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Soetomo score: score model in early identification of acute haemorrhagic stroke

Ocena Soetomo: model oceny we wczesnym rozpoznaniu ostrego udaru krwotocznego

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Abstract

Aim of the study: On financial or facility constraints of brain imaging, score model is used to predict the occurrence of acute haemorrhagic stroke. Accordingly, this study attempts to develop a new score model, called Soetomo score. **Material and methods:** The researchers performed a cross-sectional study of 176 acute stroke patients with onset of ≤24 hours who visited emergency unit of Dr. Soetomo Hospital from July 14th to December 14th, 2014. The diagnosis of haemorrhagic stroke was confirmed by head computed tomography scan. There were seven predictors of haemorrhagic stroke which were analysed by using bivariate and multivariate analyses. Furthermore, a multiple discriminant analysis resulted in an equation of Soetomo score model. The receiver operating characteristic procedure resulted in the values of area under curve and intersection point identifying haemorrhagic stroke. Afterward, the diagnostic test value was determined. **Results:** The equation of Soetomo score model was (3 × loss of consciousness) + (3.5 × headache) + (4 × vomiting) – 4.5. Area under curve value of this score was 88.5% (95% confidence interval = 83.3–93.7%). In the Soetomo score model value of ≥–0.75, the score reached the sensitivity of 82.9%, specificity of 83%, positive predictive value of 78.8%, negative predictive value of 86.5%, positive likelihood ratio of 4.88, negative likelihood ratio of 0.21, false negative of 17.1%, false positive of 17%, and accuracy of 83%. **Conclusions:** The Soetomo score model value of ≥–0.75 can identify acute haemorrhagic stroke properly on the financial or facility constrains of brain imaging.

Key words: Soetomo score, acute haemorrhagic stroke, diagnostic test

Streszczenie

Cel: W przypadku ograniczeń finansowych lub lokalizacyjnych w zakresie obrazowania mózgu stosowany jest model oceny, który ma pomóc przewidzieć wystąpienie ostrego udaru krwotocznego. W niniejszym opracowaniu podjęto próbę opracowania nowego modelu oceny, nazwanego oceną Soetomo. **Materiał i metoda:** Autorzy przeprowadzili przekrojowe badanie 176 pacjentów z ostrym udarem, który wystąpił w ciągu ≤24 godzin, przyjętych na oddział pomocy doraźnej szpitala Dr Soetomo w okresie od 14 lipca do 14 grudnia 2014 roku. Diagnoza udaru krwotocznego była potwierdzana tomografią komputerową głowy. Stwierdzono siedem predyktorów udaru krwotocznego, które poddano analizom dwuwymiarowym i wielowymiarowym. Ponadto dzięki wielowymiarowej analizie dyskryminacyjnej uzyskano równanie dla modelu oceny Soetomo. Otrzymana charakterystyczna procedura operacyjna przyniosła wartości obszaru poniżej krzywej i punktu przecięcia określającego udar krwotoczny. Następnie określono wartość badania diagnostycznego. **Wyniki:** Równanie modelu oceny Soetomo było następujące: (3 × utrata przytomności) + (3,5 × ból głowy) + (4 × wymioty) – 4,5. Wartość pola pod krzywą dla tej oceny wyniosła 88,5% (95% przedział ufności = 83,3–93,7%). Przy wartości oceny Soetomo ≥–0,75 uzyskano czułość 82,9%, swoistość 83%, wartość predykcyjną dodatnią 78,8%, wartość predykcyjną ujemną 86,5%, wskaźnik wiarygodności wyniku dodatniego 4,88, wskaźnik wiarygodności wyniku ujemnego 0,21, odsetek wyników fałszywie ujemnych 17,1%, odsetek wyników fałszywie dodatnich 17% oraz dokładność 83%. **Wnioski:** Wartość oceny Soetomo ≥–0,75 może pomóc prawidłowo rozpoznać ostry udar krwotoczny w przypadku ograniczeń finansowych lub lokalizacyjnych w zakresie obrazowania mózgu.

