/n]}$. The reported 95% CI of the proportion is presented without a p -value, as it suffices to inform readers about the statistical significance, direction, and strength of the effect [24]. We also reported the means and standard deviations (SDs) for the variables of age and length of hospital stay. Bar charts were plotted to display the trends in stroke outcomes overall and by sex. The chi-squared test of homogeneity was used to determine whether the proportions of stroke outcomes differed between years overall and by sex [25]. The level of significance was set at $p < 0.05$.

The study received approval from both the Human Ethics Committee of Universiti Sains Malaysia (USM/JEPeM/1711–576) and the Malaysia Research and Ethics Committee, Ministry of Health Malaysia. Confidentiality of the data was kept throughout the study and only the researchers had access to the data.

3. Results

We obtained the records of 9809 stroke patients with their event documented as the first episode and excluded 4.6% (448/9809) of them whose mRS were not assessed at discharge, yielding a total of 9361 eligible study subjects for analysis. Table 1 presented the proportion distributions of first-ever stroke patients overall and based on stroke outcomes (i.e. FI, FD and death) at hospital discharge according to selected demographic and clinical characteristics — that is, age, sex, ethnicity, presence of comorbidities (e.g. hypertension, diabetes mellitus, hypercholesterolemia), family history of stroke, WHO stroke classification, and length of hospital stay.

Overall, approximately 36.2% (3385/9361) of the first-ever stroke patients were discharged with FI status, 53.0% (4964/9361) had FD, and 10.8% (1012/9361) patients died at the hospital. We found that the proportions of stroke outcomes (FI, FD and death) were significantly different between males and females with a chi-squared (χ^2) value of 46.43 ($p < 0.001$). More male patients were discharged with a FI state as compared with female patients, with most females being discharged with FD. Interestingly, it was observed also that the proportion of death in males was higher than that in females at hospital discharge.

The trend values showing the proportion of stroke outcomes from July 2009 to December 2017 are displayed in Fig. 1. Notably, the overall proportions of stroke outcomes have changed significantly ($\chi^2 = 287.26$, $p < 0.001$) from 2009 to 2017. Our study revealed that the proportion of FI has increased sharply from 23.3% to 46.4%; the proportion of FD has decreased from 56.0% to 45.8%, and the proportion of death has also decreased gradually from 20.7% to 7.8% in 2009 and 2017, respectively. Table 2 and Fig. 2 demonstrate the trends in stroke outcomes by sex, wherein similar trends were akin to the overall trends seen over multiple years. That is, the trends in the proportions of stroke outcomes have changed significantly from 2009 to 2017 for males ($\chi^2 = 189.39$, $p < 0.001$) and females ($\chi^2 = 108.49$, $p < 0.001$), respectively.

4. Discussion

In the present registry-based longitudinal study, we considered the trends in stroke outcomes (i.e. death, FD, and FI) at hospital discharge from 2009 to 2017 in Malaysia. The study demonstrated four key findings. First, stroke deaths declined. Second, the proportion of stroke patients achieving a FI state at hospital discharge increased gradually. Third, the proportion of patients suffering from FD fluctuated but ultimately has decreased overall in the past decade. We also observed the proportions of stroke outcomes at hospital discharge were significantly different among the nine years both overall and according to sex.

Table 1

The demographic and clinical characteristics of the first-ever stroke patients registered in the Malaysia National Stroke Registry from July 2009 to December 2017 overall and based on their stroke outcomes at hospital discharge ($n = 9361$).

Characteristics	Stroke outcomes at hospital discharge				
	Total (N = 9361)	Functional independence (N = 3385)		Death (N = 1012)	
		n (%)		n (%)	
Age (years) ^a	62.11 (12.72)	59.93 (12.19)		64.18 (13.59)	
Sex					
Female	4117 (43.9)	1356 (32.9)		415 (10.1)	
Male	5244 (56.1)	2029 (38.7)		597 (11.4)	
Ethnicity					
Malay	7643 (81.6)	2619 (34.3)		862 (11.3)	
Chinese	927 (10.0)	424 (45.7)		75 (8.1)	
Indian	210 (2.2)	83 (39.5)		22 (10.5)	
Bumiputera	456 (4.9)	221 (48.5)		31 (6.8)	
Foreigner	125 (1.3)	38 (30.4)		22 (17.6)	
Comorbidities (Presence)					
Hypertension	6467 (69.0)	2278 (35.2)		707 (10.9)	
Diabetes Mellitus	3766 (40.2)	1384 (36.7)		388 (10.3)	
Hyperlipidemia	2137 (22.8)	760 (35.6)		177 (8.3)	
Family history of stroke					
No	8816 (94.2)	3192 (36.2)		919 (10.4)	
Yes	545 (5.8)	193 (35.4)		93 (17.1)	
WHO classification					
ICH	1593 (17.0)	296 (18.6)		392 (24.6)	
IS	7684 (82.1)	3074 (40.0)		593 (7.7)	
SAH	84 (0.9)	15 (17.9)		27 (32.1)	
Length of stay (days) ^b	5.31 (9.4)	4.2 (11.7)		6.56 (9.24)	

