A pre-admission triaging tool to predict severe COVID-19 cases: ABCD score

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SUMMARY

Introduction: Isolation of SARS-CoV-2-infected individuals is an important COVID-19 pandemic control measure. While most cases have uncomplicated infection, a small proportion of them has developed life-threatening disease. We set up a retrospective study to determine preadmission triaging tool to predict the development of severe COVID-19.

Materials and Methods: A retrospective study was conducted from 1 October 2020 to 31 January 2021 with enrolment of all SARS-CoV-2 PCR-confirmed persons aged ≥13 years. The disease severity was assessed on admission and daily throughout the hospitalisation. Test-positive individuals were considered as having "severe COVID-19" if they had ≥1 of the following: room air oxygen saturation 30 breaths/minute, signs of severe respiratory distress, or received mechanical ventilation and/or vasopressor therapy. Uni- and multi-variate analyses using SPSS Statistics Ver. 26 were performed.

Results: We showed that age ≥ 60 years, BMI ≥ 30.0, presentation on days 7–12 of illness, and ≥1 comorbidity were associated with development of severe COVID-19. A scoring system based on the four variables is a useful COVID-19 risk assessment tool. A total score ≥2 had a sensitivity of 60.9%, specificity of 88.2%, positive predictive value of 37.8% and negative predictive value of 95.0%.

Conclusion: Development of preadmission triaging tool can help health care providers (HCPs) decide on the placement of test-positive individuals to appropriate isolation facilities according to the risk of developing severe COVID-19.

KEYWORDS:
COVID-19, Sarawak, preadmission, risk stratification, ABCD score, triage, severe

INTRODUCTION

Coronavirus disease 2019 (COVID-19) infection caused by SARS CoV-2 virus has a broad spectrum of clinical presentation that ranges from asymptomatic infection, mild undifferentiated viral illness to life-threatening disease.[1,2] While majority experience a self-limiting illness, a significant minority progress to develop severe disease. These individuals may experience fulminant cytokine storm or multi-organ failure with resultant death.[3] Isolation of test-positive individuals is a key public health measure in controlling virus transmission and protecting vulnerable individuals from this potentially lethal infection.[4] Public health authorities were compelled to isolate test-positive individuals at minimally equipped makeshift isolation facilities, such as hotels, hostels, and community halls due to limitation in number of hospitals beds. This may result in suboptimal monitoring and delayed treatment. This highlights the importance of case triage to identify individuals who may progress to severe illness so that they can be cared at appropriate facilities. This is particularly important as health care facilities were already inundated with critically ill COVID-19 cases.[5] The channelling of appropriate resources to look after these high-risk individuals is crucial in a resource-limited setting. Several COVID-19 risk prediction models have been proposed since the early days of the pandemic to identify at-risk individuals. However, most models include specific laboratory and radiological details.[6,7] We set up a retrospective study with the aim to determine clinical variables associated with the development of severe COVID-19.

MATERIALS AND METHODS

A retrospective chart review (Malaysian Medical Research Ethics Committee NMRR-20-1656-55896) was conducted at Sarawak General Hospital and its affiliated makeshift isolation facilities from 1 October 2020 to 31 January 2021. All SARS-CoV-2 PCR-confirmed persons aged ≥13 years were enrolled. We excluded paediatric cases in this study. All data were collected using standardised data collection form and being anonymised for the analysis.

We assessed the disease severity of each test-positive individuals on admission and daily throughout the hospitalisation. Individuals were classified as severe COVID-19 infection if they had any of the following: room air oxygen saturation < 90%, respiratory rate > 30 breaths/minute, signs of severe respiratory distress, or received mechanical ventilation and/or vasopressor therapy.[8] Subjects without above features were classified as non-severe COVID-19.

Uni- and multi-variate analyses (SPSS Statistics Ver. 26) were used to determine clinical variables associated with the development of severe disease. A scoring system was generated by assigning point scores to each identified variable based on the coefficient in logistic regression. The

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Table I: Clinical characteristics of COVID-19 cases admitted to Sarawak General Hospital and its affiliated isolation facilities from 1st October 2020 to 31st January 2021