Słowa kluczowe: ocena Soetomo, ostry udar krwotoczny, badanie diagnostyczne

INTRODUCTION

Intracerebral haemorrhage occurs in 15–30% of all strokes. About 12–15 cases occur per 100,000 population of the world/year. Although the haemorrhagic stroke is typically located in the supratentorial, it may also occur in the infratentorial (10–15% case of haemorrhagic stroke occurs at pons and 10% occurs at cerebellum) (Greenberg, 2010).

Computed tomography (CT) scan is the main strategy that is effective in imaging of acute stroke patients (Misbach *et al.*, 2011). However, on the financial or facility constrains of brain imaging, a score model is used to distinguish between haemorrhagic and ischemic strokes clinically (Nouira *et al.*, 2009).

This study attempts to develop a score model with good diagnostic value in predicting the occurrence of acute haemorrhagic stroke located in the supratentorial and in the infratentorial.

MATERIAL AND METHODS

The subjects of the diagnostic test in this cross-sectional study were 176 acute stroke patients who visited emergency unit of Dr. Soetomo Hospital from July 14th to December 14th, 2014. The inclusion criteria of the subjects were: aged over 18, with onset of ≤24 hours, family and/or patients willing to join this research. Besides, the exclusion criterion of the subjects was the occurrence of one of the following situations: subarachnoid and/or intraventricular haemorrhagic strokes which were not a complication of intraparenchymal haemorrhage, global aphasia, double hemiplegia or bilateral severe eyelid oedema.

This study was conducted prospectively. The data collection sheet 1 was filled out by the neurologist when an acute stroke patient visited the emergency unit (before head CT scan was performed). It was a form containing questions about patient's identity, time of the patient's arrival at the emergency unit, onset of the stroke, clinical features of acute stroke syndrome experienced by patients (loss of consciousness, vomiting, acute high blood pressure response – blood pressure of patients was >200/120 mm Hg in the first measurements in the emergency unit, headache, dizziness sensation related to stroke) and history of drugs use (anticoagulant, antiplatelet, narcotics, sympathomimetic agents in flu and cough medicines). After head CT scan without contrast was performed, data collection sheet 2 (consisting of the results of the head CT scan reading) was filled out by the radiologist. Then, the researchers collected the data collection sheet 1 and 2 of all subjects.

There were seven independent variables as parameters of Soetomo score model: loss of consciousness (patients' condition with the Glasgow Coma Scale – GCS value of <15 or GCS which was not 4 × 6 on aphasia patients), vomiting, acute high blood pressure response (blood pressure of patients was >200/120 mm Hg in the first measurements in the emergency unit), headache, dizziness sensation related to stroke, history of drugs use (anticoagulant, antiplatelet, narcotics, sympathomimetic agents on flu and cough medicines) and onset during activity. The dependent variable in this study was acute haemorrhagic stroke. All these variables were analysed statistically as the nominal data.

The statistical analysis was conducted by using SPSS 18.0 software. This was derived from the calculation of odds ratio (OR) and 95% confidence interval (CI) of each parameter obtained through bivariate analysis (chi-square). Afterwards, multivariate analysis (logistic regression of backward stepwise Wald methods) was done. Parameters with significant multivariate test results were set as the parameters of Soetomo score. Furthermore, multiple discriminant analysis resulted in linear discriminant equation, namely: $D = a + b_1X_1 + b_2X_2 + \ldots + b_zX_z$, with: D = Soetomo score, a = constant, b_i = discriminant coefficient and X_i = selected parameter.

After calculating the Soetomo score model values in all subjects, receiver operating characteristic (ROC) procedure was performed to determine the area under curve (AUC) value. ROC procedure also produced some alternative intersection point values of Soetomo score model along with the sensitivity value. Afterwards, the specificity value was calculated by using Microsoft Excel software. Furthermore, the diagnostic test value on the intersection point value was also calculated. This statistic and diagnostic test value calculations were conducted by an independent individual statistical staff.

