

A prospective study of stroke sub-type from within an incident population in Tanzania

Richard W Walker, Ahmed Jusabani, Eric Aris, William K Gray, Dipayan Mitra, Mark Swai

Objectives. We aimed to establish the pathological types of stroke in two incident populations in Tanzania, one rural and one urban, and to examine the clinical utility of the Siriraj and Allen scores in identifying stroke sub-types.

Design. This prospective community-based study identified cases as part of a stroke incidence study. Each patient underwent a full assessment including recording demographic information, taking a medical and drug history, and physical examination. A computed tomography (CT) head scan was used to classify strokes as resulting from a cerebral haemorrhage or ischaemia. The results were compared with the Siriraj and Allen scores, obtained from clinical findings.

Results. One hundred and thirty-two incident stroke cases were identified in the rural Hai demographic surveillance site (DSS) and

69 in the urban Dar-es-Salaam DSS; 63 patients with stroke due to ischaemia or cerebral haemorrhage from Hai and 17 from Dar-es-Salaam had a CT scan within 15 days of the stroke. Stroke was identified as due to ischaemia in 52 cases (82.5%) and to cerebral haemorrhage in 11 (17.5%) in Hai, and as due to ischaemia in 14 cases (82.4%) and to cerebral haemorrhage in 3 (17.6%) in Dar-es-Salaam. In both sites Siriraj and Allen scores were found to be of little value in predicting stroke sub-type.

Conclusions. The ratio of ischaemic to haemorrhagic stroke is much higher in our cohort than previously reported in sub-Saharan Africa, and is closer to that in high-income countries.

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Stroke is an increasingly important cause of premature death and chronic disability in many low- and middle-income countries.¹ Worldwide, strokes resulting from ischaemia are much more common than those due to cerebral haemorrhage. A study of 3 000 hospitalised first-in-a-lifetime stroke patients across 22 countries found that overall 22% of strokes were due to cerebral haemorrhage and 78% to ischaemia.² The percentage due to cerebral haemorrhage was lowest in high-income countries, where 9% were due to cerebral haemorrhage and 91% to ischaemia. Sites in Africa (Mozambique, Nigeria, South Africa, Sudan and Uganda) had the highest percentage of strokes due to cerebral haemorrhage, at 34%.

In Europe and North America, studies have suggested rates of 10 - 20% for stroke due to cerebral haemorrhage.³⁻⁵ Data on stroke sub-type in sub-Saharan Africa (SSA) are much less reliable, with rates of 29 - 57% reported for cerebral haemorrhage.⁶⁻⁹ This variability in the incidence of stroke sub-types, both within SSA and between SSA and high-income countries, may partly be due to the low numbers in

these studies, lack of access to computed tomography (CT) scanning equipment, and the fact that all were hospital-based. In SSA, because of limited resources, often only patients with more severe symptoms are admitted to hospital. Such patients are likely to have had a stroke due to cerebral haemorrhage rather than an ischaemic stroke. In SSA neuro-imaging devices are often not available or too expensive for routine use, and the diagnosis of stroke sub-type is usually made clinically.¹⁰ Nevertheless, clinicians must know the type of stroke that has occurred to avoid administration of anticoagulant, antiplatelet or thrombolytic agents to patients who have had a cerebral haemorrhage.

Studies have investigated the utility of clinical diagnostic tools, such as the Allen (or Guy's hospital) score¹¹ and the Siriraj score,¹² in high-income countries,¹³⁻¹⁶ but there have been few from SSA.⁶⁻⁹ Of 222 strokes in consecutive black patients admitted to a Johannesburg hospital, 152 (68.5%) were due to cerebral haemorrhage and 70 (31.5%) ischaemic, and both the Allen and Siriraj scores were found to be poor at differentiating intracerebral haemorrhage from ischaemia as the cause.⁶

Our primary aim was to establish the incidence of stroke sub-type in an incident population in Tanzania, East Africa.¹⁷ Secondary aims were to establish the utility of the Siriraj and Allen scoring systems in the diagnosis of stroke sub-type and to examine individual clinical examination findings as predictors of stroke sub-type.

Patients and methods

Ethical approval was obtained from the National Institute of Medical Research, Tanzania, and the Newcastle and Northumberland Joint Ethics Committee, UK.

