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COVID-19: Laboratory Diagnosis And Specimen Collection

Juliana Bitchara Tejada, Alaa Ahmed M. Shariff, Jameela Hamed Hasan, Rabyah Abdorhman Hasan, Shahad Aziz Ayesh Albalawi, Taif Zedan

Abstract
Rapid and early laboratory diagnosis of COVID-19 is the focus of treatment and control. The objective of this study is to determine the significance of each laboratory method for the diagnosis of COVID-19. This study will also determine the preferred laboratory methods of health workers and preferred specimen collection for health workers and patients for the diagnosis of COVID-19.
The study used survey questionnaires and interviews among the participants which included the patients and health workers like Doctors, Nurses, and Medical Technologists. The questionnaires for the patients determined the types of collection they preferred in the collection for COVID-19, while the questionnaires for the health workers included the preferred collection of specimens and preferred laboratory diagnosis for COVID-19. The participants answered 1-5 Likert scale. The data gathered was encoded in Excel and SPSS to determine the percentage, weighted mean, and verbal interpretation.
The results show that most of the health workers chose reverse transcription (RT-PCR) and immunodiagnostic antigen both methods weighted mean 4 (agree) verbal interpretation for the diagnosis of COVID-19. For the specimen collection, the result shows that most of the patients rated weighted mean value for specimen collection for COVID-19 were nasopharynx 4.05 and oropharynx 4.0 with verbal interpretation of (agree) while most of the health workers were 4.26 (strongly agree) for both nasopharynx and oropharynx.
The result shows that reverse transcription (RT-PCR) and immunodiagnostic antigen are the preferred methods of health workers like doctors, nurses, and mostly medical technologists for the diagnosis of COVID-19. For the specimen collection, health workers preferred the use of both the nasopharynx and oropharynx while the patient preferred for nasopharyx or oropharynx for the diagnosis of COVID-19.

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I. Introduction:

The COVID-19 novel coronavirus pandemic disease is caused by a cruel acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that affects all phases of human existence. Accurate, sensitive, and rapid methods are important to stop the spread of SARS-CoV-2 *Wang, R. et al (2021).*

Several methods for the identification of viruses require needs methods and skills. It involves nucleic acid isolation and the collection of appropriate specimens. Determination of COVID-19 is necessary to avoid transmission of the virus in this pandemic. Both humans and animals can be infected with coronavirus. A new coronavirus called SARS-CoV2 was recently determined. The epidemic came from China in Wuhan city in 2019 and caught the attention of the World Health Organization. *MubarakAli, D. (2021).*

Xie, J et al (2020) said that a novel beta coronavirus identified as Coronavirus disease (COVID-19) developed into a pandemic since it was reported in the year 2019 of December. The standard method for diagnosing the viral infection is the determination of viral nucleic acid.

Han et al, T. (2021) believe that quick and accurate diagnosis of infected patients is very important for controlling transmission. The major approach in facing the pandemic is focused on early diagnosis and prompt isolation of the infected individuals. Several diagnostic tools have emerged within a relatively short period, which can be broadly classified into molecular and immunological assays as stated by *Bijina J. et al. (2021).*

II. Statement of the Problem

For the number one statement of the problem, the question will be: What is the profile of the participants in terms of age and gender, place of work and occupation, nationality, and location? The number two statement of the problem will answer about the significance of the selected different methods used in the laboratory for the diagnosis of COVID-19. The third question will answer which of the methods is preferred by medical technologists and health workers for the diagnosis of COVID-19. The fourth statement of the problem will answer the preferences of health workers for specimen collection of the COVID-19 virus. The last

statement of the problem will answer which of the specimen collection was preferred by the patient for the specimen collection of the COVID-19 virus**.**

III. Background of the Study

The study was conducted by the students with the help of their adviser in research subject MLT412. The selected students are fourth-year students of the Medical Laboratory Technology department.

