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Impact of adherence to key performance indicators on mortality among patients managed for ischemic stroke

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INTRODUCTION

Stroke is a leading cause of mortality and disability globally, and its burden over the past decades has increased significantly. The economic, psychological and social costs implications of stroke have run into huge budgets. The burden of stroke is projected to keep rising until more effective prevention strategies are widely adopted. Ischemic stroke is more common; however, hemorrhagic stroke is responsible for more deaths, and disability-adjusted life-years lost. All strokes should be considered for immediate treatments. Acute treatment for ischemic strokes aims to restore brain tissue perfusion and could be achieved using thrombolytic agents or endovascular procedures, or both. Reports have shown an increasing number of patients being diagnosed with acute stroke, especially in Asia Pacific. Data from the National Neurology Registry (NNeurR) of Malaysia shows that the incidence of ischemic stroke has increased by 29.5% annually from 2010 to 2014. In Malaysia, stroke is among the top five leading causes of death and as one of the top 10 causes of hospitalization. It is also among the top five diseases with the highest burden of disease based on disability-adjusted life years. The NNeurR and other studies have revealed that adherence to the evidence-based guidelines and outcomes in stroke care have not been systematically evaluated in clinical practice.

Keywords
Stroke; Brain Ischemia; Risk Factors; Anticoagulants; Guideline Adherence; Professional Practice; Mortality; Registries; Prospective Studies; Survival Analysis; Malaysia

Abstract
Background: Stroke is a leading cause of death worldwide. The cases of acute ischemic stroke are on the increase in the Asia Pacific, particularly in Malaysia. Various health organizations have recommended guidelines for managing ischemic stroke, but adherence to key performance indicators (KPI) from the guidelines and impact on patient outcomes, particularly mortality, are rarely explored.

Objective: This study aims to evaluate the impact of adherence to key performance indicators on mortality among patients managed for ischemic stroke.

Methods: We included all first-ever ischemic stroke patients enrolled in the multiethnic Malaysian National Neurology Registry (NNeurR) - a prospective cohort study and followed-up for six months. Patients’ baseline clinical characteristics, risk factors, neurological findings, treatments, KPI and mortality outcome were evaluated. The KPI nonadherence (NAR) and relationship with mortality were evaluated. NAR>25% threshold was considered suboptimal.

Results: A total of 579 first-ever ischemic stroke patients were included in the final analysis. The overall mortality was recorded as 23 (4.0%) in six months, with a median (interquartile) age of 65 (20) years. Majority of the patients (dead or alive) had partial anterior circulation infarct, PACI (43.5%; 34.0%) and total anterior circulation infarct, TACI (26.1%; 8.8%). In addition, DVT prophylaxis (82.8%), anticoagulant for atrial fibrillation (AF) patients (48.8%) and rehabilitation (26.2%) were considered suboptimal. The adherence to the KPI was suboptimal, particularly in DVT prophylaxis, anticoagulant for AF patients and rehabilitation. These findings reflect the importance of continuous quality measurement and implementation of evidence recommendations in healthcare delivery to achieve optimal outcome among stroke patients.

Conclusion: KPI nonadherence was associated with mortality among ischemic stroke patients. The adherence to the KPI was suboptimal, particularly in DVT prophylaxis, anticoagulant for AF patients and rehabilitation. These findings reflect the importance of continuous quality measurement and implementation of evidence recommendations in healthcare delivery to achieve optimal outcome among stroke patients.
demonstrate significant and sustained improvements in the United States’ stroke care.\textsuperscript{16,17,23} However, treatment of AIS has mainly remained conservative with usual clinical practice, which often falls short of guideline-established goals and only a small percentage of Asian patients undergo thrombolysis.\textsuperscript{24}

