Performance Evaluation of *SARS-CoV-2* Rapid Antigen Test Among Symptomatic and Asymptomatic Patients in the Emergency Department of a Tertiary Care Hospital

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ABSTRACT

The aim of this study was to evaluate the diagnostic performance of the *SARS-CoV-2* rapid antigen test (RAT) for the diagnosis of COVID-19 among symptomatic and asymptomatic patients. This retrospective study was done from 15th November 2021 to 15th December 2021, at National Medical Centre, Karachi, Pakistan. Two parallel nasopharyngeal swabs were collected from each patient, and *SARS-CoV-2* RAT and *SARS-CoV-2* real-time polymerase chain reaction (RT-PCR) were done. A total of 719 patients were included, mean age was 46.03±17.74 years with 378 (52.6%) males. The sensitivity was higher in symptomatic patients i.e. 95.18%, while RAT was found to be more specific in asymptomatic patients with a specificity of 99.83%. High diagnostic accuracy of 91.81% and 96.29% were noted in symptomatic and asymptomatic patients, respectively. *SARS-CoV-2* RAT (Roche) can be used for early diagnosis of *SARS-CoV-2* patients in busy emergency departments.

Key Words: *COVID-19, Diagnosis, Rapid antigen test, RT-PCR, Emergency service.*

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Severe acute respiratory syndrome coronavirus 2 (*SARS-CoV-2*) infection causes a disease with respiratory symptoms called COVID-19. The emergency department (ED) had to deal with symptomatic and asymptomatic COVID-19. Asymptomatic COVID-19 patients were acting as silent carriers causing nosocomial spread of the disease. Rapid, accurate detection, and timely isolation of COVID-19 patients presented a major challenge in EDs throughout the world.

Real-time polymerase chain reaction (RT-PCR) using nasopharyngeal secretions is regarded as the gold standard diagnostic test for the detection of *SARS-CoV-2* infection, but it has challenges like increased cost, lack of PCR instruments, and lengthy testing procedure. Delay in result reporting emerged as a limitation to the use of RT-PCR as the only diagnostic tool for COVID-19 in EDs.[1]

SARS-CoV-2 rapid antigen test (RAT) used antibodies to target the *SARS-CoV-2* nucleocapsid protein.

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The RAT could prove to be a cost-effective and fast replacement for RT-PCR for all the patients presenting in the ED initiation of isolation and treatment without the risk of nosocomial spread. RAT kits have small sizes, are user-friendly, and do not require additional equipment giving quick results with easy interpretation.

This study aimed to measure the diagnostic performance of SARS-CoV-2 RAT compared to RT-PCR for diagnosis of COVID-19 in symptomatic and asymptomatic patients admitted through ED.

This retrospective study was conducted at the clinical laboratory of the National Medical Centre, Karachi. It included all patients aged ≥18 years who were admitted through the ED from 15th November to 15th December 2021. Data on demographics, symptoms, cause of admission, RT-PCR, and RAT results were collected from electronic hospital records. All data was anonymised to protect patient privacy. Patients with incomplete data in their files were excluded from the study.

As per hospital policy for admission, a well-trained laboratory staff collected 2 parallel nasopharyngeal swabs for RT-PCR and RAT at the same time in the ED. Swab for RAT was transported to the lab within 5 minutes in buffer tube, stirred in extraction buffer, and squeezed 5 times. Three drops of extracted liquid were applied to the specimen well of the test device and the result was recorded after 15–30 minutes. The result was only considered valid if the control line was visible. Even faint test lines were considered positive. The manufacturer's instructions for quality control and testing were strictly followed.

Table I: Diagnostic performance of *SARS-CoV-2* RAT for the screening of COVID-19 taking *SARS-CoV-2* RT-PCR as the gold standard.