RESULTS

Out of 176 acute stroke patients with the onset of ≤24 hours, the youngest patient was 29 and the oldest was 90. The mean age of the patients was 58.5 ± 10.9 years. There were 100 (56.8%) male patients and 76 (43.2%) female patients. After performing the head CT scan, 76 patients were diagnosed with haemorrhagic stroke (61 patients of supratentorial haemorrhage and 15 patients of infratentorial haemorrhage). The clinical features and the history of drugs use of the 176 patients were illustrated in Tab. 1.

Statistical analysis was derived from bivariate analysis (chi-square) of the calculations of OR value and 95% CI of the seven parameters of Soetomo score, including: loss of consciousness, vomiting, acute high blood pressure response, headache, dizziness sensation related to stroke, history of drugs use and onset during activity (Tab. 2).

Five of the seven parameters of Soetomo score were the predictors of the haemorrhagic stroke which were clinically and statistically significant, namely: vomiting, headache, loss of consciousness, acute high blood pressure response (blood pressure >200/120 mm Hg) and onset during activity (Tab. 2). These five parameters were further analysed by multivariate analysis (logistic regression of backward stepwise Wald methods) (Appendix 1). It showed that only three of them were clinically and statistically significant as

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	Haemorrhagic stroke *n* (%)	Non-haemorrhagic stroke *n* (%)
Number of patients	76	100
Clinical features		
Loss of consciousness	62 (81.6)	29 (29)
Vomiting	50 (65.8)	12 (12)
Acute high blood pressure response (BP > 200/120 mm Hg)	13 (17.1)	4 (4)
Headache	57 (75)	21 (21)
Dizziness related to stroke	11 (14.5)	6 (6)
Onset during activity	65 (85.5)	60 (60)
History of drugs use		
Anticoagulant	1 (1.3)	0 (0)
Antiplatelet	3 (3.9)	24 (24)
Narcotics	0 (0)	0 (0)
Flu and cough medicines	1 (1.3)	3 (3)
n – number of patients; **BP** – blood pressure.		

Tab. 1. The clinical features and the history of drugs use of 176 acute stroke patients in emergency unit of Dr. Soetomo Hospital from July 14th to December 14th, 2014

	Odds ratio (95% CI)	*p* value
Loss of consciousness	10.84 (5.26–22.35)	<0.001
Vomiting	14.10 (6.55–30.37)	<0.001
Acute high blood pressure Response (BP > 200/120 mm Hg)	4.95 (1.55–15.87)	0.004
Headache	11.29 (5.56–22.91)	<0.001
Dizziness related to stroke	2.65 (0.93–7.53)	0.059
Onset during activity	3.94 (1.85–8.37)	<0.001
History of drugs use		
Anticoagulant	Cannot be analysed	
Antiplatelet	0.13 (0.04–0.45)	<0.001
Narcotics	Cannot be analysed	
Flu and cough medicines	0.43 (0.04–4.23)	0.46
BP – blood pressure.		

Tab. 2. The values of and 95% confidence interval (CI) of Soetomo score parameters

