Does SARI Score Predict COVID-19 Positivity? A Retrospective Analysis of Emergency Department Patients in a Tertiary Hospital

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Abstract

Effectively triaging incoming patients while preventing coronavirus disease 2019 (COVID-19) spread in any emergency department (ED) is a demanding and critical task that places a huge burden on frontline healthcare workers. The ED at our tertiary hospital utilized a slightly modified version of a formerly efficacious severe acute respiratory infections (SARI) screening tool for triaging patients presenting to the ED with respiratory illness. We conducted a retrospective chart review and included patients who were screened using the SARI screening tool and underwent a combined nasopharyngeal and oropharyngeal reverse transcription polymerase chain reaction swab for severe acute respiratory syndrome- related coronavirus 2 to determine COVID-19 positivity. Results from our study show that it may be warranted to remove the gastrointestinal symptoms (nausea, vomiting, and diarrhea) from the SARI screening tool and potentially adjusting the weights of the components in the screening tool. However, as data from additional studies become available, the current SARI screening tool could continue to be used as a screening tool to predict COVID-19 positivity and in triaging patients.

Keywords

- COVID-19
- SARI screening tool
- emergency department
- triage
- Saudi Arabia
- tertiary hospital

Introduction

Severe acute respiratory syndrome-related coronavirus 2 (SARS-CoV-2), the virus responsible for coronavirus disease 2019 (COVID-19) syndrome, was discovered in Wuhan, China on November 17, 2019.[1] It was reported to the World Health Organization on December 31, 2019.[2] The first case of COVID-19 in the Kingdom of Saudi Arabia was diagnosed on March 2, 2020.[3] The Centers for Disease Control and Prevention declared COVID-19 a global pandemic on March 26, 2020. As of December 2021, there have been more than 270 million cases reported worldwide, with Saudi Arabia reporting a total of 550,000 cases.[4]

The Kingdom of Saudi Arabia saw its peak of the COVID-19 pandemic wave in June 2020 with an average of ~4,400 new cases per day. The country experienced a second wave of increase in the number of cases after the emergence of mutated variants of the SARS-CoV-2 virus. However, a significant decrease has been documented in the number of cases after the introduction of nationwide implementation

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of preventive measures, public awareness, and vaccination programs.

During the peak of the pandemic, effectively triaging incoming patients while preventing COVID-19 spread in any emergency department (ED) was a demanding and critical task that placed a huge burden on healthcare front-line workers.[5] At that time, much research was directed toward rapid point-of-care diagnostics to quickly identify and isolate COVID-19 suspected cases. Some scoring tools have been proposed to screen for COVID-19 but very few have proven to be reliable in ED settings. The ED at our tertiary hospital utilized a slightly modified version of a formerly efficacious severe acute respiratory infections (SARI) (screening tool for triaging patients presenting to the ED with respiratory illness. The SARI screening tool had been put to use extensively during the previous Middle East respiratory syndrome epidemic in Saudi Arabia.[6]

Currently, there are no studies on SARI as a screening tool for suspected COVID-19 patients. The aim of this study is to assess the utility of the modified SARI screening tool in predicting COVID-19 positive cases in an ED setting.

Materials and Methods

This study is a retrospective chart review between March 13, 2020, and November 30, 2020. All incoming patients were screened with two tools, (a) the SARI screening tool and (b) the Canadian Triage and Acuity Scale (CTAS)-based triage tool.

SARI Screening Tool

The SARI screening tool, stipulated by the Saudi Center for Disease Prevention and Control (Weqaya), screened for COVID-19 mainly through two components: the patients' exposure risks and clinical signs and symptoms. The three types of exposure risks assessed were (a) travel history to high-risks areas and outside Saudi Arabia, or (b) close contact with a confirmed COVID-19 patient 14 days prior to symptoms onset, or (c) working in a healthcare facility with confirmed COVID-19 patients. A patient was given a score of 3 points if they presented with any one of the three exposure risks. The clinical signs and symptoms included in the checklist were (a) active or recent history of fever; (b) cough—new or worsening; (c) shortness of breath—new or worsening; (d) headache, sore throat, or rhinorrhea; (e) nausea, vomiting and/or diarrhea; (f) chronic renal failure, coronary artery disease/heart failure, immunocompromised patient. A patient was given a score of 4 points for subcomponents a, b, and c and a score of 1 point for subcomponents d, e, and f. Pediatric patients did not receive a score for subcomponent f. Therefore, incoming patients with respiratory symptoms were screened and given a total score called the SARI score. Further testing through combined nasopharyngeal and oropharyngeal reverse transcription polymerase chain reaction (RT-PCR) swab for SARS-CoV-2 as a confirmatory test was performed based on high SARI scores and/or according to case definitions. Consequently, this study includes patients who were screened using the SARI screening tool and underwent a combined nasopharyngeal and oropharyngeal RT-PCR swab for SARS-CoV-2. A total of 961 patients were included who met these criteria. SARI scores were classified into categories—low (1–4 points), medium (5—11 points), and high (12 and above points).

