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Rapid SARS-CoV-2 antigen (SD Biosensor) test in comparison with Real Time (RT-PCR) for diagnosis of COVID-19 in a secondary school, Kampala, Uganda: November, 2020

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Summary

Real time RT-PCR testing is considered the "gold standard" in SARS-CoV-2 detection. It detects RNA that is specific to the virus. The RT-PCR are financially costly, require longer evaluation time, and needs highly professional staff for sample handling. The SD Biosensor's COVID-19 antigen rapid test is cheaper than the RT-PCR, with about 30 minutes turnaround time, and demands no expertise of the staff. Following a countrywide lockdown, the government of Uganda opened schools to candidate classes on October 15, 2020 with strict COVID-19 guidelines to follow. A secondary school in Kampala reported a cluster of COVID-19 cases by November 17, 2020, and Ministry of Health recommended the need to conduct testing for COVID-19 among the students, teachers, and support staff at the school. We compared the rapid SARS-COV-2 antigen detection test (SD Biosensor) with real time RT-PCR test as the gold standard for diagnosis of COVID-19 at a secondary school in Kampala, Uganda.

Three hundred sixty-one nasopharyngeal samples were obtained from students, teachers, and support staff of the school, by trained laboratory personnel from the MOH, 19th to 22nd, November, 2020.

Of the 361 respiratory samples, 141 were positive for real-time RT-PCR test. Only 12 were positive with the rapid SARS-COV-2 antigen test. The sensitivity of the Rapid test was 8.5% and specificity of 100%. With the rapid test, the false negatives were 129 and no false positive. Among the respondents who tested positive with the RT-PCR and negative with the rapid antigen (SD Biosensor) test, majority (94.5%, n=122/129), were asymptomatic at time of sample collection.

The rapid antigen SARS-COV-2 test (SD Biosensor) showed incomparable sensitivity (8.5%), however, there was comparable specificity of 100% with the real-time RT-PCR test. We recommended concurrent use of both the real-time RT-PCR and the rapid SD Biosensor test as screening testes especially in a high prevalence area.

Introduction

On January 30, 2020, the World Health Organization (WHO) declared COVID-19 a public health emergency of international concern (1) and testing for COVID-19 has tremendous value to containing the spread of the corona virus, by enhancing detection and isolation of cases (2).

Infection with the virus causing COVID-19 (SARS-CoV-2) is confirmed by the presence of viral RNA detected by molecular testing, usually RT-PCR. Real-time RT-PCR testing is considered the "gold standard" in SARS-CoV-2 detection (3). This test detects RNA (or genetic material) that is specific to the virus and can detect the virus within days of infection, even those who have no symptoms (4). The disadvantages are the financial cost compared to the antigen tests, the longer evaluation time, and the need for highly professional staff for sample handling. Turnaround time is longer, generally in the 2-3 day range but results can be in as little as 24 hours (5).

On the other hand, the rapid SARS-CoV-2 antigen (SD Biosensor) test was approved for emergency use by the World Health Organization (6), and test looks for proteins produced by the SARS-CoV-2 virus. Their advantage is the price, the result within 15 to 30 minutes, and lower demands on the expertise of the staff (7). The disadvantage is that they are not as sensitive (accurate) as the standard RT-PCR test used to accurately identify those infected. In a few days,

these people will spread the virus to others, thinking they are healthy. The rapid antigen test reveals patients at the peak of the infection when the body has the highest concentration of these proteins, and considered most accurate in a patient who is having symptoms of COVID-19 (8).

Following a countrywide lockdown, the government of Uganda opened schools to candidate classes on October 15, 2020 with strict COVID-19 guidelines to follow. A secondary school in Kampala reported a cluster of COVID-19 cases by November 17, 2020 and at that time country had only registered the strain from Wuhan. The Ministry of Health (MoH) recommended the need to conduct testing for COVID-19 among the students, teachers and support staff at the school.

There was need to evaluate the performance of rapid SARS-COV-2 antigen tests and compare with the gold standard real time RT-PCT for diagnosis of COVID-19. We determined the sensitivity and specificity of the rapid SARS-COV-2 antigen detection test (SD Biosensor) and compared with real time RT-PCR test as the gold standard for diagnosis of COVID-19 at a secondary school in Kampala, Uganda, so as to inform COVID-19 testing.