		B	S.E.	Wald	df	Sig.	Exp(B)	95% CI for Exp(B)	
								Lower	Upper
Step 1[a]	Onset	.439	.497	.782	1	.376	1.551	.586	4.106
	Vomiting	1.743	.457	14.534	1	.000	5.714	2.332	14.000
	Headache	1.663	.429	14.995	1	.000	5.276	2.274	12.242
	BP > 200/120 mm Hg	1.022	.777	1.733	1	.188	2.780	.607	12.737
	Loss of consciousness	1.518	.440	11.887	1	.001	4.564	1.925	10.818
	Constant	−2.944	.511	33.130	1	.000	.053		
Step 2[a]	Vomiting	1.783	.454	15.427	1	.000	5.947	2.443	14.479
	Headache	1.674	.429	15.249	1	.000	5.334	2.302	12.357
	BP > 200/120	1.151	.769	2.243	1	.134	3.162	.701	14.261
	Loss of consciousness	1.573	.437	12.975	1	.000	4.823	2.049	11.352
	Constant	−2.688	.406	43.924	1	.000	.068		
Step 3[a]	Vomiting	1.824	.451	16.378	1	.000	6.197	2.562	14.991
	Headache	1.671	.423	15.575	1	.000	5.317	2.319	12.193
	Loss of consciousness	1.621	.432	14.104	1	.000	5.060	2.171	11.792
	Constant	−2.621	.398	43.464	1	.000	.073		
BP – blood pressure.									

Appendix 1. Multivariate analysis (logistic regression of backward stepwise Wald)

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the predictors of haemorrhagic stroke. They were: vomiting, headache and loss of consciousness. These three parameters then became the Soetomo score model parameters.

After performance of the multiple discriminant analysis (Appendix 2) on those three parameters, the researchers obtained the original equation of Soetomo score model, namely: SoS = 1.075 LoC + 1.163 H + 1.309 V – 1.533. This score model was then simplified by being multiplied with the constant 3, becoming: SoS = 3 LoC + 3.5 H + 4 V – 4.5, with: SoS = Soetomo score, LoC = loss of consciousness (score 1 for loss of consciousness, score 0 for no loss of consciousness), H = headache (score 1 for headache, score 0 for no headache), V = vomiting (score 1 for vomiting, score 0 for no vomiting).

The next step was counting of the Soetomo score model values of all subjects, which was then continued with the ROC procedure. This procedure resulted in the AUC value of Soetomo score of 88.5% (95% CI = 83.3–93.7%) (Fig. 1). ROC procedure also resulted in some alternative intersection point values of Soetomo score model along with the sensitivity value. It was then continued with the calculation of the specificity value by using Microsoft Excel software (Appendix 3). Microsoft Excel software was used to find the optimal intersection point obtained from the intersection of the sensitivity and specificity curves. The point was –0.75 (Fig. 2).

At the value of ≥–0.75, Soetomo score model reached the sensitivity of 82.9% and the specificity of 83% (Appendix 3). Out of 80 patients with the Soetomo score value of ≥–0.75, 63 patients who had performed the head CT scan suffered haemorrhagic stroke. Conversely, out of 96 patients with the Soetomo score value of <–0.75, 83 patients who had performed the head CT scan did not suffer haemorrhagic stroke. After obtaining the 2 × 2 table of Soetomo score model (Tab. 3), the researchers then conducted a diagnostic test of Soetomo score (Tab. 4 and Appendix 4).

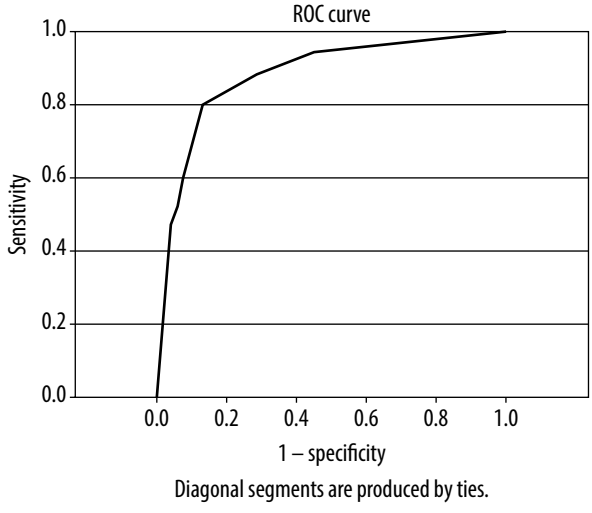

Fig. 1. Area under curve (AUC) of Soetomo score

Canonical discriminant function coefficients

	Function
	1
Vomiting	1.309
Headache	1.163
Loss of consciousness	1.075
(Constant)	–1.533