CTAS-based Triage Tool

The CTAS categorized patients into five categories depending on the acuity: (a) level I—resuscitation, (b) level II—emergency, (c) level III—urgency, (d) level IV—less urgency, and (e) level V—nonurgency.

Ethical Considerations

This study was approved by the Ethics Committee Review (C380/367/42) at King Faisal Specialist Hospital and Research Center.

Statistical Analysis

Quantitative data are presented using mean and standard deviation. Qualitative data are presented as counts and proportions (%). Normality test and statistical collinearity had been performed using Kolmogorov–Smirnov test as well as Shapiro–Wilk test. The data follows an abnormal distribution (p-value <0.001). Thus, nonparametric tests were performed. Multivariable logistic regression analysis was performed to identify the association of independent factors of the SARI screening tool with COVID-19 positivity. The multivariable model included all components of the SARI screening tool. A two-sided p-value of <0.05 was used to indicate statistical significance, while $p < 0.01$ was considered statistically significant. All data analyses were performed using Jamovi (v 1.6.23) and IBM SPSS Statistics for Windows, Version 28.0 (IBM Corp, Armonk, New York, United States).

Results

We retrospectively analyzed 961 patients who underwent COVID-19 PCRs as seen in ►**Table 1**. The majority (78.1%) of patients were in the middle age group (14–65 years) with about half being females (51.6%). The proportion of patients with low (<95%) oxygen saturation level levels was 15.9%, while 35.5% of the patients were wheelchair-bound, and 8% were bedridden. The proportion of patients who had been tested outside for COVID-19 was 17.1%, while the proportion of patients with first presentation was 92.6%. In terms of SARI score, more than half (52.4%) were classified as medium, 28.4% as low, and 19.1% as high. With regard to swab history, more than two-third (67.7%) had one swab and the others had more than one (32.3%). The proportion of patients with comorbidities such as heart disease, and diabetes mellitus was 53.6%. The proportion of patients who had known COVID-19 exposure was 78.7%, while 95.8% of all included participants were COVID-19 positive upon swab testing.

When measuring the association between COVID-19 positivity and patient presentation, as seen in ►**Table 2**, we found significant association for fever ($p < 0.001$),

Table 1 Summary statistics of patients presented at KFSHRC, March 10, 2020, to November 30, 2020

Study variables	*n* (%)
Age group in years ($n = 961$)	
< 14 years	54 (5.6%)
14–65 years	751 (78.1%)
> 65 years	156 (16.2%)
Gender ($n = 961$)	
Male	465 (48.4%)
Female	496 (51.6%)
SpO_2 level ($n = 966$)	
Less than 85%	16 (1.7%)
85–94%	137 (14.3%)
Normal ($\geq$95%)	808 (84.1%)
Mobility ($n = 966$)	
Walking	543 (56.5%)
Wheelchair	341 (35.5%)
Bedridden	77 (8.0%)
COVID-19 swab ($n = 961$)	
Outside	164 (17.1%)
At KFSHRC	797 (82.9%)
Swab number ($n = 961$)	
One	651 (67.7%)
Two	198 (20.6%)
More than two	112 (11.7%)
Presentation number ($n = 961$)	
First	890 (92.6%)
Second	59 (6.1%)
Third	10 (1.0%)
Fourth	2 (0.2%)
SARI score ($n = 961$)	
Low	273 (28.4%)
Medium	504 (52.4%)
High	184 (19.1%)
Triage score ($n = 961$)	
Low	481 (50.1%)
Medium	391 (40.7%)
High	89 (9.3%)
COVID-19 exposure ($n = 961$)	
Yes	756 (78.7%)
No	205 (21.3%)
COVID-19 test ($n = 961$)	
Positive	921 (95.8%)
Negative	40 (4.2%)

Abbreviations: COVID-19, coronavirus disease 2019; KFSHRC, King Faisal Specialist Hospital and Research Center; SARI, severe acute respiratory infection; SpO2, oxygen saturation level.

headache ($p = 0.002$), and COVID-19 exposure ($p < 0.001$), and existence of comorbidities ($p < 0.001$).

The median SARI score was found to be 40% higher in COVID-19 positive patients as compared with COVID-19 negative patients ($p = 0.002$) (►**Table 3**). However, the multivariate logistic regression analysis showed that the SARI model may only explain 3% of the variability in COVID-19 positivity (R-square = 0.03). The multivariate analysis of the SARI model variables resulted also in a weak prediction ability, where only 24% of the COVID-19 positivity could be explained through model predictors (R-square = 0.242) (►**Table 4**).

