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Development and Validation of Clinical Prediction Score of Mortality in Tuberculosis Patients

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OBJECTIVES

Tuberculosis (TB) is one of public health problems both globally and nationally. Death is the main serious problem for tuberculosis (TB) treatment programs. Therefore, this study aimed to develop a simple risk scoring for predicting mortality in TB patients.

METHODS

Data were collected from TB patients registry in Phichit Hospital and Community Hospitals in Phichit Province, Thailand between January 1, 2017 - December 31, 2020. Eligible patients were over 18 years old and have completed treatment or death. All TB patients were diagnosed by clinicians using the standard procedure, i.e. chest x-ray, sputum acid-fast bacillus (AFB) and/or GeneXpert test. To develop and internal validate the risk score system, we used multivariable logistic regression, and weighted point using regression coefficient. The scoring scheme was applied in validation cohort to test the diagnostic performances.

RESULTS

A total of 2,157 patients were included in the study and randomly divided into 2 groups; derivation cohort (n=1,585), and validation cohort (n=572). The risk score consists of 4 predictors: Age ≥ 65 years, liver disease, HIV status positive and TB meningitis. The risk score showed area under thereceiver operating characteristic curve (AuROC) 78.53% with good calibration (Hosmer-Lemeshow χ=2.47; P=.29). The positive likelihood ratio of death in TB patients with low risk (scores ≤ 2.5) and high risk (scores > 4.5) were 1.22 (95% CI:1.15-1.29) and 25.63 (95% CI:7.56-86.87) respectively. When applied in validation cohort, the score showed good performance with AuROC 76.93%, and illustrated 85.19%, and 77.78% certainty in low-and high-risk groups respectively.

Figure 1 Flowchart of the study population

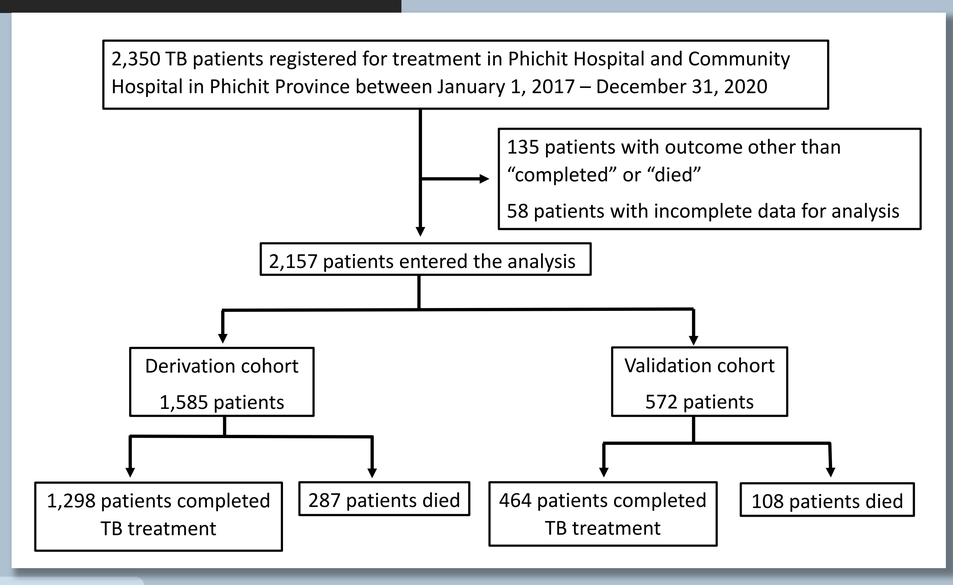


Table 1 Clinical and demographic characteristics of tuberculosis patients

Characteristics	All patients (n=2,157)	Derivation cohort (n=1,585)		Validation cohort (n=572)	
		Dead (n=287)	Completed (n=1,298)	Dead (n=108)	Completed (n=464)
Age ≥ 65 years	764 (35.42)	167(58.19)	391 (30.12)	59 (54.63)	147 (31.68)
Male gender	1,525 (70.70)	196 (68.29)	914 (70.42)	79 (73.15)	336 (72.41)
Extrapulmonary TB	318 (14.74)	48 (16.72)	194 (14.95)	15 (13.89)	61 (13.15)
Relapse TB infection	174 (8.07)	29 (10.10)	102 (7.86)	11 (10.19)	32 (6.90)
Weight < 35 kg.	58 (2.69)	13 (4.53)	34 (2.62)	4 (3.70)	7 (1.51)
COPD	61 (2.83)	14 (4.88)	36 (2.77)	4 (3.70)	7 (1.51)
CKD	58 (2.69)	16 (5.57)	27 (2.08)	3 (2.78)	12 (2.59)
Liver disease	13 (0.60)	4 (1.39)	6 (0.46)	3 (2.78)	0 (0.00)
DM	260 (12.05)	37 (12.89)	157 (12.10)	15 (13.89)	51 (10.99)
HIV status (+)	262 (12.15)	90 (31.36)	108 (8.32)	36 (33.33)	28 (6.03)
AFB smear (+)	931 (43.16)	120 (41.81)	559 (43.07)	53 (49.07)	199 (42.89)
TB meningitis	39 (1.81)	21 (7.32)	8 (0.62)	6 (5.56)	4 (0.86)