Recruitment

The Tanzanian Stroke Incidence Project (TSIP) prospectively recruited patients from 15 June 2003 until 15 June 2006 at two demographic surveillance sites (DSS) in Tanzania: rural Hai and urban Dar-es-Salaam.¹⁷ Both sites have been described previously as part of the Adult Morbidity and Mortality Project (AMMP).¹⁸ The TSIP was extensively advertised within the study areas and paid for participants to attend hospital and receive treatment for the first year

North Tyneside General Hospital, Rake Lane, North Shields, Tyne and Wear, and Institute of Health and Society, University of Newcastle-upon-Tyne, UK
Richard W Walker, MD

Kilimanjaro Christian Medical Centre, Moshi, United Republic of Tanzania
Ahmed Jusabani, MD
Mark Swai, MD

Department of Neurology, Muhimbili University Hospital, Dar-es-Salaam, United Republic of Tanzania
Eric Aris, MD

North Tyneside General Hospital
William K Gray, PhD

Department of Neuroradiology, Newcastle General Hospital, Newcastle-upon-Tyne
Dipayan Mitra, MB BS

Correspondence to: R Walker (Richard.walker@nhct.nhs.uk)

after their stroke. A system of verbal autopsy (VA) was also used to identify stroke cases that were only identified after death. During the 3-year study 453 incident strokes (132 by TSIP and 346 by VA, with 25 overlapping cases) were identified in Hai and 183 in Dar-es-Salaam (69 by TSIP and 114 by VA, with no overlapping cases).

Measurement

Demographic information, social history, past medical history and information about events around the time of the stroke were recorded as part of the TSIP. All participants underwent medical assessment and examination including recording blood pressure no less than 7 days after the stroke, pulse rate, cardiac auscultatory findings, height and weight, physical function (Barthel index,¹⁹ modified Rankin scale²⁰), neurological status (communication, swallowing, vision, muscle activity, sensation), an echocardiogram, a chest radiograph and a CT brain scan. Hypertension was defined as a blood pressure higher than 160 mmHg systolic or 90 mmHg diastolic no less than 7 days after the stroke. CT scans were analysed independently by a general radiologist at Kilimanjaro Christian Medical Centre, Tanzania (AJ) and a neuro-radiologist from Newcastle General Hospital, UK (DM), and the diagnoses of ischaemic stroke and cerebral haemorrhage were compared. In the event of a difference of opinion with regard to diagnosis, a consensus was reached. An intracerebral bleed was classified as stroke due to cerebral haemorrhage. Findings of ischaemia, haemorrhagic infarct, or no evidence of stroke were classified as ischaemic stroke. No evidence of stroke on the CT scan was taken as evidence of ischaemic stroke, since CT would indicate cerebral or subarachnoid haemorrhage less than 15 days after a stroke. More than 15 days after a stroke, some cases of stroke due to small haemorrhage may not be apparent on the CT scan, leading to possible misclassification. Cases diagnosed as subarachnoid haemorrhage by CT scan were excluded. The Siriraj score¹² and Allen score¹¹ were calculated based on clinical findings, as originally described.

Statistics

The data were quantitative and collected at a nominal, ordinal and interval/ratio level. Data were analysed using standard statistical software, PASW-18 for Windows (SPSS, Chicago, IL, USA). All variables were found to be non-normally distributed (Kolmogorov-Smirnov test) and so did not meet parametric assumptions. The Mann-Whitney U-test and Pearson's chi-square test (categorical data) were therefore used to characterise differences between groups. Correlation between variables was established by point biserial test.

Results

Hai district

One hundred and thirty-two incident stroke cases were identified in the Hai DSS between 15 June 2003 and 15 June 2006 as part of the TSIP study. One case of subarachnoid haemorrhage was excluded from further analysis. The median time from incident stroke to assessment interview was 10 days (range 0 - 252 days). Although every attempt was made to assess and examine stroke cases as soon after incident stroke as possible, 22 died shortly before being identified and 2 died before a full examination could take place. In addition, 44 cases did not have a CT scan until 15 days or more after the stroke owing to a delay in identification as a stroke case or in attendance at hospital after identification. Therefore, 63 cases had a CT head scan within 15 days of incident stroke. The mean age of the 63 cases was 67.4 years (range 23 - 94, standard deviation (SD) 14.0) and 34 (54.0%) were male. Age and gender of those who had a CT scan within 15 days are compared with those who did not in Table

I. Fifty-two (82.5%) had had an ischaemic stroke and 11 (17.5%) a stroke due to cerebral haemorrhage.

Of patients who had a CT scan within 15 days, 5 with ischaemic stroke had had one previous stroke and 2 with ischaemic stroke had had two previous strokes. No patient with a haemorrhagic stroke had had a previous stroke. Stroke sub-type was not significantly associated (chi-square test or point-biserial correlation) with age, sex, 3 - 6-year mortality, findings on the electrocardiogram or echocardiogram, smoking history, alcohol consumption or a pre-stroke diagnosis of angina, diabetes or hypertension.