In contrast to the bivariate analysis (►**Table 2**), the multivariate regression analysis clarified that the significant association seen initially between gastrointestinal symptoms and COVID-19 positivity could be explained by other SARI screening tool predictors, confirming a confounding effect. On the other hand, the association between shortness of breath and COVID-19 positivity was suppressed by other SARI screening tool components, and therefore was significant after controlling for them in the regression analysis. Yet, the model showed that COVID-19 positive patients are less likely to present at the emergency room in our study settings with shortness of breath (odds ratio [OR] = 0.4, *p*-value = 0.018). In our model, presence of comorbidities was the strongest predictor for COVID-19 positivity (OR = 8.6), while other significant predictors include COVID-19 exposure, headache, and fever. The loss of smell/taste was also not significant (►**Table 4**).

Discussion

Using screening tools to manage patient flow is used in many clinical settings. Of these tools, the CTAS is the one that is most commonly used in EDs around the world. In certain circumstances, when a higher risk of contamination exists like in cases of Middle East respiratory syndrome coronavirus outbreak and the ongoing COVID-19 pandemic; additional screening tools may be necessary to identify highly contagious individuals and manage them accordingly. This would include immediate isolation in pressure negative rooms, notification of infection control teams, and proper use of personal protective equipment by staff. Here, in this study, we specifically used the SARI screening tool for screening of symptoms that could suggest a SARS-CoV-2 infection. Of note, the SARI screening tool was the stipulated screening tool at the time of the study and was implemented in all hospitals in accordance with national COVID-19 prevention regulations.

Although in our study the SARI screening tool was able to improve patient flow and helped in redirecting resources to patients in need appropriately, the tool was not perfect. According to the SARI screening tool, all hospital employees that showed up to the ED received an additional score of 3 under the "hospital employee" category. These 3 points were added even if the patient had no other symptoms. According to the hospital policy, anyone who scored 4 or higher had to be seen in the ED. Subsequently, many hospital staff were

Table 2 Relationship of COVID-19 positivity among presented patients with different variables

		COVID-19 positivity						Chi-squared test
		Negative		Positive		Total		
		Count	Row N %	Count	Row N %	Count	Row N %	*p*-Value
	Total	**40**	**3.9%**	**921**	**96.1%**	**961**	**100.0%**	
Hospital employee	No	24	4.2%	554	95.8%	578	100.0%	0.989
	Yes	16	4.2%	367	95.8%	383	100.0%	
	Total	40	4.2%	921	95.8%	961	100.0%	
Fever	No	31	6.7%	431	93.3%	462	100.0%	<0.001**
	Yes	9	1.8%	490	98.2%	499	100.0%	
	Total	40	4.2%	921	95.8%	961	100.0%	
Shortness of breath	No	24	3.6%	636	96.4%	660	100.0%	0.227
	Yes	16	5.3%	285	94.7%	301	100.0%	
	Total	40	4.2%	921	95.8%	961	100.0%	
Sore throat	No	29	3.8%	735	96.2%	764	100.0%	0.263
	Yes	11	5.6%	186	94.4%	197	100.0%	
	Total	40	4.2%	921	95.8%	961	100.0%	
Cough	No	24	4.8%	481	95.2%	505	100.0%	0.335
	Yes	16	3.5%	440	96.5%	456	100.0%	
	Total	40	4.2%	921	95.8%	961	100.0%	
Headache	No	34	5.8%	554	94.2%	588	100.0%	0.002**
	Yes	6	1.6%	367	98.4%	373	100.0%	
	Total	40	4.2%	921	95.8%	961	100.0%	
Loss of smell/taste	No	40	4.3%	885	95.7%	925	100.0%	0.202
	Yes	0	0.0%	36	100.0%	36	100.0%	
	Total	40	4.2%	921	95.8%	961	100.0%	
Nausea, vomiting, or diarrhea	No	37	4.8%	734	95.2%	771	100.0%	0.047**
	Yes	3	1.6%	187	98.4%	190	100.0%	
	Total	40	4.2%	921	95.8%	961	100.0%	
COVID-19 exposure	No	18	8.8%	187	91.2%	205	100.0%	<0.001**
	Yes	22	2.9%	734	97.1%	756	100.0%	
	Total	40	4.2%	921	95.8%	961	100.0%	
Comorbidities	No	33	7.4%	413	92.6%	446	100.0%	<0.001**
	Yes	7	1.4%	508	98.6%	515	100.0%	
	Total	40	4.2%	921	95.8%	961	100.0%	

Abbreviation: COVID-19, coronavirus disease 2019.
**Significant at the 0.05 level.

seen in the ED instead of being directed to the designated outpatient employee health clinic. This was counterproductive in improving patient flow.