IV. Importance of the study

This study identified the significance of each method and preferred specimen collection for the diagnosis of COVID-19. The result of this study is beneficial to MLT students because this is one of the tests performed in the laboratory. This study was helpful to health practitioners to give an idea about the significant method and preferred specimen collection for laboratory diagnosis of COVID-19.

V. Review of Related Literature

One of the gold standards for the analysis of COVID-19 is the real-time fluorescence quantitative reverse transcriptase-polymerase chain reaction (reverse transcriptase-polymerase chain reaction, RT-PCR) and viral gene sequencing. The most recent method used to collect COVID-19 is nasopharyngeal swabs of the upper respiratory tract. *Wu, Jianguo, et al. (2020).*

Mubarak Ali, D. (2021) stated that the standard tool for the detection of human coronavirus is RT-PCR. Electrophoresis was analyzed after the PCR process. Sequencing for the confirmation of viral RNA is necessary. Sputum collection from the oropharynx was collected posterior side if possible in the morning. Collection of blood, sputum, feces, and urine specimens, and examination in different biochemical procedures will be done during the illness of the patient.

The study of *Khiabani, K., & Iranaq, M. H. (2021)* intends to review the sensitivity and reliability of SARS-CoV-2 determination in saliva and deep throat sputum to match with nasopharyngeal and combined naso/oropharyngeal, and oropharyngeal swabs. They established an overall sensitivity of 92% (95% CI, 80-99) for double naso/oropharyngeal swabs, 87% among symptomatic patients found in severe patients were higher than mild and in the symptomatic patients higher than asymptomatic cases.

A proposed a one-spot visual SARS-CoV-2 detection system called "opvCRISPR" by integrating reverse transcription loop-mediated isothermal amplification (RT-LAMP) and Cas12a cleavage in a single reaction system. They demonstrate the collateral activity against single-stranded DNA (ssDNA) reports of activated Cas12a triggered by RT-LAMP amplicon increases detection sensitivity and detected the results visible with naked eye. *Wang, R. et al (2021).*

A CRISPR-augmented RT-PCR assay that sensitively detects SARS-CoV-2 RNA was employed in the study of *Huang, Zhen, et al.* (2021) to analyze viral kinetics viral RNA kinetics in longitudinal plasma samples from nonhuman primates (NHPs) after virus exposure; Microarray approaches that use a scanner to display the hybridization between the probe and the target are a quick, sensitive, specific, and accurate way of detecting hybridization which is successfully used for detecting 24 single nucleotide polymorphisms mutation in the gene that encodes spike protein of human coronavirus, *MubarakAli, D. (2021)* mentioned that this technique showed 100% accuracy, but this approach does not allow for the detection of a few viral genes in small samples.

VI. Rationale of the Study

This study determined the significance of each selected method for the diagnosis of COVID-19. The Medical Technologists students become aware and know about how these methods were done in the laboratory setting. The preferred specimen collection by the patient and the health workers gave an idea of how effective these methods and specimen collection are for the diagnosis of COVID-19.

VII. Research Objective

The study will determine the significance of the selected method for the diagnosis of COVID-19. It will also determine which methods are preferred by the medical technologist for the diagnosis of COVID-19. Moreover, the study will determine which specimen collection for COVID-19 was prepared by the health workers and the patients in the study.

VIII. Hypothesis

There is no significant method for the diagnosis of COVID-19. There is no preferred specimen collection for the diagnosis of COVID-19 for health workers. There is no preferred specimen collection for health workers and the patient in the study for the diagnosis of COVID-19.