Dar-es-Salaam district

Sixty-nine stroke cases were identified in the Dar-es-Salaam DSS between 15 June 2003 and 15 June 2006 as part of the TSIP study. The median time from incident stroke to assessment interview was 37 days (range 0 - 491 days). Although every attempt was made to assess and examine stroke cases as soon after incident stroke as possible, 7 died shortly before being identified. In addition, 45 cases did not have a CT scan until 15 days or more after the stroke owing to a delay in identification as a stroke case or in attendance at hospital after identification. Of the 17 cases who had a CT scan within 15 days of incident stroke, 14 (82.4%) had had an ischaemic stroke and 3 (17.6%) a cerebral haemorrhage. For 1 case age could not be reliably obtained. The mean age of the remaining 16 cases was 57.7 years (range 30 - 84, SD 15.4) and 8 (47.1%) were male. Age and gender of those who had a CT scan within 15 days are compared with those who did not in Table I.

Of those who had had a CT scan within 15 days, 1 patient with haemorrhagic stroke had had a previous stroke. There were no significant differences in age, gender, Barthel index or blood pressure readings between the two groups. Given the limited number of cases, it was not possible to find meaningful associations of stroke sub-type with clinical findings.

The odds of having a stroke due to cerebral haemorrhage (rather than due to ischaemia) in Hai compared with Dar-es-Salaam were 1.01 (95% confidence interval (CI) 0.49 - 2.09).

Siriraj and Allen scores

A Siriraj score and an Allen score could be calculated for 60 of the 63 patients from Hai and 16 of the 17 from Dar-es-Salaam who had a CT scan within 15 days of incident stroke. The remaining 4 patients did not have sufficient information recorded. The comparisons between Siriraj and Allen scores and CT scan results are shown in Table II for Hai and in Table III for Dar-es-Salaam.

For Hai patients, using an alternative cut-off of Siriraj score <1 for ischaemic stroke and ≥ 1 for cerebral haemorrhage, an accuracy of 70.0% was achieved; using a cut-off of Allen score ≤ 27 for ischaemic stroke and >27 for cerebral haemorrhage, an accuracy of 74.6% was achieved (Table IV). For Dar-es-Salaam patients using an alternative cut-off of Siriraj score ≤ 1 for ischaemic stroke and >1 for cerebral haemorrhage and a cut-off of Allen score ≤ 20 for ischaemic stroke and >20 for cerebral haemorrhage, an accuracy of 81.2% was achieved in both cases (Table V).

Hypertension

Hai district

Using a cut off of >160 mmHg systolic or 90 mmHg diastolic for hypertension, 50 (48.1%) of 104 participants who had their blood pressure recorded at interview had hypertension. Of these 50, 31 (62.0%) reported a history of hypertension, 21 (42.0%) were currently taking antihypertensives, 24 (48.0%) had been taking antihypertensives before their stroke, 30 (60.0%) had had their blood

Table I. Demographic information for patients with CT scan within 15 days and those without CT scan or CT scan done after 15 days