Interestingly, not all components of the SARI screening tool were significantly correlated with COVID-19 positivity. Primary analysis showed that factors such as fever, headache, gastro symptoms (nausea, vomiting, or diarrhea), exposure to SARS-CoV-2 infected individuals, and presence of comorbidities were significantly correlated with COVID-19 positivity. Additional testing through logistic regression analysis revealed that there was no association between gastro symptoms (nausea, vomiting, and diarrhea) and COVID-19 positivity. In contrast, the association between shortness of breath and COVID-19 positivity was confounded by other SARI screening tool components and only was statistically significant in the multivariate logistic regression analysis. Other SARI screening tool components that remained significantly correlated with COVID-19 positivity in the logistic regression models are fever, headache, exposure to SARS-CoV-2 infected individuals, and presence of comorbidities. However, loss of smell or taste was clearly not correlated with COVID-19 positivity. Moreover, the study also

Table 3 Relationship of SARI score with COVID-19 positivity

		COVID-19 positivity			Mann–Whitney U test	*p*-Value
		Positive	Negative	Total		
SARI score	Median	7	5	7	23,838	0.002**
	Mean rank	486.88	345.55			

Abbreviation: COVID-19, coronavirus disease 2019.
** Significant at the 0.05 level.

Table 4 Multivariate analysis of SARI screening tool components

		B	SE	Wald	df	*p*-Value	OR
Nagelkerke R-square = 0.031							
Step 1[a]	SARI score	0.137	0.049	7.843	1	0.005**	1.147
	Constant	2.303	0.306	56.526	1	<0.001**	10.005
Nagelkerke R square = 0.242							
Hospital employee		0.487	0.374	1.690	1	0.194	1.627
Fever		1.045	0.401	6.782	1	0.009**	2.844
Shortness of breath		−0.906	0.383	5.590	1	0.018*	0.404
Sore throat		−0.548	0.408	1.800	1	0.180	0.578
Cough		0.430	0.382	1.267	1	0.260	1.538
Headache		1.152	0.465	6.132	1	0.013*	3.164
Loss of smell/taste		17.768	6188.971	0.000	1	0.998	52086155.12
Gastro symptoms		0.577	0.628	0.844	1	0.358	1.781
COVID-19 EXP		1.137	0.359	10.026	1	0.002**	3.116
Comorbidities		2.147	0.468	21.071	1	<0.001**	8.562
Constant		0.878	0.381	5.321	1	0.021	2.407

Abbreviations: COVID-19, coronavirus disease 2019; OR, odds ratio; SARI, severe acute respiratory infection; SE, standard error.
** Significant at the 0.05 level.
[a]variable(s) entered on Step 1: SARI score, Constant.

highlighted that an increase in the SARI score by 1 point was associated with ∼15% increase in the odds of having a positive COVID-19 PCR test.

The overall positive rate of COVID-19 at the time of the study in our tertiary care hospital was ∼95.8%; however, the overall percentage of people who were being screened at the time in the country was ∼2%. This is likely because the majority of patients who presented to the ED did not achieve a high enough score on the SARI screening tool and were less likely to undergo a PCR for SARS-CoV-2. Therefore, the predominant representation was of patients with high SARI scores. This is also evident from the data since the most common SARI score in our dataset was a score of 5, and only 28.4% of the patients presented with a low SARI score (SARI score = ≤4). Moreover, during the duration of the study, an estimate of ∼65,000 patients were seen in the ED. Of the 961 included in this study, 71.6% had a SARI score of 4 or higher.

Name	Role	Duties
Baraa Alghalyini	PI	Started and lead the team, created project idea and proposal, oversaw the development of project protocol, obtained Institutional Review Board approval, managed the project, manuscript write-up, and submission
Ismail M. Shakir	Co-investigator	Contributed to data analysis, contributed to write-up of the methods and results, offered overall revision of the manuscript
Muaz M. Wahed	Co-investigator	Data collection, write-up of literature review
Sultan M. Babar	Co-investigator	Offered medical expertise to reflect on results. Contributed to write-up of the discussion and conclusion sections
Mohamed S. Mohamed	Co-investigator	Data analysis, contributed to write-up of results section

In terms of limitations, since this study was conducted in a tertiary level hospital, only approved patients presented to the ED for care. This selective acceptance of patients means that our sample population may not have been entirely representative of the general population and poses a limitation of the study.

Conclusion

In conclusion, it seems that the SARI screening tool has a role in predicting COVID-19 positivity and requires additional studies on a larger and more representative population to further assess the accuracy and utility of the tool. Based on our study, it may be warranted to remove the gastrointestinal symptoms (nausea, vomiting, and diarrhea) from the SARI screening tool and potentially adjusting the weights of the SARI tool screening tool components. Meanwhile, as data from additional studies become available, the current SARI screening tool could continue to be used as a screening tool to predict COVID-19 positivity and in triaging patients.

Conflict of Interest
None declared.

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