IX. Scope and Limitation of the Study

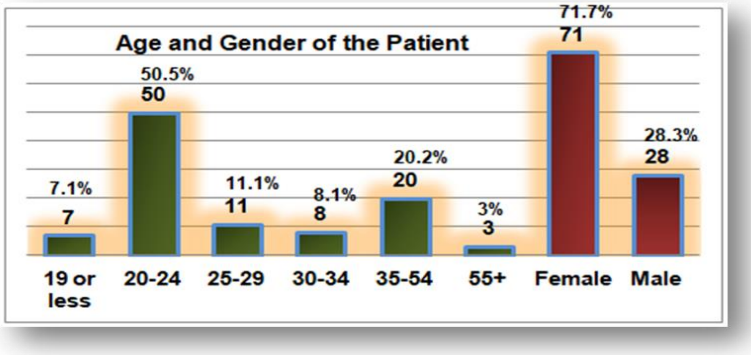
The participants selected in the study were health workers which included doctors, nurses, and medical technologists, those who are exposed in the laboratory diagnosis and specimen collection. Other health workers who were not exposed to it were not included in the study. Patients that are not exposed to specimen collection of COVID-19 were not also included in the study.

X. Materials and Methods of the Study:

The major tool in gathering the data based on the presentation in the statement of the problem was interview and survey questionnaires. There were two types of questionnaires in the study. The first questionnaire was for health workers like doctors, nurses, and medical technologists, it included the was the demographic profile of the participants in terms of the following: age and gender, place of work and occupation, nationality, and location, it also includes questions about methods they used for the diagnosis of COVID19 and the specimen collection they used in the laboratory. The second questionnaire was for the patient. it includes the was the demographic profile of the participants in terms of the following: age and gender, place of work and occupation, nationality, and location, it also includes questions about the types of specimen collection for the determination of COVID-19. The data gathered was encoded in Excel and SPSS to get the frequency. Likert scale from 1-5, weighted mean, and verbal interpretation were utilized as statistical tools in the study.

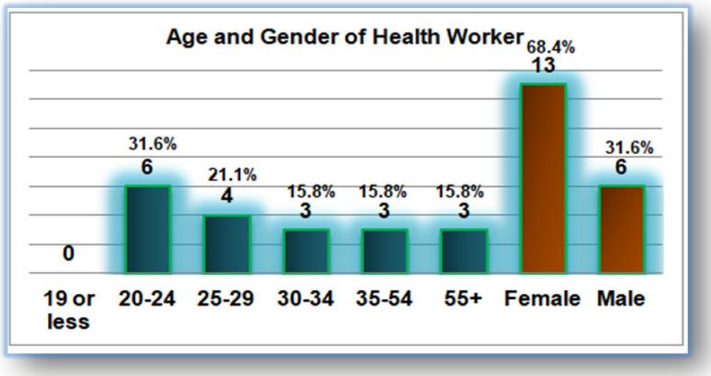
XI. Presentation and Analysis of Data:

Graph 1
Distribution of Patient Respondents in Terms of Age and Gender



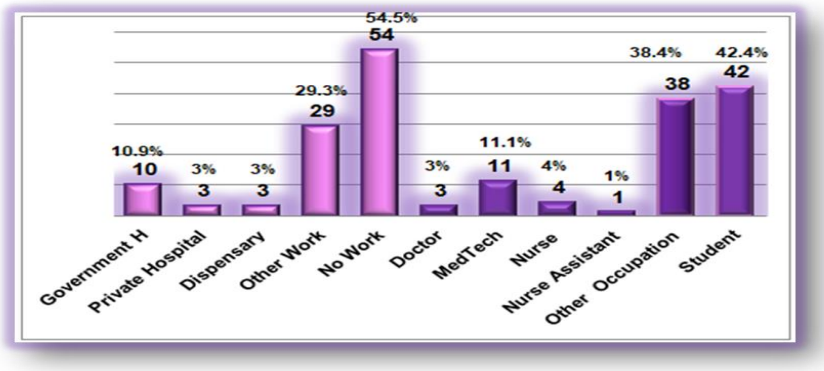
Graph 1 demonstrates the percentage of the patient's age and gender. At age 19 or less, patients were 7 (7.1%), in age 20-24 were 50 (50.5%), in age 25-29 were 11 (11%), in age 30-34, patients were 8 (8%), in age 35-54, the patient was 20 (20.2%), in age 55+, the patient was 3 (3%). In gender the female patients were 71 (71%), male patients were 28 (28%).