Methods

Study setting

The study was conducted at secondary school in Kampala, Uganda. The school has both day and boarding sections, however, the study was conducted among the students in the boarding section.

Study design

We conducted a cross-sectional study, employing quantitative methods of data collection among the students, teachers, and support staff at the secondary school. We defined a confirmed case as laboratory-confirmed SARS-CoV-2 infection identified during November 21-23, 2020 in a student, teacher or support staff at a secondary school in Kampala, Uganda. A suspected case was defined as high temperature (above 37.5˚C) and at least one sign/symptom of respiratory illness in a student, teacher or support staff at a secondary school in Kampala, Uganda.

Sample size

We considered a sample size of 427 as determined using Kish Leslie (1965) formula.

$$n = \frac{Z^2 PQ}{\partial^2}$$

n=sample size, z= critical value at 95% level of confidence, ∂= margin of error at α=0.05, P= prevalence of COVID-19 is assumed to be 50%, since no study has been identified in Urban settings, Q= (1-P) which is the probability of not finding cases of COVID-19; with a non-response rate of 10%

Sampling procedure

We used convenient sampling for students, teachers, and support staff. Everyone at the school during testing days was allowed to test for COVID-19, and those willing to test were interviewed.

Specimen collection and laboratory testing

Samples were taken from students, teachers, and support staff conveniently, from the nasopharynx by the trained laboratory personnel from the MOH. We used the RT-PCR molecular diagnostic test to identify SARS-COV-2, and the rapid antigen Biosensor test for the qualitative detection of specific antigens to SARS-COV-2 present in human nasopharynx. The results for rapid antigen tests were read within 15 to 30 minutes. Feedback with test results from the RT-PCR was given to the clients through the MOH using an emailing platform.

Ethical consideration

This investigation was conducted as part of the Ministry of Health (MoH) efforts to control the COVID19 pandemic in Uganda. The MoH of Uganda through the office of the Director General Health Services gave the directive and approval to conduct this investigation. Additionally, the office of the Associate Director for Science, Centers for Disease Control and Prevention, Uganda, determined that this investigation was not human subjects' research because the primary purpose was to identify, characterize, and control disease in response to a perceived immediate public health threat. Prior to participation, information about the evaluation was provided, including the risks, and benefits of participating. The participants were informed of their right to

voluntarily participate or even withdraw their participation at any time without consequences. The potential participant was allowed to ask questions and answers provided after which a verbal consent was obtained

Results

Socio-demographic characteristics of respondents

The average age of the respondents was 20 years (Range: 14 -77 years). Males were average, 53%, (n=191/316). The majority, 84%, (n=280/361) were in the 10-20 years age group and the majority, 86%, (n=311/361) of the respondents were students. The students were in senior four, (56%, n=177/361) and senior six classes (44%, n=134/361).

Sensitivity and specificity of Rapid antigen SD Biosensor test

We tested a total of 361 respondents for COVID-19. The positivity rate was 39.1% (n=141/361). And the positivity of Biosensor as regards the gold standard (RNA PCR) was only 8.5% (Table 1).

Table 1: Comparison between Biosensor Rapid diagnostic test against the gold standard RT- PCR for COVID-19 at a secondary school, Kampala, Uganda, November, 2020

		RNA PCR		
		Positive	Negative	**Total**
Bio-Sensor RDT	Positive	12	0	**12**
	Negative	129	220	**349**
	Total	**141**	**220**	**361**

The sensitivity, (12/141) of the Bio-Sensor RDT as regards the RT-PCR was 8.5%. The level of discrepancy of in the positivity of the Bio-Sensor RDT against the gold standard RNA PCR, (129/141) was 91.5%. The specificity of the Bio-Sensor RDT as regards the RT-PCR, (220/220) was 100%. The positive predictive value of the Bio-Sensor RDT as regards the RT-PCR,

(12/12), was 100%. The negative predictive value of the Bio-Sensor RDT as regards the RT-PCR, (220/349), was 63%.

Among the respondents who tested positive with the RT-PCR and negative with the rapid antigen (SD Biosensor) test, the majority (94.5%, n=122/129), were asymptomatic at the time of sample collection (Figure 1).