Abbreviations: WHO, World Health Organization; ICH, intracerebral hemorrhage; IS, ischemic stroke; SAH, subarachnoid hemorrhage.

^a Mean (SD).

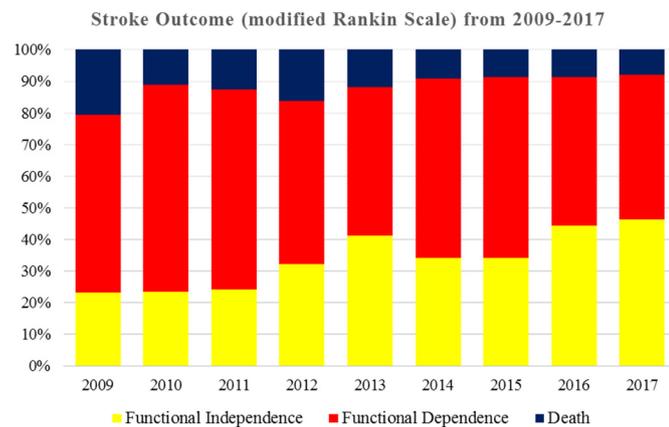


Fig. 1. Stacked bar chart showing the proportions of stroke outcomes at hospital discharge in first-ever stroke patients in Malaysia from 2009 to 2017. The trends in stroke outcomes changed significantly over the period ($\chi^2 = 287.26$, $p < 0.001$). Functional independence (mRS 0–2), functional dependence (mRS 3–5) and death (mRS 6).

In general, Malaysians are dying at an older age, due to the improvement in overall health outcomes [3]. At this stage of understanding, it is believed that the decline in stroke deaths seen is due to the successful implementation of cardiovascular risk factor control interventions [26] and the introduction of standardized clinical practice guidelines [17]. The National Strategic Plan for Non-communicable Diseases for example has placed an emphasis on efforts to strengthen the disease prevention and control programs in Malaysia. It advocates for a holistic approach to health promotion and clinical management under the Ministry of Health, involving partnering with other sectors for environmental and lifestyle interventions [27]. The decline in stroke deaths could simply mean that the burden to managing stroke survivors has increased [5].

Elderly people reportedly would prefer a painless death over any

disability from stroke [28], but it was demonstrated that, over the past decade, almost half of stroke survivors were disabled at hospital discharge. It is true that this proportion has shown a downward trend; however, in Malaysia, there is no universal policy on insurance coverage for long-term care and the cost of rehabilitation equipment [29]. Besides, obstacles for stroke rehabilitation include limited availability of and access to rehabilitation services and care such as physical, occupational, or movement therapy; speech therapy or cognitive rehabilitation; and recreation therapies [30]. Malaysia public health centers as well as are facing difficulties with optimizing poststroke care at the primary care level and have urged the consideration of four important needs, as follows: access to rehabilitation services, a multi-disciplinary care approach with synchronized care linking tertiary centers with primary care, post discharge stroke care guidelines, and family and caregiver support [31]. Our findings reinforce the paramount demand for tertiary stroke prevention in terms of rehabilitative care and the prevention of stroke recurrence.

The results regarding the sex differences in stroke outcomes ties in well with the findings of previous studies, wherein women generally have been found to have poorer functional outcomes [32,33]. It is difficult to explain such results within the context of the pathophysiology of stroke, as the contributions of sex hormones, genes, and social and lifestyle factors are unknown [32]. It is believed that, apart from improving post discharge stroke care, further research should look for ways to provide social support for female stroke survivors. This suggestion is made on account of two key studies. One found that elderly women were more susceptible to a deterioration in functional outcomes between three months and 12 months poststroke [34]. Furthermore, it was documented that women had a higher chance of being institutionalized as compared to men (odds ratio: 3.50) at three to six months poststroke [33]. Considering these findings, it is clear that women's health should be taken care of, as a stroke event could overshadow everything else in their life, due to them being at a higher risk of becoming disabled and institutionalized poststroke.