Graph 2
Distribution of Health Worker Respondents in Terms of Age and Gender



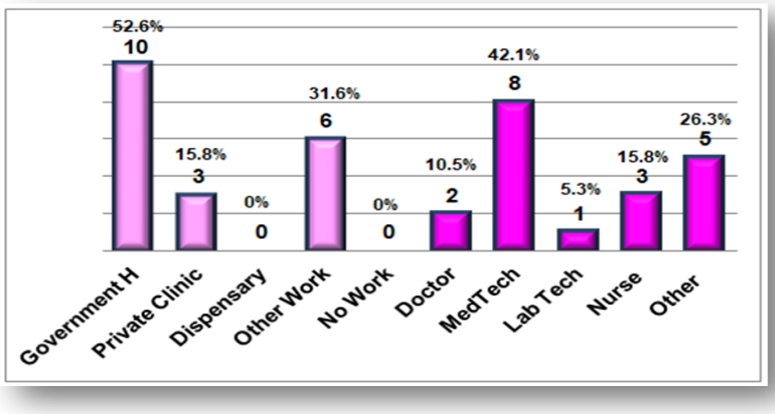
Graph 2 demonstrates the percentage of the health workers. In age 19 or less, 0% were health workers, ages 20-24 were 6 (31.6%), 25-29 were 4 (21.1%), age 30-34, 35-54, and age more than 55 were 3 (15.8%). In gender, 13 (68.4%) female patient and 6 (31.6%) were male.

Graph 3
Distribution of Patient Respondents in Terms of Place of Work and Occupation



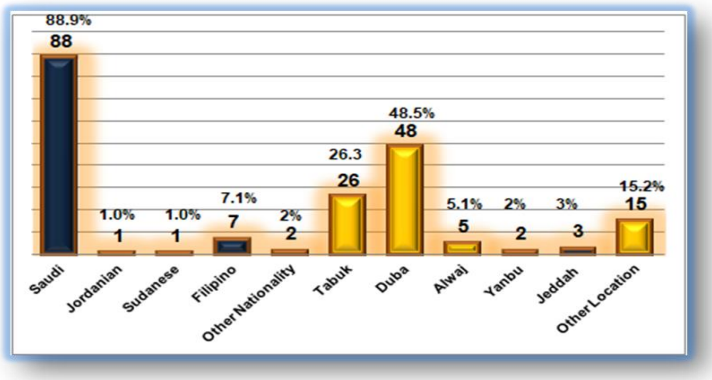
Graph 3 demonstrates the percentage of patient working in government hospitals were 10 (10.9%), patients working in private hospital and dispensary were 3 (3%), other work were 29 (29.3%), and patient with no work were 54 (54.4%). In occupation, doctor patient was 3 (3%), medical technologists were 11(11.1%), nurse in patients were 4 (4%), nurse assistant were 1 (1%), other occupation were 38 (38.4%), students were 42 (42.4%).

Graph 4
Distribution of Health Worker Respondents in Terms of Place of Work and Occupation



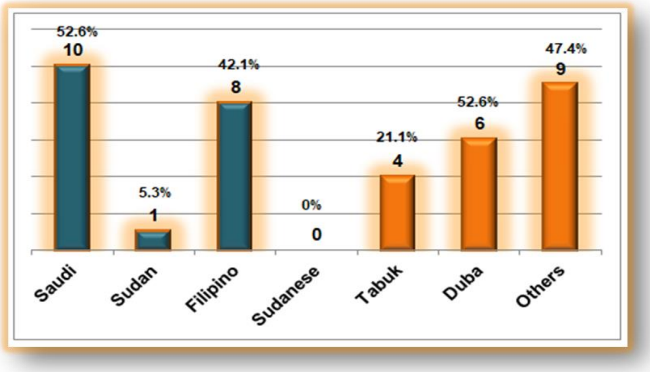
Graph 4 demonstrates the percentage of the place of work and occupation of health worker: working in government hospitals were 10(52.6%), work in the private hospital were 3 (15.8%) work in dispensary were 0%, other work was 6 (31.6%), no work was 0% or none, in occupation, doctors were 2 (10.5%), the medical technologist was 8 (42.1%), lab tech was 1 (5.3%), nurses were 3 (15.8%), other occupations were 5 (26.3%).

