

Assessment of the Utility of a Screening Tool for COVID-19 Diagnosis in an Accident and Emergency Department in Lagos, Nigeria: A Pilot Study

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Abstract

The use of reverse transcription–polymerase chain reaction (RT-PCR) is the gold standard laboratory test for diagnosing SARS-CoV-2 infection. However, it has the disadvantage of a long turnaround time and cost. The Nigeria Centre for Disease Control (NCDC) formulated a case definition for COVID-19. We sought to determine the utility of a 14-item, point-weighted clinical screening questionnaire adapted from the NCDC case definition in identifying patients more likely to have the disease. This was to aid prompt clinical decision-making. **Methods:** We retrospectively reviewed the data of 113 non-surgical patients presenting to the Accident and Emergency Department (A and E) of Lagos University Teaching Hospital, Lagos, Nigeria. Patients were stratified based on screening scores into low (0–2), moderate (3–5) and high (6) pre-test categories. Patients with low and high scores ≥ 6 were admitted to the A and E and the COVID-19 holding ward, respectively, while the moderate group had chest computed tomography scans to aid further decision-making, pending the outcome of their RT-PCR results. The validity of the triage score as compared to the RT-PCR test result was calculated and the kappa score of agreement was utilised to evaluate the concordance between two triage scores. The optimum cut-off score was also obtained based on the maximal Youden's index. **Results:** The frequencies of low, moderate and high pre-test scores were 34 (30%), 43 (38.1%) and 36 (31.9%), respectively. Overall, 38.1% (43/113) were RT-PCR positive. RT-PCR was positive in 26.5% (9/34) with low screening scores, 55.8% (24/43) with moderate scores and 27.8% (10/36) with high scores. The sensitivity and specificity of a high score of 6 were 25% and 92.86%, while the lower score of 3 had sensitivity and specificity of 62.5% and 58.6%, respectively. **Conclusion:** The screening tool showed a high specificity in its initial design, which suggests that anyone with a low score using this tool has a high probability of testing negative. We recommend a cut-off score of 4 (score A) or 6 (score B) of the current screening tool be used to increase the chances of identifying persons with COVID-19 for RT-PCR testing.

Keywords: Accident and emergency, COVID-19, reverse transcription–polymerase chain reaction, screening tool

INTRODUCTION

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which causes the coronavirus diseases (labelled COVID-19 by the World Health Organization), is a major pandemic with associated morbidity and mortality.^[1] Nigeria has a high infectious disease vulnerability index based on high population density. Moreover, poor implementation of social

distancing protocol and inadequate COVID-19 testing in the population are strong factors encouraging the transmission of the disease in the country.^[2] The Nigerian Centre for Disease

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Control (NCDC) updated its National Case Definition for COVID-19 in March 2020 releasing a screening tool to guide health practitioners on who to refer for COVID-19 test.^[3] This was necessary to guide rational use of the available test kits for symptomatic patients who were likely to test positive than asymptomatic carriers (even with a positive history of contact to a certified patient). The SARS-CoV-2 polymerase chain reaction (PCR) test, however, has a turnaround time (TAT) of between 24 and 48 h, which poses a challenge for patients presenting in an emergency setting, where clinicians need to decide whether to admit into the accident and emergency (A and E), or into the holding ward for suspected COVID-19 infection. The need for confirmatory virology test with reverse transcription (RT)-PCR leads to delays in the management of these patients who may not have COVID-19 but present with other morbidities that require urgent intervention in the A and E, hence the need for an evidence-based, yet efficient approach to triaging suspected cases.

Due to rising need for increased testing and treatment capacity, the management of Lagos University Teaching Hospital (LUTH) under the Federal Ministry of Health put the operational capacity in place for the screening of suspected cases of COVID and the triaging and management of confirmed cases as per NCDC guidelines.^[3,4] A COVID response team was mobilised, trained and subsequently activated for the above objectives. Given time and resource constraints as stated above, the LUTH COVID-19 response team utilised the NCDC's case definition and created a weighted screening tool that reflected our tertiary care context, especially in the face of limited COVID-19 test and extraction kits in the country [Appendix 1]. The primary intention of this tool was to clinically evaluate all patients presenting to A and E to discriminate them into high pre-test probability and low pre-test probability for COVID-19, and thereby avoid unnecessary admissions into the suspected COVID-19 ward, where their care could be compromised while awaiting the availability of the PCR tests, which may take between 48 and 72 h. The aim of this study was, therefore, to evaluate the diagnostic utility of the screening questionnaire in triaging patients in the A and E to identify patients with COVID-19, especially where the presentation could have been due to an alternative diagnosis.