			CT scan carried out within 15 days	CT scan not carried out within 15 days	Significance of difference
Hai	N		63	68	
	Age	Mean	67.4	70.0	U=1836.0, z=-1.411, p=0.158
		Range	23 - 94	29 - 100	
		SD	14.065	15.515	
		95% CI	63.90 - 71.00	66.24 - 73.76	
	Barthel index	Mean	7.64	10.26	U=965.0, z=-1.896, p=0.058
		Range	0-20	0-20	
		SD	7.644	6.886	
		95% CI	5.80 - 9.49	8.12 - 12.41	
	Diastolic blood pressure	Mean	98.1	91.2	U=1159.5, z=-1.064, p=0.288
		Range	60.0 - 181.0	50.0 - 134.0	
		SD	26.247	19.326	
		95% CI	991.35 - 104.91	85.35 - 97.10	
	Systolic blood pressure	Mean	154.9	151.7	U=1212.0, z=-0.712, p=0.476
		Range	60.0 - 260.0	80.0 - 284.0	
SD		37.719	35.548		
95% CI		145.12 - 164.61	140.92 - 162.54		
Gender	Males (N (%))	34 (54.0)	35 (51.5)	$\chi^2(1)=0.082, p=0.861$	
Dar-es-Salaam	N		17	52	
	Age	Mean	57.8	62.4	U=342.500, z=-1.064, p=0.292
		Range	30 - 84	29 - 82	
		SD	15.356	13.499	
		95% CI	50.02 - 65.47	58.64 - 66.02	
	Barthel index	Mean	19.88	19.53	U=359.500, z=-0.189, p=1.000
		Range	19 - 20	6 - 20	
		SD	0.332	2.186	
		95% CI	19.72 - 20.04	18.88 - 20.18	
	Diastolic blood pressure	Mean	90.12	97.03	U=282.500 z=-1.271, p=0.207
		Range	63.5 - 122.5	60.0 - 133.5	
		SD	18.881	18.007	
		95% CI	80.88 - 99.37	91.77 - 102.29	
	Systolic blood pressure	Mean	149.25	158.66	U=310.500, z=-0.812, p=0.423
		Range	84.0 - 216.0	101.0 - 234.0	
SD		36.960	35.110		
95% CI		131.14 - 167.36	148.40 - 168.92		
Gender	Males (N (%))	8 (47.1)	30 (57.7)	$\chi^2(1)=0.585, p=0.576$	

pressure monitored in the past 12 months, and 15 (30.0%) had never had their blood pressure measured. Having hypertension was not

significantly associated with stroke sub-type ($\chi^2(1)=0.842, p=0.559$), with 6 of the 11 who had a cerebral haemorrhage and 24 of the 49

Table II. CT scan results compared with Siriraj and Allen scores for Hai patients

		CT scan result		Total
		Haemorrhage	Ischaemia	
Siriraj score	Stroke due to cerebral haemorrhage	7	15	22
	Ischaemic stroke	3	21	24
	Indeterminate	1	13	14
	Total	11	49	60
	$\kappa^{*\dagger}$	0.238	0.107	
	Sensitivity*	0.636	0.429	
	Specificity*	0.694	0.727	
	Positive predictive value*	0.318	0.875	
	Likelihood ratio for a positive score*	2.078	1.571	
	Likelihood ratio for a negative score*	0.524	0.785	
	Accuracy	0.467 (0.609 with indeterminate scores removed)		
Allen score	Stroke due to cerebral haemorrhage	7	18	25
	Ischaemic stroke	1	17	18
	Indeterminate	3	14	17
	Total	11	49	60
	$\kappa^{*\dagger}$	0.180	0.205	
	Sensitivity*	0.636	0.347	
	Specificity*	0.633	0.909	
	Positive predictive value*	0.280	0.944	
	Likelihood ratio for a positive score*	1.733	3.813	
	Likelihood ratio for a negative score*	0.575	0.718	
	Accuracy	0.400 (0.558 with indeterminate scores removed)		

*Value refers to statistic for cases with stroke sub-type (haemorrhage or ischaemia) v. all other cases, as such indeterminate cases are included.
†Values indicate the level of agreement between the score and the CT scan result: 0.0 - 0.2 slight agreement; 0.2 - 0.4 fair agreement; 0.4 - 0.6 moderate agreement; 0.6 - 0.8 good/substantial agreement; 0.8 - 1.0 almost perfect agreement.³³

who had an ischaemic stroke (and had blood pressure measured) having hypertension. Using a lower cut-off of $\geq 140/90$ mmHg, used by some authors, 77 participants (73.3%) were hypertensive.⁵

Dar-es-Salaam district

Using the 160/90 mmHg cut-off, of 61 participants who had their blood pressure recorded at interview, 37 (60.7%) had hypertension. Of these, 21 (56.8%) reported a history of hypertension, 14 (37.8%) were currently taking antihypertensives, 7 (18.9%) had been taking hypertensives before their stroke, 11 (29.7%) had had their blood pressure monitored in the past 12 months, and 17 (45.5%) had never had their blood pressure measured. Using the lower cut-off (140/90 mmHg), 45 participants (73.8%) were hypertensive. Having hypertension was not significantly associated with stroke sub-type ($\chi^2(1)=0.788$, $p=0.550$), with 2 of the 3 who had a cerebral haemorrhage and 5 of the 13 who had an ischaemic stroke (and had blood pressure measured) having hypertension. Hypertension was not significantly associated with stroke sub-type. Using the lower cut-off (140/90 mmHg), 45 (73.8%) participants were hypertensive.