Although Malaysia lacks stroke units, it has in place KPIs, which serve as a quality measurement of stroke healthcare delivery. Nine KPIs, adapted from the Centers for Disease Control and Prevention’s Paul Coverdell National Acute Stroke Registry, are used to assess the compliance rate of stroke care delivery: (1) thrombolytic therapy administration, (2) antiplatelet therapy within 48 hours of admission, (3) venous thromboembolism prophylaxis, (4) anticoagulation therapy for atrial fibrillation, (5) discharge on antiplatelet therapy, (6) discharge on statin medication, (7) dysphagia screening, (8) stroke education, and (9) rehabilitation.\textsuperscript{25} The performance indicators are standards of care that show inadequacy if eligible patients do not receive that standard of care. Thus, these indicators are used to monitor adherence to guidelines, and support transfer of new evidence into routine practice.\textsuperscript{26}

Many countries produce their guidelines, and updates occur at varying intervals, but the impact on outcomes remain unvalidated.\textsuperscript{27} Despite the wide the availability of guidelines for the prevention and treatment of stroke, many patients do not still receive these recommended interventions.\textsuperscript{28,29} Stroke Council of the Malaysian Society of Neurosciences has developed a guideline on ischemic stroke management with the latest version in 2012.\textsuperscript{3,11} While the guidelines are developed to bridge the research - clinical practice gap, evidence regarding their use, implementation, and impact on patients’ outcome, including mortality, disability, and costs remain limited.\textsuperscript{25,26,29} To date, there is no report on the mortality outcome in association with adherence to guidelines for stroke care and performance in Malaysia. Therefore, our study was aimed to assess the impact of KPI adherence on mortality among ischemic stroke patients.

METHODS

The Stroke Registry in Malaysia was founded in 2009. The multiethnic NNeuR is a prospective cohort program that gathers data on patient’s admitted into the hospital in any of the participating hospitals of the states in the country and diagnosed with stroke. NNeuR is a multicenter, hospital-based registry which aims to introduce extensive epidemiological information on the stroke statistics, trend, and management in Malaysia. It is funded by the Ministry of Health Malaysia (MOH) with the support from the National Network Clinical Research Centre, Ministry of Health. The complete details on the stroke registry have been previously described elsewhere.\textsuperscript{19,20,30} Further details about the registry can also be found through the link http://wcrm.org.my/nneur/. NNeuR study protocol was approved by the Ministry of Health Medical Research and Ethics Committee (MREC) (NMRR-08-1631-3189).

Patients’ data were extracted from the Malaysian National Stroke Registry, NNeuR (2009-2016). Only adult patients (>18 years of age), diagnosed with first-ever acute ischemic stroke (AIS) based on the WHO’s criteria were included in the study.\textsuperscript{31} Clinical first-ever ischemic stroke was defined as an acute focal neurological deficit lasting >24 hours with no cause other than a cerebrovascular disease in patients who have not had a previous stroke. We excluded recurrent stroke, non-ischemic stroke, and stroke mimics. Based on the features of the initial neurological examination, the patients were grouped according to the Oxfordshire Community Stroke Project (OCSB) stroke subtypes; total anterior circulation infarct (TACI), partial anterior circulation infarct (PACI), lacunar infarct (LACI) and posterior circulation infarct (POCI).\textsuperscript{32} The clinical diagnosis was also confirmed by neuro-imaging findings; computer tomography (CT) or magnetic resonance imaging (MRI). Other patients baseline characteristics reviewed include; socio-demographics, vascular risk factors such as hypertension, diabetes, hyperlipidaemia, ischemic heart disease, atrial fibrillation, hyperuricaemia, medical history, stroke family history, smoking, alcohol, medication use, stroke KPIs and patient status during hospitalization and recovery. The Stroke Registry in Malaysia was founded in 2009. The multiethnic NNeuR is a prospective cohort program that gathers data on patient’s admitted into the hospital in any of the participating hospitals of the states in the country and diagnosed with stroke. NNeuR is a multicenter, hospital-based registry which aims to introduce extensive epidemiological information on the stroke statistics, trend, and management in Malaysia. It is funded by the Ministry of Health Malaysia (MOH) with the support from the National Network Clinical Research Centre, Ministry of Health. The complete details on the stroke registry have been previously described elsewhere.\textsuperscript{19,20,30} Further details about the registry can also be found through the link http://wcrm.org.my/nneur/. NNeuR study protocol was approved by the Ministry of Health Medical Research and Ethics Committee (MREC) (NMRR-08-1631-3189).