In addition, geographic disparities in stroke outcome might suggest an important area for future research [35]. The nature of non-

Table 2

The proportions and corresponding 95% confidence intervals for stroke outcomes in first-ever stroke patients overall and by sex, in years 2009 and 2017 (n = 9361).

Stroke outcome	Overall	Male	Female
	Proportion (95% Confidence Interval)		
FI	36.2 (35.66, 36.66)	38.7 (38.02, 39.36)	32.9 (32.20, 33.67)
FD	53.0 (52.51, 53.54)	49.9 (49.23, 50.61)	57.0 (56.21, 57.75)
Death	10.8 (10.47, 11.13)	11.4 (10.95, 11.82)	10.1 (9.61, 10.55)
In year 2009			
FI	23.3 (19.35, 27.20)	23.4 (18.14, 28.73)	23.1 (17.23, 28.92)
FD	56.0 (51.43, 60.64)	51.6 (45.32, 57.81)	61.5 (54.79, 68.29)
Death	20.7 (16.93, 24.45)	25.0 (19.59, 30.41)	15.4 (10.38, 20.39)
In year 2017			
FI	46.4 (44.79, 47.97)	50.2 (48.06, 52.30)	41.4 (38.98, 43.77)
FD	45.8 (44.18, 47.36)	42.7 (40.56, 44.75)	49.9 (47.45, 52.31)
Death	7.8 (6.99, 8.71)	7.1 (6.08, 8.26)	8.7 (7.37, 10.12)

Note: Confidence interval = proportion ± z*√ [p (1-p)/n].

Abbreviations: FI, Functional Independence; FD, Functional Dependence; p, proportion.

mandatory stroke notifications made it difficult to ascertain whether or not there are higher rates in certain regions of Malaysia so as to identify possible hotspot localities. For instance, the United States long ago (1940) observed higher rates of stroke mortality in the southeastern region and defined that area as the “stroke belt” [26]. In spite of the Malaysia government being highly committed to the principle of universal health coverage [36], pertaining to stroke care in Malaysia, only approximately 66 registered neurologists [4] and 60 neurosurgeons [37] serve in government, private and university hospitals in Malaysia. We strongly encourage the enhancement of stroke notifications so as to inform policymakers to allocate health care resources more effectively.

The implications of this study on daily practices reinforced the vitality of optimal stroke control. The proportion of stroke survivors at hospital discharge has increased substantially, a trend that is attributed to higher health quality loss across the lifespan. The stroke outcomes observed in first-ever stroke patients could provide insight for formulating effective strategies to use in addressing the aftermath of stroke events. Malaysia perhaps could adopt and adapt the implementation cycle for combating cardiovascular disease to surmount the devastating effects of stroke by enhancing the engagement of stakeholders (e.g. providers and physicians, patients and the populace, policymakers and payers) in addressing gaps in controlling stroke disease [38]. A more holistic poststroke community care was again proved in this study to be in need.

A major source of limitation is due to the source of secondary data, in terms of the aspects of data quality and data accuracy [39,40]. We cannot deny the presence of some sample selection biases. Nevertheless, the sample was heterogeneous with respect to demographic characteristics and geographical locations, as it included patients from 19 public hospitals nationwide. The present study excluded patients with missing data of the variables of WHO stroke diagnosis and outcomes at hospital discharge. Similarly to other research conducted using administrative data [41], the stroke outcomes are subject to misclassification and imperfect accuracy. However, this research aimed to describe relative rather than absolute changes in the proportion of stroke outcomes over time and also did not strive to determine the causality for such trend. Attempts to minimize the degree of information bias included training of the staff in charge of stroke notifications, regular frequent audits, and quality assurance activities. Biases in the present study using registry data were diminished. We believe that as well as looking for better interrater reliability in obtaining stroke outcomes, more attempts could be made to encourage stroke notifications, with a focus on obtaining insightful information to ascertain stroke “hotspots”.