The odds of having hypertension in Dar-es-Salaam compared with Hai were 1.67 (95% CI 0.95 - 2.92).

Discussion

Our prospective study of incident stroke cases occurring in a rural and an urban area of Tanzania, East Africa, reveals a lower incidence of stroke due to cerebral haemorrhage compared with ischaemic stroke than in previous studies in SSA.^{2,6-9} Considering only those patients seen within 15 days after their stroke, the percentage of haemorrhagic and ischaemic strokes was similar in both areas. The percentage of strokes due to cerebral haemorrhage and the mean age of participants were similar to studies in high-income countries.^{2,5,14,21} Participants were much older than in previous studies from SSA.^{2,5,6,9} In a resource-poor setting younger people may be more likely to be taken to hospital.

The lack of data on cases picked up by the VA system (i.e. patients who died soon after their stroke), and including only those cases identified by TSIP who were able to have a CT scan within 15 days of stroke, mean that our data may have a bias. We cannot discount the possibility that patients who died rapidly following stroke, or were unable to have a CT scan for other reasons, may have been more likely to have had a cerebral haemorrhage. Our percentage of strokes due to haemorrhage was around half of that for SSA reported in the INTERSTROKE study, in which stroke patients were recruited from hospital admissions only if they had had a CT scan.² Whether this

Table III. CT scan results compared with Siriraj and Allen scores for Dar-es-Salaam patients

		CT scan result		Total
		Haemorrhage	Ischaemia	
Siriraj score	Stroke due to cerebral haemorrhage	2	2	4
	Ischaemic stroke	0	7	7
	Indeterminate	1	4	5
	Total	3	13	16
	$\kappa^*\dagger$	0.455	0.304	
	Sensitivity*	0.667	0.538	
	Specificity*	0.846	1.000	
	Positive predictive value*	0.500	1.000	
	Likelihood ratio for a positive score*	4.331	-	
	Likelihood ratio for a negative score*	0.394	0.462	
	Accuracy	0.562 (0.818 with indeterminate scores removed)		
Allen score	Stroke due to cerebral haemorrhage	1	1	2
	Ischaemic stroke	1	8	9
	Indeterminate	1	4	5
	Total	3	13	16
	$\kappa^*\dagger$	0.294	0.186	
	Sensitivity*	0.333	0.615	
	Specificity*	0.923	0.666	
	Positive predictive value*	0.500	0.888	
	Likelihood ratio for a positive score*	4.325	1.848	
	Likelihood ratio for a negative score*	0.721	0.577	
	Accuracy	0.562 (0.818 with indeterminate scores removed)		

*Value refers to statistic for cases with stroke sub-type (haemorrhage or ischaemia) v. all other cases, as such indeterminate cases are included.
 †Values indicate the level of agreement between the score and the CT scan result: 0.0 - 0.2 slight agreement; 0.2 - 0.4 fair agreement; 0.4 - 0.6 moderate agreement; 0.6 - 0.8 good/substantial agreement; 0.8 - 1.0 almost perfect agreement.³³

difference reflects regional differences in stroke risk factors, an underestimate of stroke due to cerebral haemorrhage in our study (due to early death of those having had a haemorrhage), or an over-estimate of stroke due to cerebral haemorrhage in the INTERSTROKE study (due to those with haemorrhage being more likely to be hospitalised), is not clear. However, reports of stroke sub-type incidence from hospital-based studies are likely to be unrepresentative of the entire population of those having strokes. In a UK-based study the odds of being admitted to hospital having had a primary intracerebral haemorrhage were 2.54 those of being admitted having had an ischaemic stroke.²²⁻²³ Furthermore, we have previously reported that in Tanzania only 56% of stroke deaths occur in hospitals, suggesting that it may not be possible to draw firm conclusions regarding the relative proportions of stroke sub-types from hospital-based studies.²⁴ We therefore suggest this study is likely to represent the most accurate estimate of stroke sub-type incidence in SSA to date.