METHODS

Study method

This was a retrospective cross-sectional study conducted at LUTH adult Accident and Emergency Department (A and E). The hospital is a leading tertiary centre in Nigeria which serves Lagos and surrounding states, and receives referrals from other parts of the country. The A and E department has a triage team trained to rapidly sort patients. The triage team is made up of medical officers and resident doctors and headed by two consultants. Ethical approval to conduct this research was sought and obtained from the Health Research and Ethics Committee of LUTH with approval number LUTHHREC/EREV/0520/40.

Study population

All patients who had the COVID-19 screening tool administered after a suspicion of COVID-19 at the LUTH A and E triage for the period under review were included in the study.

Data collection

All patients presenting with non-surgically related illnesses seen by the triage team during the period under review (1 August 2020–31 September 2020) were evaluated for possible COVID-19 infection using the structured screening tool [Appendix 1]. The questionnaire contained a checklist of 14 items, which were given weighted points. The total points accrued after the clinical evaluation were utilised to make decisions at A and E. Patients with scores of 0–2 were labelled low pre-test category and admitted into the A and E for further management, while those with scores between 3 and 5 were labelled moderate pre-test category and sent for chest CT scan, and those with scores ≥ 6 labelled as high pre-test category. Patients with high pre-test category and moderate pre-test category patients whose computed tomography (CT) scans were suggestive of COVID-19 were reviewed by the Infectious Disease Unit, and eventually admitted into the holding area of the COVID-19 ward for PCR sampling and treatment in line with protocol. Details of age, gender, presenting complaints, history of contact with COVID-positive patient, alternate medical conditions to explain clinical features and final score allotted were extracted from the case records. These were matched against the result of the RT-PCR test to assess the accuracy of the screening tool (sensitivity and specificity) in detecting COVID-19 infection. Two triage scores were studied. Both scores A and B had 14 variables; score B had weighted scores ranging from +1 to +3, with higher scores assigned to recent onset shortness of breath, easy fatigability, history of recent travel/known contact with an individual with COVID-19 and a score of –3 for the presence of an alternative diagnosis. Score A was a non-weighted scale, with a score of +1 given to all the variables except for the presence of an alternative diagnosis which had a score of –1 [Appendix 1]. For both scores, the absence of the criteria being assessed was awarded a score of 0.

The data was entered into Excel spreadsheet and then imported into StataCorp. 2019. Stata Statistical Software: Release 16. (College Station, TX, USA: StataCorp LLC.). Continuous variables were described as mean and standard deviation while categorical variables were described as frequency and percentages. The prevalence (and 95% confidence interval [CI]) of COVID-19 based on PCR test results was calculated. Student's *t*-test and Pearson's Chi-square test were, respectively, utilised to assess the association between age, gender and COVID-19 status. The association between triage classification score (0–2 [low], 3–5 [moderate] and ≥ 6 [high risk]) and COVID-19-positive results was assessed using the Pearson's Chi-square and McNemar test. Validity test (sensitivity, specificity, negative predictive value and positive predictive value) of the triage score A and score B was assessed at cut-off of 6 (high risk) and 3 (moderate to high risk),

respectively. Series of threshold of a cut-off point of score A was conducted using receiver operating characteristic (ROC) curves. The optimum cut-off score was then calculated using the maximal Youden's index. Similarly, the optimum cut-off for Score B was also calculated. Concordance between scores A and B was assessed using the Cohen's kappa score of agreement. The accuracy of predicting COVID-19 using scores A and B was also compared by comparing the area under the ROC of the two triage scores. $P < 0.05$ was considered statistically significant, and two-tailed test of hypothesis was assumed.

RESULTS

COVID-19 prevalence

The prevalence of COVID-19 amongst the study population was 40.6% (95% CI: 31.4%–50.5%), $n = 41/101$. Three of the participants with COVID test did not have triage score and were excluded from further analysis. After the exclusion, the prevalence of positive COVID result was 40.8% (95% CI: 31.4%–50.9%).