Tests of equality of group means

	Wilks' lambda	F	df1	df2	Sig.
Vomiting	.689	78.580	1	174	.000
Headache	.710	71.043	1	174	.000
Loss of consciousness	.728	64.889	1	174	.000

Appendix 2. Multiple discriminant analysis

Intersection point	Sensitivity	Specificity
–5.5	1.000	0.000
–3.0	0.947	0.550
–1.25	0.882	0.730
–0.75	0.829	0.830
0.75	0.803	0.870
2.25	0.632	0.920
2.75	0.526	0.940
4.5	0.474	0.960
7.0	0.000	1.000

Appendix 3. Sensitivity and specificity values of Soetomo score of several alternative intersection points

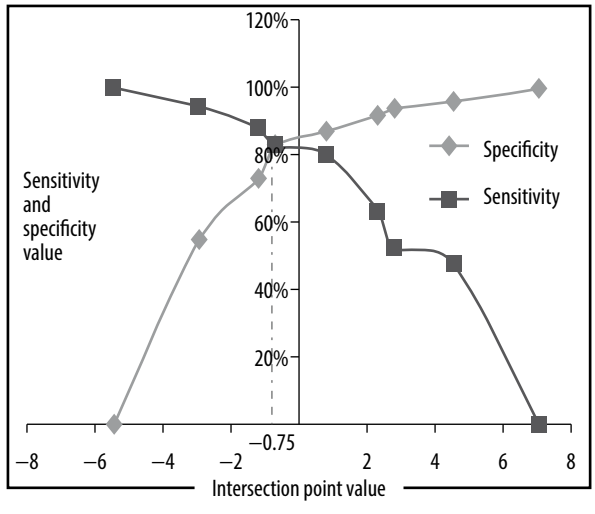

Fig. 2. Sensitivity and specificity curves of Soetomo score model

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		CT scan	
		Haemorrhagic ***n***	**Non-haemorrhagic** ***n***
Soetomo score	≥–0.75	63	17
	<–0.75	13	83
n – number of patients.			

Tab. 3. 2 × 2 table of Soetomo score model

Parameter	Value
Sensitivity	82.9%
Specificity	83%
Positive predictive value	78.8%
Negative predictive value	86.5%
Positive likelihood ratio	4.88
Negative likelihood ratio	0.21
False negative	17.1%
False positive	17%
Accuracy	83%

Tab. 4. Diagnostic test of Soetomo score model

DISCUSSION

Acute stroke is a neurological emergency and a head CT scan as the gold standard of diagnostic test of acute stroke should be done immediately. Improper diagnosis and management may endanger the acute haemorrhagic stroke patients. The score model, beside early identification of acute haemorrhagic stroke, also takes into consideration the sort of acute stroke patients who should be referred to perform the head CT scan.

As mentioned previously, intracerebral haemorrhage occurs in 15–30% of all strokes. In this study, haemorrhagic stroke was found in 43.2% of 176 acute stroke patients. This percentage rate difference was obtained because this research was a hospital-based study. Another hospital-based study also resulted in the number of haemorrhagic stroke incidents of 44.17% of all acute stroke patients becoming the subjects of the research (Kochar *et al*., 2000).

Some literature suggested that the history of anticoagulants and narcotics use was the risk factor for haemorrhagic stroke (Caplan, 2009; García-Rodríguez *et al*., 2013; Lovelock *et al*., 2010; McEvoy *et al*., 2000; Pozzi *et al*., 2008; Terecoasa *et al*., 2012). However, in this study both drugs could not be analysed statistically because the history of anticoagulants use was only found in one patient and there was no history of narcotics use found in the 176 patients.

Cantu *et al.* (2003) argued that the history of sympathomimetic agents (phenylpropanolamine and pseudoephedrine)

		CT scan	
		Haemorrhagic ***n***	**Non-haemorrhagic** ***n***
Soetomo score	**Haemorrhagic (≥–0.75)**	a = 63	b = 17
	Non-haemorrhagic (<–0.75)	c = 13	d = 83
n – number of patients.			