Rapid Antigen Test	RT-PCR COVID-19		
	Positive	**Negative**	**Total (%)**
Overall (n=719)			
Positive	87 (TP)	3 (FP)	90 (12.5)
Negative	7 (FN)	622 (TN)	629 (87.5)
Symptomatic (n=106)			
Positive	79 (TP)	2 (FP)	81 (76.4)
Negative	4 (FN)	21 (TN)	25 (23.6)
Asymptomatic (n=613)			
Positive	8 (TP)	1 (FP)	9 (1.4)
Negative	3 (FN)	601 (TN)	604 (98.6)
	Overall (95% CI)	**Symptomatic (95% CI)**	**Asymptomatic (95% CI)**
Sensitivity	92.55% (85.26% to 96.95%)	95.18% (88.12% to 98.67%)	72.73% (39.03% to 93.98%)
Specificity	99.52% (98.60% to 99.90%)	91.30% (71.96% to 98.93%)	99.83% (99.08% to 100.00%)
PPV	96.67% (90.35% to 98.90%)	62.20% (30.43% to 86.10%)	98.50% (89.98% to 99.79%)
NPV	98.89% (97.76% to 99.45%)	99.21% (97.96% to 99.70%)	96.05% (90.27% to 98.46%)
Diagnostic Accuracy	98.61% (97.46% to 99.33%)	91.81% (84.87% to 96.25%)	96.29% (94.47% to 97.64%)

TP: True positive, FP: False positive, TN: True negative, FN: False Negative cases in symptomatic and asymptomatic patients. PPV: Positive Predictive Value, NPV: Negative Predictive Value, CI: Confidence Interval. Sensitivity = TP/(TP+FN) x100; Specificity = TN/(TN+FP) x100; PPV = TP/(TP+FP) x100; NPV = TN/(TN+FN); Diagnostic accuracy = (TP+TN)/(TP+TN+FP+FN) x100.

A swab for RT-PCR was transported to the PCR laboratory in a viral transport medium. The RT-PCR amplification was performed by using the *SARS-COV-2* kit supplied by Zeesan Biotech company, Xiamen, China. The sensitivity of this kit was 200 copies/ml. This kit used a multiplex Taqman probe based one step RT-PCR which enabled simultaneous quantitative detection of ORF1ab and N gene of *SARS-COV-2* and a non-human internal control armored RNA for SUC2 in one reaction. The test was performed on a fully Automated Real-Time PCR Rotor-Gene Q5-Plex Analyzer from Qiagen, Hilden, Germany.

Data were organised and entered in SPSS version 22. Frequency and percentages were calculated for age, gender, and patient symptoms. Data were divided into 3 groups of overall, symptomatic, and asymptomatic groups. Two by two tables were made for all 3 groups, keeping RT-PCR as gold standard test and RAT as index test, hence, diagnostic accuracy including sensitivity, specificity, positive predicted value (PPV), and negative predicted value (NPV) were computed. ROC curve analysis was done to validate the performance of RAT in symptomatic and asymptomatic patients.

A total of 719 patients included 378 (52.6%) males and 314 (47.4%) females. Mean age was 46.03 ± 17.74 years. Ninety-four (13.1%) were found to be positive for COVID-19 using the RT-PCR, and the COVID-19 RAT yielded positive results in 90 (12.5%) cases. Six hundred and thirteen (85.3%) were asymptomatic, while only 106 (14.7%) were symptomatic. The commonest symptom was fever in 92 (86.7%) individuals, followed by cough in 63 (59%), dyspnea in 59 (55.6%), malaise/fatigue in 36 (33.9%), and loss of smell in 15 (14%) patients.

The overall sensitivity of the RAT was 98.61% and specificity was 99.52%. The RAT yielded 87 true positive results, confirming the presence of COVID-19, while 622 true negative results were obtained. Only 2 false positive cases were reported among symptomatic patients, and a single false positive case was observed in asymptomatic patients (Table I).

The RAT showed an overall diagnostic accuracy of 98.61% (95% CI 97.46% to 99.33%). Sensitivity was higher in symptomatic patients, at 95.18%, while specificity was higher in asymptomatic patients, at 99.83%. Symptomatic patients had a diagnostic accuracy rate of 91.81%, and asymptomatic patients had a rate of 96.29% (Table I). The AUC for symptomatic patients was 0.93, indicating strong discriminatory ability, whereas in asymptomatic individuals, it was slightly lower at 0.86, indicating slightly reduced discriminatory power.