Our findings provide a good starting point for discussion and further research. Based on our limited search, we are unable to compare our results to those of studies outside Malaysia. We believe future research could fruitfully explore this issue further by replicating results in a

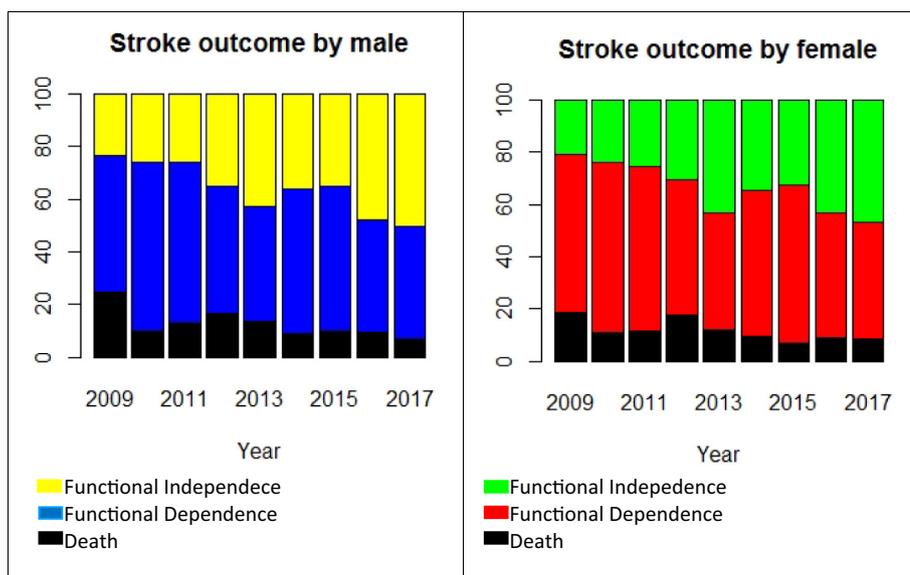


Fig. 2. Bar chart showing the proportions of stroke outcomes at hospital discharge, by sex, in first-ever stroke patients in Malaysia from 2009 to 2017. The trends in stroke outcomes changed significantly over the period for males ($\chi^2 = 189.39, p < 0.001$) and females ($\chi^2 = 108.49, p < 0.001$). Functional independence (mRS 0–2), functional dependence (mRS 3–5) and death (mRS 6).

larger scale, in particular where better surveillance data could be generated. This is paramount to guide us for better prevention and management. Besides that, a point to note is that while the study does provide new knowledge on the stroke outcomes, it does not reflect the extent to which the disability affects the stroke survivors in performing their activity of daily livings, in which Barthel Index would be a more appropriate measurement [42]. This may constitute the object of future studies.

5. Conclusion

In summary, our study reported up-to-date trends in stroke outcomes at the time of hospital discharge from a nationwide hospital-based registry. We observed a trend toward lower rates of stroke deaths and the state of FD, along with an increasing trend regarding the proportion of patients achieving FI; these findings reached statistical significance from 2009 to 2017. On the basis of the amount of disability at hospital discharge following the first stroke event, we suggest the need to optimize post discharge stroke care at the community level. Although biological and social factors explaining sex-specific disability trends remain unanswered, the provision of adequate social support should be emphasized for women poststroke. The use of a holistic approach to minimize the dreadful stroke burden in individuals, their families, and the community is paramount.

Acknowledgement

Upmost acknowledgement should be prioritized to the Director General of Health Malaysia for his permission to publish this paper. The authors would like to express sincere gratitude to one and all for their willingness to contribute in this paper.

Statement of ethics

This work has gained ethical approval from both the Human Research and Ethics Committee (HREC) of Universiti Sains Malaysia (USM/JEPeM/1711-576) and Malaysia Research and Ethics Committee, Ministry of Health Malaysia (NMRR-17-2500-38534). The HREC is in compliance with the Declaration of Helsinki, International Conference on Harmonization Guidelines, Good Clinical Practice Standards, Council for International Organizations of Medical Sciences Guidelines, World Health Organization Standards and Operational Guidance for Ethics Review of Health-Related Research and Surveying and Evaluating Ethical Review Practices, Institutional Review Standard Operating Procedures (with Institutional Review Board number IRM 00004494), and Local Regulations and Standards in Ethical Review.

Disclosure statement

The authors declare that there is no conflict of interest in this work.

Funding sources

This work was not funded.

Author contributions

All authors have made substantial contributions in various stages of the study.

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All authors have given the final approval of the version submitted. We agree to be accountable for all aspects of the work in ensuring the accuracy or integrity of the work has been adequately addressed.

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