Clinical parameters	Total (n=607) n (%)	Severe disease (n=64)	Non-severe disease (n=543)	Univariate analysis, p	Multivariate analysis, P, OR (95% CI), Co-efficient
Male	326 (53.8%)	30 (47.6%)	296 (54.5%)	0.299	-
≥ 60-year-old	80 (13.2%)	33 (51.6%)	47 (8.7%)	<0.001	<0.001, 11.8 * (6.4-21.7), 2.3
BMI ≥ 30	110 (18.1%)	23 (35.9%)	87 (16.0%)	<0.001	<0.001, 3.5 ** (1.8-6.7), 1.2
Comorbidities					
Comorbid (Any)	58 (9.6%)	13 (20.3%)	45 (8.3%)	0.002	0.025 *** - 0.8
• Ischemic heart disease	16 (2.6%)	8 (12.5%)	8 (1.5%)	<0.001	-
• Diabetes mellitus	34 (5.6%)	4 (6.3%)	30 (5.5%)	0.811	-
• Chronic kidney disease	1 (0.2%)	0	1 (0.2%)	0.731	-
• Malignancy	5 (0.8%)	1 (1.6%)	4 (0.7%)	0.489	-
• Bronchial asthma	9 (1.5%)	2 (3.1%)	7 (1.3%)	0.250	-
• COPD	1 (0.2%)	0	1 (0.2%)	0.799	-
Day 7 to 12 of illness	89 (14.7%)	17 (26.6%)	72 (13.3%)	0.004	0.016, 2.2 (1.1-4.5) ****, 0.8
Symptoms					
Symptomatic	317 (52.3%)	30 (46.9%)	287 (52.9%)	0.365	-
• Fever	170 (28.1%)	25 (39.1%)	145 (26.8%)	0.038	-
• Rhinorrhoea	82 (13.5%)	10 (15.6%)	72 (13.3%)	0.605	-
• Cough	178 (29.4%)	33 (53.1%)	145 (26.6%)	<0.001	-
• Dyspnoea	24 (4.0%)	13 (20.3%)	11 (2.0%)	<0.001	-
• Vomiting	3 (0.5%)	0	3 (0.5%)	0.658	-
• Diarrhoea	29 (4.8%)	4 (10.8%)	25 (4.4%)	0.076	-
Blood investigations					
• Haemoglobin (g/dL)	14.3 (13.2-15.5)	13.7 (12.4-14.7)	14.4 (13.3-15.6)	<0.001	-
• Total white cells (10^3/uL)	6.4 (5.1-8.1)	6.0 (4.4-7.5)	6.4 (5.2-8.1)	0.031	-
• Lymphocytes (10^3/uL)	2.0 1.5-2.6)	1.4 (1.1-1.9)	2.1 (1.6-2.6)	<0.001	-
• LDH (U/L)	346.5 (369.1-418.0)	435.5 (351.2-581.0)	338.0 (268.5-409.0)	<0.001	-
Outcome					
Mortality	4 (0.7%)	4 (0.7%)	0	-	-

The Mann-Whitney U test was used for numerical variables and either the $\chi 2$ test or Fisher exact test was used for categorical variables.
* Reference group: age < 60-year-old
** Reference group: BMI < 30
*** Reference group: No comorbidity
**** Reference group: Asymptomatic or any other day of illness other than day 7 to 12

Table II: The distribution of the total score of the 607 COVID-19 cases according to the disease severity on admission and subsequent development of severe COVID-19.

Disease severity group	Disease severity on admission and subsequent progression	N (%)	Median (IQR)	0	1	2	3	4
Severe COVID-19	1. Severe disease at presentation	5 (0.8%)	1.4 (0.5-2.0)	1 (20.0%)	1 (20.0%)	3 (60.0%)	0 (0.0%)	0 (0.0%)
	2. Non-severe disease on admission, developed severe COVID-19 during the isolation period	36 (5.9%)	1.3 (1.0-2.0)	4 (11.1%)	19 (52.8%)	10 (27.8%)	3 (8.3%)	0 (0.0%)
Non-severe COVID-19	3. Remained to have non-severe disease throughout the isolation period	566 (93.2%)	0.5 (0.0 -1.0)	337 (59.5%)	181 (32.0%)	43 (7.6%)	4 (0.7%)	1 (0.2%)

Table III: Diagnostic performance of the scoring system based on age, body mass index, day of illness and the presence of co-morbidity*

Total score	Sensitivity, % (95% CI)	Specificity, % (95% CI)	PPV, % (95% CI)	NPV, % (95% CI)	+LR
1 and above	89.0 (78.7-95.4)	61.6 (57.4- 65.8)	21.5 (19.2-23.9)	97.9 (95.9-98.9)	2.3
2 and above	60.9 (47.9-72.9)	88.2 (85.2-90.8)	37.8 (31.0-45.1)	95.0 (93.3-96.3)	5.1
3 and above	32.8 (21.5-45.6)	96.1 (94.1-97.5)	50.0 (36.6-63.3)	92.3 (91.0-93.5)	8.4
4 and above	4.6 (21.5-45.6)	99.2 (98.1-99.8)	42.8 (14.6-76.6)	89.8 (89.3-90.3)	6.3
5	0.0 (0.0-5.6)	99.8 (98.9-100.0)	0.0	89.4 (89.4-89.4)	0.0

* Age ≥60 years was assigned with two points, and BMI ≥30, presented on day 7-12 of illness and ≥1 co-morbidity each with one point.