Socio-demographic characteristics

More than half of the study participants were female (58/95; 61.05%) and the average age of the participants was 37.47 ± 14.96 years and about 60% of the participants were younger than 40 years. From Table 1, there was no statistically significant relationship between gender and age and COVID-19 PCR status. Table 2 shows the prevalence of Covid -19 in the

Table 1: Comparison of the socio-demographic characteristics amongst participants with positive and negative COVID-19 polymerase chain reaction test

Characteristics	COVID-19 negative	COVID-19 positive	Total	P
Gender				
Female	36 (66.67)	22 (53.66)	58 (61.05)	0.198
Male	18 (33.33)	19 (46.34)	37 (38.95)	
Age (years)	35.82±15.32	39.75±14.33	37.47±14.96	0.2077
<40	36 (65.45)	21 (52.50)	57 (60.00)	0.203
≥40	19 (34.55)	19 (47.50)	38 (40.00)	

Table 2: Comparison of true positive and true negative of triage score A and score B in predicting COVID positivity

	PCR result		Total
	Positive	Negative	
Score A			
Positive (≥4)	21 (52.50)	18 (31.03)	39 (39.80)
Negative (<4)	19 (47.50)	40 (68.97)	59 (60.20)
Total	40 (100.00)	58 (100.00)	98 (100.00)
Score B			
Positive (≥6)	16 (40.00)	15 (25.86)	31 (31.63)
Negative (<6)	24 (60.00)	43 (74.14)	67 (68.37)
Total	40 (100.00)	58 (100.00)	98 (100.00)

PCR: Polymerase chain reaction

study population. The predictive prevalence of COVID-19 based on Triage Score B (≥6) was 31.6% (95% CI: 23.1% - 41.6%), $n = 31/98$, which was lower than the predictive prevalence of COVID-19 based on Triage Score A (≥4).

Performance of triage score A

When the differential-weighted score tool was used (score A), the optimum cut-off triage score for diagnosing positive COVID-19 was 4 with sensitivity and specificity of 52.5% and 68.97%, respectively. However, as shown from Table 3, the accuracy of the test is poor, with the area under the ROC curve of 0.60 and correctly classifying only 62.67% of cases. When the performance was stratified by gender, the optimum cut-off for males was 4 while the optimum cut-off for females was 5. The area under the curve (AUC) of ROC for male participants was slightly higher than for females (0.64 vs. 0.59).

Of all the various clinical scenarios, the best performance of the triage score A will be amongst older males (male and ≥40 years) with ROC of 79.9% at optimum cut-off score of 3. Generally, the triage tool A appears to be more useful as a diagnostic tool than a screening tool as the specificity (true negative rate) was generally higher than the sensitivity (true-positive rate) in all scenarios. Based on the priori classification of the triage tool (0–2 [low], 3–5 [moderate] and ≥6 [high risk]), the sensitivity and specificity of triage score A at cut-off of 6 (high risk) were 25% and 92.86%, respectively [Supplementary Table 1], while the sensitivity and specificity of the triage score A at cut-off of 3 (moderate-to-high-risk classification) were 62.5% and 58.62%, respectively [Supplementary Table 2].

Performance of triage score B

From Table 4, the optimum cut-off triage score B (non-differential-weighted score) for diagnosing positive COVID-19 was 6 with sensitivity and specificity of 40.0% and 74.14%, respectively. However, the accuracy of the test is poor, with the area under the ROC curve of 0.52 and correctly classifying only 60.20% of cases. When the performance was stratified by gender, the optimum cut-off score for males was 8 while the optimum cut-off score for females was 6. The AUC of ROC for male participants appears higher than for females (0.58 vs. 0.48). Of all the various clinical scenarios, the best performance of the triage score will be amongst older males (male and ≥40 years) with ROC of 66.7% at optimum cut-off score of 8. Generally, the triage tool appears to be more useful as a diagnostic tool than a screening tool as the specificity (true negative rate) was generally higher than the sensitivity (true-positive rate).

Comparison of the performance of triage score A and score B

As shown in Table 5, the ROC for score A was higher than the ROC for score B (0.60 vs. 0.52, $P = 0.0047$). The kappa score of agreement between the predictive values of score A and score B for diagnosing positive COVID test was fairly good (0.78, $P < 0.0001$).

Table 3: The utility of COVID triage score A in diagnosing/predicting COVID as compared to polymerase chain reaction as gold standard

	Number of participants	Optimum cut-off	Sensitivity (%)	Specificity (%)	AUC, ROC	Correctly classified (%)
Overall	98	4	52.50	68.97	0.5985	62.24
Gender						
Male	36	4	57.87	70.59	0.6424	63.89
Female	57	5	42.86	80.56	0.5939	66.67
Age (years)						
<40	57	6	28.57	91.67	0.5939	68.42
≥40	35	4	55.56	88.24	0.7075	71.43
Male and <40	18	7	20.00	100.00	0.5500	55.56
Male and ≥40	17	3	75.00	77.78	0.7986	76.47
Female and <40	39	6	36.36	89.29	0.5893	74.36
Female and ≥40	18	4	50.00	87.50	0.6250	66.67