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Table 1. Baseline characteristics of the acute ischemic stroke patients

| Features                  | Death (%) | Alive (%) | p-value |
|---------------------------|-----------|-----------|---------|
| Age (Median, interquartile)| 65 (20)   | 59 (16)   | 0.012   |
| Female gender             | 9 (39.1)  | 234 (42.1)| 0.478   |
| OCSP classification       |           |           | 0.004*  |
| LACI                      | 4 (17.4)  | 235 (42.8)|         |
| PACI                      | 10 (43.5) | 189 (34.0)|         |
| POCI                      | 2 (8.7)   | 69 (12.4) |         |
| TACI                      | 6 (26.1)  | 49 (8.8)  |         |
| Unclassified              | 1 (4.3)   | 10 (1.8)  |         |
| Risk Factors              |           |           |         |
| Hypertension              | 19 (82.6) | 376 (67.6)| 0.096   |
| Diabetes Mellitus         | 13 (56.5) | 226 (40.6)| 0.098   |
| Hyperlipidaemia           | 8 (34.8)  | 172 (30.9)| 0.426   |
| Ischemic heart disease    | 4 (17.4)  | 53 (9.5)  | 0.182   |
| Atrial fibrillation       | 1 (4.3)   | 17 (3.1)  | 0.523   |
| Hyperuricaemia            | 1 (4.3)   | 21 (3.8)  | 0.597   |
| Family history            | 1 (4.3)   | 58 (10.4)| 0.299   |
| Smoking                   | 18 (78.3) | 274 (49.3)| 0.005*  |
| Alcohol                   | 0 (0)     | 16 (2.9)  | 0.518   |

Oxfordshire community stroke project (OCSB); Lacunar infarct (LACI); Partial anterior circulation infarct (PACI); Posterior circulation infarct (POCI); Total anterior circulation infarct (TACI); *= significance at p<0.05 using Chi-square and Mann-Whitney U tests respectively.
discharge as described in the NNeuR. Patients were followed up for six months for mortality. These evaluations were made by the attending physicians and data uploaded onto the NNeuR. In the event of a patient’s death, the date and cause of death were noted and identified as either given by relatives or general practitioners.

The primary outcome, KPI nonadherence (NAR) was calculated based on the eight KPIs for each included ischemic stroke patient. The NAR value initially starts at zero and increase by one, for each practice not according to the guideline recommendation, to a maximum of 8. The KPIs included are anti-platelet within 48 hours of admission, dysphagia screening before feeding, DVT prophylaxis within 48 hours of admission for non-ambulatory patients, stroke education, rehabilitation, anticoagulant for AF patients, antiplatelet upon discharge and lipid-lowering therapy upon discharge. All measures indicate the proportion of eligible patients who received the intervention as described. The optimal adherence is defined as the proportion of patients who received all of the performance measure interventions for which they were eligible. The NAR, >25% threshold was considered sub-optimal. The secondary study outcome was death within 6-months follow-up. The NAR was categorised into two groups (NAR <2 vs NAR >2), as the NAR recorded ranged from 0 to 5, and NAR >2 is reported to be sub-optimal, as supported by previous studies.

Data were presented descriptively as frequencies, percentages, median and interquartile range in tables and figures. Chi-square test, Mann-Whitney U test, and Kaplan-Meier survival analysis were conducted using IBM SPSS Statistics version 20.0. p<0.05 was considered statistically significant.