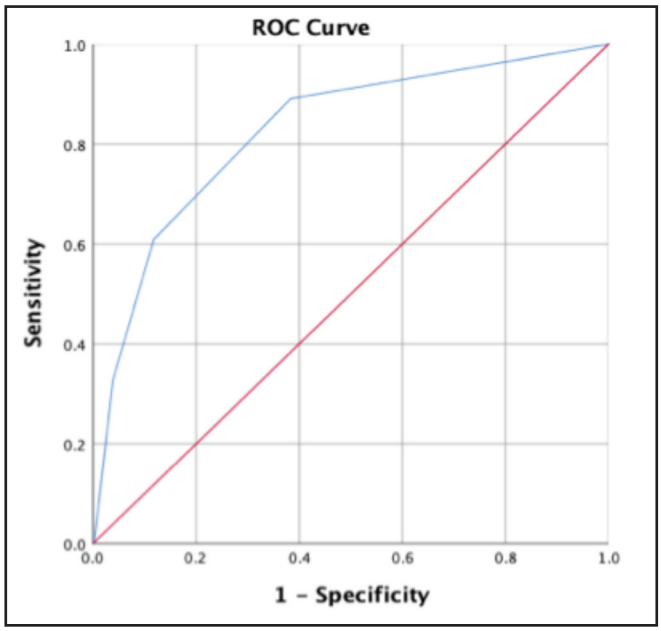

Fig. 1: The Receiving Operating Characteristic (ROC) curve of the ABCD score.

total score was calculated for each test-positive individual, and the diagnostic performance of the scoring system in identifying test-positive individuals who developed severe COVID-19 was examined by receiver operating characteristic (ROC) curve.

RESULTS

Six-hundred and seven test-positive individuals were recruited of which 5.4% had severe disease on admission. Of the remaining individuals, another 5.4% developed severe COVID-19 subsequently. We compared clinical variables of individuals who had either severe COVID-19 on admission or thereafter (N = 64) with those who had non-severe COVID-19 (Table I). Significantly more cases with background of ischemic heart disease (IHD) developed severe COVID-19. Significantly more cases in severe COVID-19 group had cough and dyspnoea.

Factors such as age ≥ 60 years, body mass index (BMI), the presence of ≥1 comorbidities, and presentation on days 7–12 of illness were significantly associated with severe diseases on univariate analysis. Based on coefficient in logistic regression, we assigned age ≥ 60 years (A) with two points, and BMI ≥ 30 (B), ≥1 comorbidity (C), and presentation on days 7–12 of illness (D) each with one point. The total score of every individual was recorded based on assessment upon admission.

Individuals who had severe COVID-19 were more likely to have a total score of ≥2 compared with those who had non-severe COVID-19 [16/41 (39.0%) vs. 48/566 (8.5%), $p < 0.001$] (Table II). Total score ≥2 had a sensitivity of 60.9%, specificity of 88.2%, positive predictive value of 37.8% and negative predictive value of 95.0%. (Table III). The area under the curve of ROC curve was 0.82 (95% CI: 0.77–0.88, $p < 0.001$) (Figure 1).

DISCUSSION

We demonstrated that ABCD score could be used to identify individuals who are likely to have severe COVID-19 disease. The scoring system can be applied with minimal clinical variables, even from phone consultation. This enables HCP to perform immediate risk assessment and triaging to identify high-risk individuals to be placed in facilities equipped for close observation. Cases who had disease progression in makeshift isolation facilities usually brought detrimental outcomes. Several COVID-19 risk prediction models have been proposed to aid clinicians assess the likelihood of severe disease when faced with SARS-CoV-2-infected individuals.[6,7,9,10] The existing risk prediction models were based on severe COVID-19 cases who were admitted to intensive care units.[9,10] Most models require specific laboratory and radiological features that involve blood sample collection and diagnostic imaging that may not be readily accessible in all clinical settings with a short turn-around time.

The limitation of our study is that the variables were identified through a small cohort over a short study period and have not been validated with a larger cohort in a prospective manner. Prospective study with larger cohort can be considered to validate this scoring system.

CONCLUSION

We developed this ABCD scoring system with four easy-to-elicit clinical variables that can guide HCP decide placement of test-positive individuals to appropriate isolation facilities according to the risk of developing severe COVID-19.

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CONFLICT OF INTEREST

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