Table 2 Univariable analysis of risk factors associated with death in tuberculosis patients

Variable	Derivation cohort (n=1,585)		
	Odds ratio	95% of Odds ratio	P-value
Age ≥ 65 years	3.23	2.46, 4.24	<0.001
Male gender	0.90	0.68, 1.20	0.477
Extrapulmonary TB	1.14	0.19, 1.63	0.468
Relapse TB infection	1.32	0.82, 2.06	0.235
Weight < 35 kg.	1.18	0.84, 3.48	0.121
COPD	1.80	0.88, 3.47	0.090
CKD	2.78	1.38, 5.43	0.002
Liver disease	3.04	0.63, 12.92	0.089
DM	1.08	0.71, 1.59	0.691
HIV status (+)	5.03	3.61, 6.70	<0.001
AFB smear (+)	0.95	0.73, 1.24	0.742
TB meningitis	12.73	5.33, 33.52	<0.001

Table 3 Distribution of risk of death in tuberculosis patients, diagnostic performance and interpretation in derivation cohort (n=1,585)

Derivation (n=1,585)	Low (score ≤ 2.5)	Moderate (score 3-4.5)	High (score >4.5)	Total
Total	1,515	50	20	1,585
Completed	1,282	13	3	1,298
Dead	233	37	17	287
Diagnostic performance				
Sensitivity	98.77%	18.82%	5.92%	
Specificity	18.82%	98.77%	99.77%	
Positive predictive value	84.62%	77.14%	85.00%	
Negative predictive value	77.14%	84.62%	82.75%	
Likelihood ratio (+)	1.22 (95% CI: 1.15-1.29)	15.26 (95% CI: 8.87-26.27)	25.63 (95% CI: 7.56-86.87)	
Likelihood ratio (-)	0.07 (95% CI: 0.04-0.11)	0.82 (95% CI: 0.78-0.87)	0.94 (95% CI: 0.92-0.97)	
Interpretation	Absence of death (77.14% certainty)		Presence of death (85.00% certainty)	

Figure 2 Risk score for death in tuberculosis patients

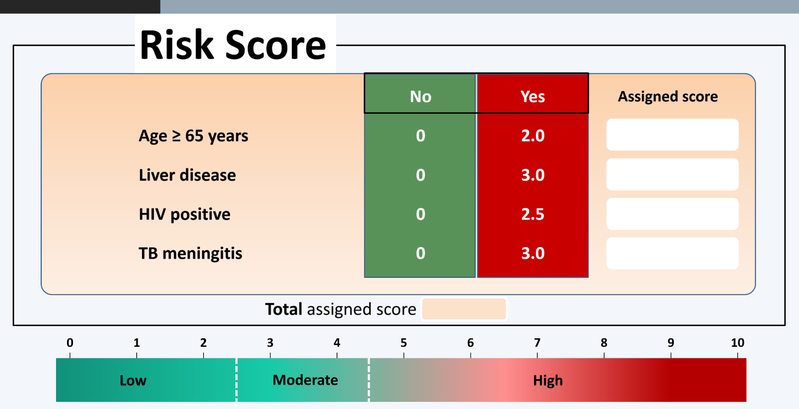
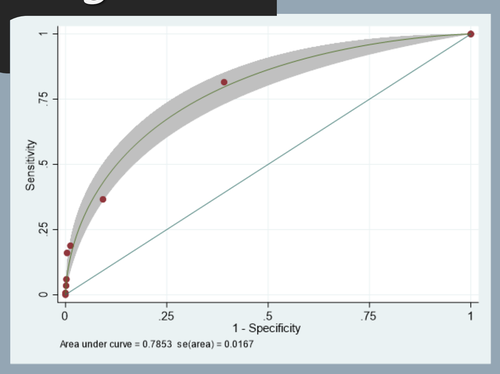
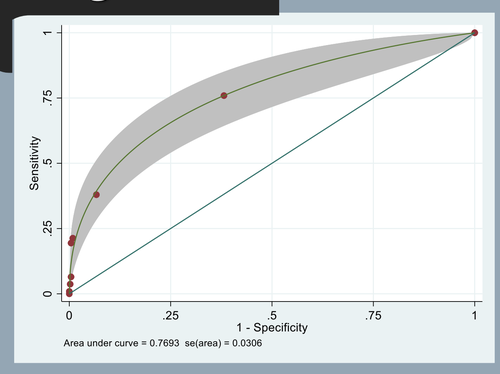


Figure 3



Receiver operator characteristic (ROC) curve of the scoring system in predicting death in tuberculosis patients in derivation cohort (n=1,585)

Figure 4



Receiver operator characteristic (ROC) curve of the scoring system in predicting death in tuberculosis patients in validation cohort (n=572)

CONCLUSIONS

The simple risk score with four predictors developed from routine data collection might be used to predict mortality in TB patients care. This risk score may help clinicians in terms of planning a proper care of TB patients.