Parameter	Formula	Calculation	Value
Sensitivity	a : (a + c)	63 : (63 + 13) × 100%	82.9%
Specificity	d : (b + d)	83 : (83 + 17) × 100%	83%
Positive predictive value	a : (a + b)	63 : (63 + 17) × 100%	78.8%
Negative predictive value	d : (c + d)	83 : (13 + 83) × 100%	86.5%
Positive likelihood ratio	Sensitivity : (1 – specificity)	0.829 : (1 – 0.83)	4.88
Negative likelihood ratio	(1 – sensitivity) : specificity	(1 – 0.829) : 0.83	0.21
False negative	c : (a + c)	13 : (63 + 13)	17.1%
False positive	b : (b + d)	17 : (17 + 83)	17%
Accuracy	(a + d) : (a + b + c + d)	(63 + 83) : (63 + 17 + 13 + 83)	83%

Appendix 4. Diagnostic test calculation of Soetomo score at statistic intersection point

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use in flu and cough medicines also caused the haemorrhagic stroke. However, in this study, the history of those drugs use was not proven as the predictor of the haemorrhagic stroke occurrence (OR = 0.43; 95% CI = 0.04–4.23; $p = 0.46$).

Although some literature concluded that the history of antiplatelet use was a risk factor of haemorrhagic stroke (Gorelick and Weisman, 2005; James *et al.*, 2013), this study found that the history of antiplatelet use was not proven as the predictor of the haemorrhagic stroke occurrence (OR = 0.13; 95% CI = 0.04–0.45; $p < 0.001$).

The history of drugs use (anticoagulant, antiplatelet, narcotics, sympathomimetic agents on flu and cough medicines) could not be properly evaluated because 81.6% of 76 haemorrhagic stroke patients in this study experienced loss of consciousness. Accordingly, the patients were taken to the hospital by the people who did not know certainly the history of drugs use of the patients.

Minor cerebellar haemorrhage, especially around vermis, sometimes causes a sensation of dizziness isolated by positional nystagmus (called central paroxysmal positional vertigo – CPPV), which clinical symptoms are difficult to distinguish from benign paroxysmal positional vertigo (BPPV) (Johkura, 2007). However, in this study, dizziness related to stroke was not a predictor of the haemorrhagic stroke occurrence (OR = 2.65; 95% CI = 0.93–7.53; $p = 0.059$). These results are in accordance with the literature suggesting that the sensation type of dizziness is inconsistent in describing the basic cause of acute vestibular syndrome, namely: vestibular neuritis, posterior fossa stroke and cerebellar haemorrhage (Tarnutzer *et al.*, 2011).

Onset during activity became the predictor of haemorrhagic stroke in this study (OR = 3.94; 95% CI = 1.85–8.37; $p < 0.001$) because activity increased sympathetic activity, causing an increase in arterial blood pressure correlated with the intracerebral and subarachnoid haemorrhagic strokes (Butt *et al.*, 2009; Caplan, 2009).

The increase of acute blood pressure in the first 24 hours after the haemorrhagic stroke onset is often considered as autoregulation of cerebral blood rate (Powers *et al.*, 2001). The increase of acute blood pressure in haemorrhagic stroke may also occur as a result of Cushing reflex due to increased intracranial pressure (Prakash and Madanmohan, 2005). Expenditure of cortisol has a positive association with 24-hours blood pressure, which supports the theory of stress response as a determinant of blood pressure level in acute stroke (Christensen, 2007). In this study, the acute high blood pressure response (blood pressure >200/120 mm Hg) was the predictor of haemorrhagic stroke (OR = 4.95; 95% CI = 1.55–15.87; $p = 0.004$). This result proves Massaro *et al.*'s (2002) study concluding that blood pressure of >200/120 mm Hg is the predictor of the haemorrhagic stroke occurrence (OR = 3.8, CI 2.5–5.6).