**RESULTS**

Patients demographics, stroke sub-type and vascular risk factors are shown in Table 1. This study involved a total of five hundred and seventy-nine (579) first-ever ischemic stroke patients. The results also showed a total of 23 (4.0%) patients died within six months, with a median (interquartile) age of 65 (20) years. Also, the deceased were mostly PACI 10 (43.5%) and TACI 6 (26.1%) with hypertension 19 (82.6%), smoking 18 (78.3%) and diabetes 13 (56.5%) as the most common risk factors. The overall survival status was found to be significantly associated with smoking (p=0.005) and OCSP classification (p=0.004).

The major areas of nonadherence based on KPIs and the relative percentage are reported in Table 2. Of the 579 patients included in this study, and considering NAR >25% threshold, NAR was common in DVT prophylaxis 480 (82.8%), anticoagulant for AF 289 (49.8%), and rehabilitation 152 (26.2%). The best performance based on NAR was in dysphagia screening before oral intake 9 (1.6%) and lipid-lowering agent at discharge 11 (1.9%).

This study also revealed that most of the stroke patients had NAR <2 according to their survival status. Also, NAR <2 was significantly associated with a decrease in mortality (OR 0.16; 95% CI 0.02-0.12) compared to NAR>2. Further details are shown in Table 3.

The survival curves of the two groups of patients with NAR <2 and >2 are illustrated in Figure 1. The Kaplan-Meier survival analysis for mortality event among the stroke patients showed a significant difference of survival rate with NAR (p=0.05), with the patients in the group of NAR >2 having a higher chance of death during the 6-months follow up compared to those in NAR <2, as shown in Figure 1.

**DISCUSSION**

This study was designed to investigate the quality of ischemic stroke care based on key performance indicators enshrined in the Malaysian stroke registry and the management guideline, and to establish a possible relationship with stroke patients’ short-term survival. Using the standard set of performance indicators, we found significant gaps in the quality of care provided for ischemic stroke patients. Some areas of stroke care quality were found to be suboptimal, cutting across the in-hospital and discharge indicators, particularly in DVT prophylaxis, anticoagulant for AF, and rehabilitation. These encounters may have impacted negatively to the short-term survival outcome of the stroke patients. The consequences might widen further with longer follow-ups. While it is

| Features          | KPI nonadherence (%) | p-value   | OR (95% CI)     |
|-------------------|----------------------|-----------|-----------------|
| Status            |                      |           |                 |
| Alive             | 433 (77.9)           | 1 (4.3)   | 0.039*          | 0.16 (0.02-0.12)|
| Alive             | 433 (77.9)           | 123 (22.1)| Ref             |                 |
| KPI nonadherence (NAR) | *significant at p<0.05 |           |                 |
possible that in our setting, physicians still prefer a medical approach based on personal experience to an evidence-based one, especially in the choice of pharmacological treatments. Inadequate documentation could also explain the low performance. Studies have demonstrated that adherence to stroke performance indicators and other processes of care were associated with improved outcomes among acute stroke patients.

The management of vascular risk factors is essential to reduce the risk of recurrent stroke. Our study also identifies sub-optimal adherence with secondary prevention measures, particularly at discharge, including the use of anticoagulant for AF patients. For stroke patients with atrial fibrillation, only advanced tertiary hospitals have the facility to monitor international normalised ratio. Many physicians, especially in the lower-level hospitals, therefore, may be reluctant to prescribe warfarin. This might be a reason for the reduced use of anticoagulants in NNeuR. It could also be possible that the status of bleeding risk in this cohort is unknown; therefore, a high risk of bleeding may also explain why the anticoagulants are not being prescribed. For patients with ischemic stroke, the use of antiplatelets on admission or discharge is strongly recommended to reduce the risk of recurrence. However, only less than 5% of eligible patients did not receive antiplatelets during hospitalisation or at discharge, which is consistent with findings of other studies about the use of secondary prevention methods for stroke care.