ROC: Receiver operating characteristic, AUC: Area under the ROC curve

Table 4: The utility of COVID triage score B in diagnosing/predicting COVID as compared to polymerase chain reaction as gold standard

Characteristics	Number of participants	Optimum cut-off	Sensitivity (%)	Specificity (%)	AUC, ROC	Correctly classified (%)
Overall	98	6	40.0	74.14	0.5183	60.20
Gender						
Male	36	8	26.32	94.12	0.5759	58.33
Female	57	6	42.86	75.00	0.4854	63.16
Age (years)						
<40	57	5	47.62	61.11	0.5046	56.14
≥40	35	6	50.00	88.24	0.5931	68.57
Male and <40	18	4	70.00	37.50	0.5000	55.56
Male and ≥40	17	8	37.5	100.00	0.6667	70.59
Female and <40	39	6	36.36	75.00	0.4675	64.10
Female and ≥40	18	6	50.00	75.00	0.5125	61.11

ROC: Receiver operator characteristic, AUC: Area under the ROC curve

Table 5: Comparison of the overall performance of triage score A and score B in predicting COVID positivity

Parameters	Score		P
	A	B	
Number of participants	98	98	
Optimum cut-off	4	6	
Sensitivity (%)	52.50	40.0	
Specificity (%)	68.97	74.14	
AUC, ROC (95% CI)	0.5985 (0.4804-0.7166)	0.5183 (0.3962-0.6405)	0.0047
Agreement between score A and score B (%)	60.20	-	
Kappa score of agreement between score A and score B	0.7794	-	<0.0001

ROC: Receiver operating characteristic, AUC: Area under the ROC curve, CI: Confidence interval

DISCUSSION

This study aimed to evaluate the utility of NCDC triage score as a useful algorithm in the diagnosis and management of COVID-19 patients in our environment. The justification for a clinical screening tool in our centre lay in the fact that our ward for keeping patients with suspected COVID-19 (i.e., individuals who fulfilled case definition for COVID-19 but who could still turn out to be negative) was not sufficient to accommodate the high number of possible/suspected cases that presented to our

A and E. Our report has generated hypothesis and basis for larger study to guide decision.

The study showed that males had a higher test positivity rate (51.4% vs. 37.9%), a similar finding reported in some other studies within and outside the country.^[5,6] A meta-analysis revealed that male sex is associated with a significantly increased risk of mortality within a COVID-19 patient despite no differences in the risk of infection, which may be attributed to both socio-economic factors and fundamental differences in the immune responses between males and females.^[7]

The above demographic characteristics indicate that despite the dangers of the pandemic, the need to go out and earn a daily living outweighed the dangers posed by the virus.^[8]

The specificity of 74.14 (score B) and 68.97 (score A), as well as AUC ROC of 0.5183 (95% CI: 0.3962–0.6405) and 0.5985 (95% CI: 0.4804–0.7166) for scores B and A, respectively, as demonstrated in our study, will seem to suggest a positive role for such clinical algorithms when their primary role is to prevent unwarranted admissions into the infectious disease ward. Management of alternative diagnoses will not only have been compromised, but the previously uninfected (but clearly vulnerable) patients will be at a higher risk of getting infected with COVID-19. A similar study conducted in Brazil found that the use of two or more symptoms with or without anosmia or ageusia in a patient without known contact or one or more symptoms with or without anosmia or ageusia in a patient with known contact was 80.4% accurate in clinical diagnosis of COVID-19, and yielded a higher pre-test probability and accuracy than the RT-PCR for SARS-CoV-2.^[9] A model that utilised machine learning algorithm for the diagnosis of COVID-19 had an area under the ROC of 0.91 (95% CI: 0.87–0.96) and achieved a sensitivity of 0.93 (95% CI: 0.85–0.98) and specificity of 0.64 (95% CI: 0.58–0.69).^[10]

This tool was primarily intended to be highly discriminatory and specific, i.e., identify patients presenting in the A and E with a low pre-test probability of COVID-19 so that they could receive care in the A and E, and not be transferred to the COVID-19 ward. In this regard, a low sensitivity as recorded with this tool using a score of 6 will probably make it pertinent for such patients to still be sampled for SARS-CoV-2 RT-PCR while receiving the needed care within the A and E and applying all the standard precautions for infection prevention and control.