Three clinical features in this study, namely vomiting (OR = 14.10; 95% CI = 6.55–30.37; $p < 0.001$), headache (OR = 11.29; 95% CI = 5.56–22.91; $p < 0.001$) and loss of consciousness (OR = 10.84; 95% CI = 5:26 to 22:35; $p < 0.001$), are the predictors of haemorrhagic stroke that are clinically and statistically significant. Vomiting, headache and loss of consciousness as the predictors of the haemorrhagic stroke has been proven by several studies (Lovelock *et al.*, 2010; Massaro *et al.*, 2002; Poungvarin *et al.*, 1991).

Studies on loss of consciousness related to neuroanatomy and haemorrhagic stroke have been described by many researchers (Bateman, 2001; Caplan, 2009; Kase, 2012; Tindall, 1990; Yeo *et al.*, 2013). In addition, studies on vomiting related to neuroanatomy and haemorrhagic stroke are also found in some literature (Becker, 2010; Caplan, 2009). Furthermore, headache in haemorrhagic stroke is also discussed in some literature (Caplan, 2009; Kase, 2012; Machfoed *et al.*, 2010; Sacco *et al.*, 2013; Shigematsu *et al.*, 2013).

Multivariate analysis (logistic regression of backward stepwise Wald methods) showed that only loss of consciousness, headache and vomiting were clinically and statistically significant (Appendix 1). These three predictors of haemorrhagic stroke then became the parameters of Soetomo score model.

After performance of the multiple discriminant analysis on the three parameters of the Soetomo score model (loss of consciousness, headache, and vomiting) (Appendix 2) which were simplified by being multiplied with constant 3, the Soetomo score model equation was obtained as follows:

$$SoS = 3\ LoC + 3.5\ H + 4\ V - 4.5$$

with:

SoS = Soetomo score
LoC = loss of consciousness (score 1 for loss of consciousness, score 0 for no loss of consciousness)
H = headache (score 1 for headache, score 0 for no headache)
V = vomiting (score1 for vomiting, score 0 for no vomiting)

The ROC procedure showed that Soetomo score model had the AUC of 88.5% (95% CI = 83.3–93.7%). AUC value of 88.5% statistically demonstrated that the Soetomo score model has good diagnostic value (Dahlan, 2009).

From several alternatives of Soetomo score intersection point resulting from ROC procedure and assisted by Microsoft Excel software, an optimal intersection point was obtained, namely –0.75, which was also the statistical intersection point (Fig. 2 and Appendix 3). This point was obtained by the intersection of the sensitivity and specificity curves. Determination of another intersection point affected the increase of just one of the sensitivity or specificity values. At the value of ≥–3.0, Soetomo score model reached the highest sensitivity of 94.7% and the lowest specificity of 55%. At the value of ≥4.5, it reached the lowest sensitivity of 47.4% and the highest specificity of 96%.

After the 2 × 2 table of Soetomo score model was arranged (Tab. 3) with the intersection point constraint of ≥–0.75,

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the diagnostic test was performed on the intersection point. At the value of ≥–0.75, Soetomo score model reached the sensitivity of 82.9%, specificity of 83%, positive predictive value of 78.8%, negative predictive value of 86.5%, positive likelihood ratio of 4.88, negative likelihood ratio of 0.21, false negative of 17.1%, false positive of 17% and accuracy of 83% (Tab. 4).

The Soetomo score model has an advantage of being used for the ≤24-hours acute stroke patients and for the acute supratentorial and infratentorial strokes patients. This score model has the diagnostic accuracy of 83% according to the ability to recognise subjects without haemorrhagic stroke. If three parameters of Soetomo score model (loss of consciousness, headache and vomiting) are found in ≤24-hours acute stroke patients, the physicians are about 83% certain that the patients suffer from haemorrhagic stroke and can determine the course of action to be taken.