This study established an association between mortality and performance indicators non-adherence, though not adjusted for confounders. The risk of death was found to be associated with increasing NAR. Previous studies have reported a reduction in mortality and the risk of death to be directly associated with the level of compliance to stroke guidelines. Besides, an improved functional outcome, such as motor and daily activities, was linked to higher compliance. Our study also established a significant association between OCSP clinical type of stroke and smoking with survival status. Also, the most common risk factors identified were hypertension, diabetes and hyperlipidemia may have partly contributed to the deterioration of health status and possibly the death among the stroke patients. A strong relationship between stroke risk factors such as hypertension, diabetes, dyslipidemia, smoking, age, and poor outcome have been reported. Smoking remains a singular most significant social risk in stroke. A study reported that smoking might be related to up to 49% (95%CIs, 22-67) of the strokes cases of the population. This finding suggests that smoking exposed individuals to the risk of stroke and complications such as death.

Standard stroke management procedures recommended by both local (e.g. Malaysian stroke CPG) and international (e.g. AHA/ASA guidelines) organizations include but not limited to complete history, vital signs, physical, neurological and cardiovascular assessment, early reperfusion and mobilization, secondary prevention modalities. These procedures may have strongly influenced the outcomes of stroke patients. Though our study did not evaluate whether an individual nonadherence area was related to evidence of prior failure to proceed with further management, the importance of such specific areas, like early mobilization, investigations, and acute monitoring have been established in previous studies. The real importance of these results reflects that a good clinical practice achieved through the adoption of guidelines can improve the health professionals’ approach to managing stroke cases. It means that patients are routinely managed better from presentation to discharge and follow-ups.
Our study also demonstrated significant association between KPI nonadherence and mortality. Implying that with stroke patients with less NAR, there is a less likely hood of mortality cases. Our findings are supported by similar studies that demonstrated optimal compliance with in-hospital and discharge measures to be associated with better clinical and functional outcomes. Patients with better outcome might have been those admitted to hospitals with a higher quality of stroke care and might have received an additional in-hospital intervention. Improving the quality of care must, therefore, be a national priority. DVT prophylaxis has been consistently associated with significant benefits in the USA and Canada. Early anticoagulant use for ischemic stroke patients with AF is associated with a reduction in early and late case fatality. Similarly, stroke rehabilitation is one key measure that ensures continuity of care and is associated with improved patient short and long-term outcomes.

Our study is the first attempt to verify the possible impact of KPI adherence on stroke short-term survival outcome from the Malaysian stroke population. The findings of this study could further validated with a more robust extensive multi-randomized study. The study is not without limitations. It is a longitudinal observational study based on secondary data from the Malaysian stroke registries. As of 2016, there were only 15 participating hospitals in the whole country. As such the sample size may be small to generalise our findings. Also, the initial objectives of the register are to determine epidemiologic data including the demographic pattern of stroke patients, the stroke types, the risk factors for stroke, stroke management and complications, and not to improve the adherence of stroke performance measures. Nevertheless, the registry includes all necessary information to treat, measure clinical evolution, and define etiology with the indicators that contribute to a quality evaluation in stroke care. It is also possible that some performance measures were not properly documented on the medical records before transfer into the registry, and it would mean that some of the performance measures may be wrongly estimated. To account for this, only patients with complete data were included in the analysis.

CONCLUSIONS

Nonadherence to key performance indicators was demonstrated to be associated with mortality among ischemic stroke patients. The adherence to guidelines in acute ischemic stroke management was sub-optimal, particularly in DVT prophylaxis, rehabilitation and anticoagulant for AF patients. These findings suggest the importance of continuous quality improvement in stroke care in Malaysia. Our study also reflects the need for full implementation of guidelines, raising awareness and professional education on stroke management among health professionals.

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CONFLICT OF INTEREST

The authors have no conflict of interest to disclose.

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