The diagnostic and analytical performance of *SARS-COV-2* RAT vary widely as reported by the Cochrane COVID-19 Diagnostic Test Accuracy Group.[2] The overall sensitivity was found to be 92.55%, specificity was 99.52%, and the diagnostic accuracy of *SARS-COV-2* RAT was 98.61%. Another researcher has reported comparable specificity but lower overall sensitivity.[3]

In symptomatic patients, the *SARS-CoV-2* RAT demonstrated excellent sensitivity (95.18%) with slightly lower specificity (91.30%) and diagnostic accuracy (91.81%). It correctly identified 100 out of 106 cases, with only 2 false positive and 4 false negative results. The test showed an excellent negative predictive value (NPV) of 99.21% and a low positive predictive value (PPV) of 62.20%. However, caution should be exercised when interpreting PPV, as it is influenced by

disease prevalence in other study populations. In a similar study, Kruttgen *et al*. reported assay specificity as 96%, but sensitivity declined with decreased viral loads in patient samples.[4]

Among the asymptomatic patients *SARS-COV-2* RAT displayed a relatively low sensitivity of 72.73%, with high specificity of 99.83% and diagnostic accuracy of 96.29% as compared to symptomatic patients. This data suggests that *SARS-COV-2* RAT is ideal for diagnosis of COVID-19 in asymptomatic patients because of high specificity, however, low sensitivity means that asymptomatic patients with negative RAT results may still contribute to the nosocomial spread of COVID-19. A similar problem of low sensitivity in asymptomatic has been reported about RAT provided by other companies.[5]

There was a higher diagnostic accuracy of 96.29% in asymptomatic patients while a lower diagnostic accuracy of 91.81% in symptomatic patients. In order to remove the effect of disease prevalence, the authors constructed a ROC graph and calculated the area under the curve (AUC) for *SARS-COV-2* RAT in both groups of patients. It is another global measure of diagnostic performance independent of disease prevalence. The AUC for symptomatic patients was 0.93, which corresponds to excellent diagnostic accuracy, while AUC was slightly lower i.e. 0.86 in asymptomatic individuals corresponding to very good diagnostic accuracy.[6]

The limitations of this study was that it was conducted at a single-centre study and used RAT kits from a single vendor. It should be noted that current results apply only to *SARS--COV-2* RAT from Roche Diagnostics. *SARS-COV-2* rapid antigen test (Roche) has high sensitivity, specificity, and diagnostic accuracy and can be used for rapid identification of asymptomatic carriers and symptomatic COVID-19 patients.

ETHICAL APPROVAL:
The study was conducted after obtaining approval from the hospital's Ethical Committee.

COMPETING INTEREST:
The authors declared no competing interest.

AUTHORS' CONTRIBUTION:
NA: Study conception and design, data collection, and manuscript preparation.
SD: Analysis and interpretation of results, and manuscript preparation.
RA: Manuscript preparation and data collection.
All authors reviewed the results and approved the final version of the manuscript for publication.

REFERENCES

1. Porte L, Legarraga P, Vollrath V, Aguilera X, Munita JM, Araos R, *et al*. Evaluation of a novel antigen-based rapid detection test for the diagnosis of *SARS-CoV-2* in respiratory samples. *Int J Infect Dis* 2020; **99**:328-33. doi:10.1016/j.ijid.2020.05.098.
2. Dinnes J, Deeks JJ, Adriano A, Berhane S, Davenport C, Dittrich S, *et al*. Rapid, point-of-care antigen and molecular-based tests for diagnosis of *SARS-CoV-2* infection. Cochrane Database Syst Rev 2020; **8(8)**:CD013705. doi:10.1002/14651858.CD013705.
3. Salvagno GL, Gianfilippi G, Bragantini D, Henry BM, Lippi G. Clinical assessment of the Roche *SARS-CoV-2* rapid antigen test. *Diagnosis (Berl)* 2021; **8(3)**:322-26. doi:10.1515/dx-2020-0154.
4. Krüttgen A, Cornelissen CG, Dreher M, Hornef MW, Imöhl M, Kleines M. Comparison of the *SARS-CoV-2* Rapid antigen test to the real star *Sars-CoV-2* RT PCR kit. *J Virol Methods* 2021; **288**:114024. doi:10.1016/j.jviromet.2020.114024
5. Jegerlehner S, Suter-Riniker F, Jent P, Bittel P, Nagler M. Diagnostic accuracy of a *SARS-CoV-2* rapid antigen test in real-life clinical settings. *Int J Infect Dis* 2021; **109**:118-22. doi:10.1016/j.ijid.2021.07.010
6. Simundić AM. Measures of diagnostic accuracy: Basic definitions. *EJIFCC* 2009; **19(4)**:203-11.