The Soetomo score is a diagnostic score model. It cannot determine the prognosis of an acute stroke patient who had loss of consciousness, headache and vomiting. The Soetomo score model cannot replace head computed tomography (CT) scan as the gold standard of diagnostic test of acute stroke.

CONCLUSION

This study resulted in Soetomo score model equation:

$$SoS = 3 \times LoC + 3.5 \times H + 4 \times V - 4.5$$

with:

SoS = Soetomo score
LoC = loss of consciousness (score 1 for loss of consciousness, score 0 for no loss of consciousness)
H = headache (score 1 for headache, score 0 for no headache)
V = vomiting (score 1 for vomiting, score 0 for no vomiting)

Soetomo score model value of ≥–0.75 = haemorrhagic stroke
Soetomo score model value of <–0.75 = non-haemorrhagic stroke

The Soetomo score value of ≥–0.75 can identify an acute haemorrhagic stroke properly on the financial or facility constrains of brain imaging. At the Soetomo score value of ≥–0.75, Soetomo score reached the sensitivity of 82.9%, specificity of 83% and accuracy of 83%. The diagnostic test obtained from external validation needs to be performed further to the Soetomo score model.

Conflict of interest

The authors declare no conflicts of interest.

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Note from Editor

Comment on: Machfoed MH *et al. Soetomo score: score model in early identification of acute haemorrhagic stroke*

The symptomatic approach has been central to diagnosis in neurology for many decades. Typically, there was a required set of symptoms and the more symptoms were present, the more likely the correct diagnosis was. Since the emergence, development and availability of different additional tests such as neuroimaging techniques and biomarkers, the role of symptoms has gradually diminished and they are now rather a starting point than an independent tool in diagnosis of most of neurologic disorders. The notable exception from this rule is Parkinson's disease when symptoms strengthened by response to levodopa are still primary to any auxiliary investigations, including neuroimaging (this is sustained in the newest MDS clinical criteria for Parkinson's disease, Postuma *et al.*, 2015). The good example of an enhancement of the role of additional tests in the diagnosis is normal pressure hydrocephalus. Since its initial description (Hakim and Adams, 1965), the set of three symptoms (classic triad of gait disorder, urinary incontinence and cognitive disturbances) has been used with later refinements (such as symptom progression and sequence in time) as a diagnostic tool in such a way that the more symptoms were present, the more likely the diagnosis was. Clinical approach was used despite low accuracy and the picture has changed dramatically only with the use of neuroimaging, at first computed tomography. Now, neurologic symptoms and signs (including the classic symptoms triad) are just the first step to diagnosis and magnetic resonance imaging is a gold standard (Shprecher *et al.*, 2008). The correct diagnosis of the type of stroke and distinguishing between the haemorrhagic and ischaemic one is critical for treatment. In emergency departments, the standard procedure involves neuroimaging, usually with computed tomography scan use. However, in developing, lower income countries the medical infrastructure and organisation of health care systems commonly limit the access to neuroimaging techniques. This problem is partially addressed by the paper of the Indonesian researchers who tried to establish a set of symptoms predictive of haemorrhagic type of stroke and developed a statistical model that weighs the role of each symptom. The resulting so-called Soetomo score (Machfoed *et al.*, 2016) had the general accuracy of 83%. This is naturally unacceptable when neuroimaging is available (and even might be seen as unethical considering emerging treatment choices), however in a place where neuroimaging is not an option (due to limited access or costs), it might be used as an interesting addition to standard clinical evaluation. Interestingly, the Authors using only clinical features ended up with the same set of symptoms as earlier studies, such as, among others, the one of Efstathiou *et al.* (2002).

Bearing this is mind, the Editor has decided to publish the paper, understanding its possible importance for the underdeveloped countries or less equipped clinical centres as well as emergency medicine but very limited usefulness for more westernised and more modern (equipment-wise) medical settings.

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