Previous studies comparing white and black stroke populations have found a higher incidence of stroke due to cerebral haemorrhage in black populations with a higher incidence of risk factors for cerebral

haemorrhage, specifically hypertension.^{2,5, 25-26} In our study, although hypertension was found in 48.1% of cases in Hai and 60.7% in Dar-es-Salaam, it was not significantly associated with a higher incidence of cerebral haemorrhage. Studies of the general population have indicated an age-standardised rate of hypertension in the Hai DSS of 13.1% in men and 13.3% in women, and in the Dar-es-Salaam DSS of 18.5% in men and 22.0% in women using a cut off of >160/90 mmHg, indicating higher levels of hypertension in those who have had a stroke than in the general population.²⁷ Other risk factors for stroke such as smoking, alcohol consumption, diabetes, angina and cardiac function (auscultation, ECG and echocardiogram) were not significantly associated with stroke sub-type. Swai *et al.*²⁸ noted a lower prevalence of risk factors for coronary heart disease and ischaemic stroke (smoking, alcohol consumption, serum cholesterol, dyslipidaemia) in the Hai district than in many high-income countries.

Studies in the USA have noted the roles of race and genetics, and of racial differences in socio-economic status, diet and lifestyle, in predicting stroke sub-type incidence.^{25-26,29-30} Nevertheless, Owolabi *et al.*⁵ suggested that even when comparing cohorts of urban black

Table IV. CT scan result compared with Siriraj and Allen score, with new cut-offs for Hai patients

		CT scan result		Total
		Haemorrhage	Ischaemia	
Siriraj score	Cerebral haemorrhage (>1)	8	15	23
	Ischaemic stroke (\leq 1)	3	34	37
	Total	11	49	60
	κ	0.296		
	Sensitivity	0.727	0.694	
	Specificity	0.694	0.727	
	Accuracy	0.700		
Allen score	Cerebral haemorrhage (>27)	7	9	33
	Ischaemic stroke (\leq 27)	4	40	30
	Total	11	49	63
	κ	0.385		
	Sensitivity	0.636	0.816	
	Specificity	0.816	0.636	
	Accuracy	0.746		

Table V. CT scan result compared with Siriraj and Allen scores with new cut-offs for Dar-es-Salaam patients

		CT scan result		Total
		Haemorrhage	Ischaemia	
Siriraj score	Cerebral haemorrhage (\geq 1)	3	3	6
	Ischaemic stroke (<1)	0	10	10
	Total	3	13	16
	κ	0.556		
	Sensitivity	1.000	0.769	
	Specificity	0.769	1.000	
	Accuracy	0.812		
Allen score	Cerebral haemorrhage (>20)	2	2	4
	Ischaemic stroke (\leq 20)	1	11	12
	Total	3	13	16
	κ	0.455		
	Sensitivity	0.667	0.846	
	Specificity	0.846	0.667	
	Accuracy	0.812		

Africans and urban Caucasian Europeans the incidence of stroke due to cerebral haemorrhage, and associated risk factors, is still higher in Africans.

Urban dwellers from Africa have a higher incidence of hypertension than those from rural communities, with a rise in blood pressure seen on migration from the countryside to cities.³¹⁻³² In Hai 73.3% and in Dar-es-Salaam 73.8% of participants were hypertensive (cut-off \geq 140/90 mmHg), compared with 99% of hypertensive stroke patients using the same cut-off in Ibadan, Nigeria.⁵ Although not statistically significant, the Hai cohort had lower rates of hypertension than the Dar-es-Salaam cohort. This may in part be due to the relatively good coverage of primary health care services in Hai compared with SSA as a whole,²⁷ which in turn may account for the fact that over 60% of

those with hypertension in the Hai DSS had had their blood pressure monitored in the 12 months before interview, compared with less than 30% in Dar-es-Salaam.

Both the Siriraj and Allen scoring systems are poor at classifying strokes into sub-types. This is not surprising given that, of the clinical findings used to calculate the Siriraj and Allen scores, only level of consciousness 24 hours after admission was significantly associated with CT scan result in the Hai cohort. Clinicians need to rule out cerebral haemorrhage before commencing treatment with anticoagulants, antiplatelets or thrombolytics. In differentiating cerebral haemorrhage from non-cerebral haemorrhage strokes, the Siriraj score was marginally better than the Allen score in both Hai and Dar-es-Salaam. However, low specificity and sensitivity

suggest that it would be of little clinical use. Connor *et al.*⁶ in South Africa came to similar conclusions, although we have found even lower levels of agreement between clinical score and CT scan result. Employing new cut-off scores increases the performance of both scores, although their clinical use is still questionable.

Conclusion

To the best of our knowledge this is the first prospective study of stroke sub-types in an incident population in SSA. The incidence of stroke due to cerebral haemorrhage is lower than previously reported, and similar to rates seen in high-income countries. Given the lack of CT scanning equipment in SSA there remains a need for a clinically effective screening tool for determining stroke sub-type.

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