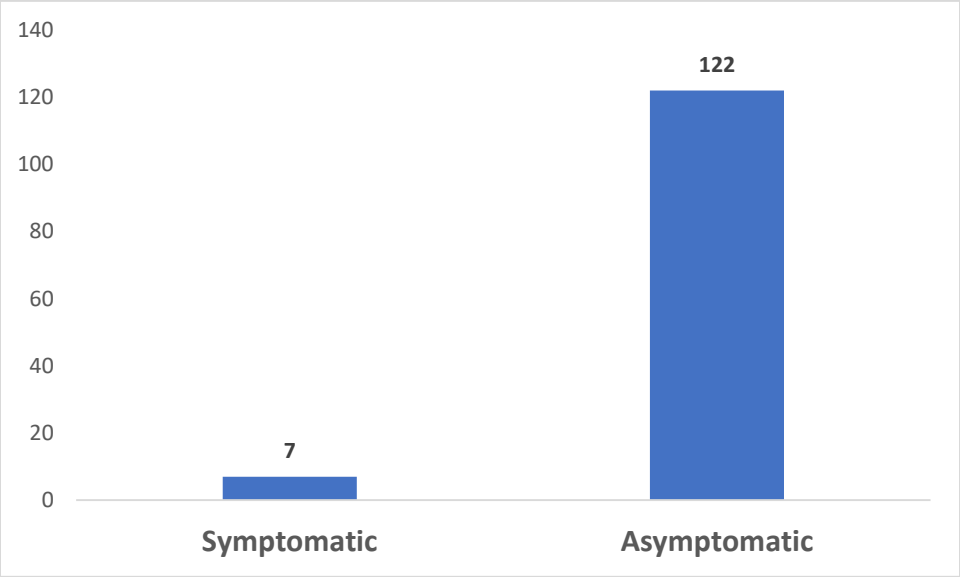

Figure 1: ***Symptoms at time of sample collection among respondents who tested positive with RT-PCR and Negative with SD Biosensor rapid diagnostic test for COVID-19 at a secondary school, Kampala, Uganda, November, 2020, (n=129)***

Discussion

Real time RT-PCR are the gold standard in testing for COVID-19 as it detects the presence of viral RNA (3)**.** It is a very accurate and efficient test. In our study, we compared the RT-PCR with the rapid antigen (SD Biosensor) test using nasopharyngeal swab samples among students, teachers, and support staff at a secondary school in Kampala, Uganda that had reported a cluster of COVID-19 cases.

The rapid antigen test detects proteins produced by the SARS-CoV-2 virus (9). The sensitivity of the rapid antigen test as compared to the gold standard RT-PCR was 8.5%. This low level of

sensitivity of a test is likely to have high false negatives (10), and similarly did our study record high (91.5%, n=129/141) false negatives. This low sensitivity could also be explained by the fact that the rapid antigen test detects viral proteins and reveals patients at the peak of the infection when the body has the highest concentration of these proteins. This low specificity using the rapid test could also be because the targeted antigen maybe absent on some strains of the SARS-COV-2 virus.

In addition, in the RT-PCR test, the amount of the sample may not matter because it is amplified during the polymerase chain reaction processes (11) and an adequate sample for an antigen rapid test is likely to cause no reaction on the test strip.

Technical errors in reading test results from the rapid antigen test lead to false negatives. Other technical errors include interferences with room temperatures that affect rapid diagnostic test kits (12), amount of diluent used, and the waiting time to read the test results.

Rapid antigen tests are considered most accurate in a patient who is having symptoms of COVID-19 at the time of sample collection (13). Our study showed that among the respondents who tested positive with the RT-PCR and negative with the rapid antigen (SD Biosensor) test, majority 94.5%, were asymptomatic at time of sample collection. The rapid antigen (SD Biosensor) recorded a specificity of 100%, meaning no false positive.

Conclusion and recommendation

The rapid antigen SARS-COV-2 test (SD Biosensor) showed incomparable sensitivity of 8.5% with the gold standard RT-PCR, however, the specificity was 100%. We recommended concurrent use of both the RT-PCR and the rapid SD Biosensor test as screening tests especially in a high prevalence area.

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