Clinical algorithms for the diagnosis of COVID-19 generally suffer due to the non-specific symptoms and the varied clinical presentations patients may present with, making the accurate clinical diagnosis of COVID-19 unreliable. However, if clinical algorithms such as ours are used primarily to determine pre-test probability and therefore guide admission patterns in resource-limited but over-burdened multidisciplinary settings like ours, it could potentially shorten the time to access the appropriate specialist care, especially in an emergency setting. Additionally, using a clinical scoring tool to determine who should undergo chest CT scan for further decision-making is a very useful way of both reducing patient expenditure and limiting exposure to radiation amongst such patients.

The limitation of this study was that it was a retrospective study and sample size was not calculated. Thus, the power of the utilised sample size may not be adequate.

CONCLUSION

The clinical algorithm as developed and utilised in our hospital showed some specificity in its initial design. It helped to identify and limit the number of patients that will have to be sent for chest imaging, thereby making efficient use of limited resources and reducing patients' exposure to radiations.

Recommendations

A screening score of 4 (score A) or 6 (score B) of the current screening tool will increase the chances of identifying persons with COVID-19 for RT-PCR testing. It is also recommended that the negative score of – 3 which was to capture alternative diagnosis should be expunged due to the prevailing community spread of the disease. A larger multicentre study can be conducted to validate our findings.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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Appendix 1: COVID-19 screening tool

Patient name:

Age:

Gender:

Date:

Questions	Score A	Score B	No
Cough of recent onset, within the last 14 days	+1	+1	0
Catarrh/running nose of recent onset, within the last 14 days	+1	+1	0
Sore throat	+1	+1	0
Diarrhoea	+1	+1	0
Body pains	+1	+1	0
Headaches	+1	+1	0
Fever	+1	+1	0
Anosmia	+1	+1	0
Ageusia	+1	+1	0
Difficulty breathing of recent onset, within the last 14 days	+2	+1	0
Easy fatigability	+2	+1	0
Any travel during the past 14 days	+3	+1	0
Contact with an individual who tested positive for COVID-19	+3	+1	0
Symptoms explainable by an alternative diagnosis	-3	-1	0
Total			

Supplementary Table 1: Validity of the triage score based on cut off of 6 as compared to PCR test

Triage score	PCR Test result		Total	P-value
	Positive	Negative		
Score A				
Low (<6)	30 (75.00)	52 (89.66)	82 (83.67)	0.001 ^c
High (≥6)	10 (25.00)	6 (10.34)	16 (16.33)	
	40 (100.00)	56 (100.00)	98 (100.00)	
Score B				
Low (<6)	24 (60.00)	43 (74.14)	67 (68.37)	0.1495 ^c
High (≥6)	16 (40.00)	15 (25.86)	31 (31.63)	
	40 (100.00)	58 (100.00)	98 (100.00)	

From supplementary Table 1, for scoreA at cut-off of 6 (High risk), Sensitivity = 10/40 = 25% ; specificity = 52/56 = 92.86% ; Negative predictive Value = 52/82 = 63.41% ; positive predictive value = 16/31 = 62.5%.

For scoreB at cut-off of 6 (High risk), Sensitivity = 16/40 = 40% ; specificity = 43/58 = 74.14% ; Negative predictive Value = 43/67 = 64.18% ; positive predictive value = 16/31 = 51.61%.

Supplementary Table 2: Validity of the triage score based on cut off of 3 as compared to PCR test

Triage score	PCR test result		Total	P-value
	Positive	Negative		
Score A				
Low (<3)	15 (37.5)	34 (58.62)	49 (50.00)	0.1495 ^c
High (≥3)	25 (62.50)	24 (41.38)	49 (50.00)	
	40 (100.00)	56 (100.00)	98 (100.00)	
Score B				
Low (<3)	11 (27.50)	9 (15.52)	20 (20.41)	< 0.001 ^c
High (≥3)	29 (72.50)	49 (84.48)	78 (79.59)	
	40 (100.00)	58 (100.00)	98 (100.00)	

From Supplementary Table 2, for score A at cut-off of 3 (Moderate to high risk), Sensitivity = 25/40 = 62.5% ; specificity = 34/56 = 58.62% ; Negative predictive Value = 34/49 = 69.39% ; positive predictive value = 25/49 = 51.02%.

For scoreB at cut-off of 3 (Moderate to high risk), Sensitivity = 29/40 = 72.5% ; specificity = 9/58 = 15.52% ; Negative predictive Value = 9/20 = 45.0% ; positive predictive value = 29/78 = 31.18%.