Graph 5
Distribution of Patient Respondents in Terms of Nationality and Location



Graph 5 demonstrates the percentage of the patients in the nationality and locations: Saudi patients were 88 (88.9%), Jordanian patients were 1(1%), Sudanese patients were 1(1%), Filipino patients were 7(7.1%), other nationalities were 2(2%). In location, patients in Tabuk were 26 (26.3%), in Duba patients were 48 (48.5%), Alwaj were 5 (5.1%), Yanbu were 2 (2%, Jeddah were 3 (3%), other locations were 15 (15.2%).

Graph 6
Distribution of Health Worker Respondents in Terms of Nationality and Location



Graph 6 demonstrates the percentage of the health workers in the nationality and locations: Saudi health worker was 10 (52.6%), Sudan was 1(5.3%), Filipinos were 8 (42.1%), Sudanese were 0 (0%). In the location of health workers, Tabuk was 4 (21.1%), Duba was 6 (52.6%), and other locations were 9 (47.4%).

Table 1. Comparative Analysis of Laboratory Methods for the Diagnosis of Covid-19

Collection	Health Workers Weighted Mean	Verbal Interpretation
1.Reverse Transcription (RT -PCR)	4	Agree
2. Microarray Technique	3	Neutral
3. RT Loop-Mediated Isothermal Amplification (RT-LAMP)	3.6	Agree
4. Multiplex Test	3.5	Agree
5. Paper-Based Colorimetric Test	3.6	Agree
6. Immunodiagnostic of Antigen	4	Agree
7. Immunodiagnostic of Antibody	3.9	Agree
8. Colloidal Gold-Based Immunochromatographic Assay (CG-ICG)	3.6	Agree
9. Cobas SARS-CoV2	3.6	Agree

Likert Scale	Likert Scale Interval	Verbal Interpretation
5	4.21-5.00	Strongly Agree
4	3.41-4.20	Agree
3	2.61-3.40	Neutral
2	1.81-2.60	Dis Agree
1	1.00-1.80	Strongly Dis Agree

Table 1. In Reverse Transcription (RT -PCR) method; agree (4.0). In the Microarray Technique method; neutral was (3.0). In the RT Loop-Mediated Isothermal Amplification (RT-LAMP) method; agree were (3.6). In the Multiplex Test method; agree were (3.5). In Paper -Based Colorimetric test method; agree were (3.6). In the immunodiagnostic of antigen method; agree were (4.0). In immunodiagnostic of antibody method; agree were (3.9). In the Colloidal Gold-Based immunochromatographic Assay (CG-ICG) method; agree were (3.6). In Cobas SARS-CoV2 method; agree were (3.6).

Table 2. Comparative Analysis of Collection of Specimen for the Diagnosis of Covid-19

Collection	Patient Weighted Mean Value	Verbal Interpretation	Health Workers Weighted Mean	Verbal Interpretation
1. Nasopharynx	4.0	Agree	4.16	Agree
2. Oropharynx	4.0	Agree	4.1	Agree
3. Both Nasopharynx&oropharynx	3.7	Agree	4.26	Strongly agree
4. Saliva Collection	3.4	Agree	3.1	Neutral
5. Blood Collection	3.6	Agree	3.3	Neutral
6. Endotracheal	2.9	Neutral	3.42	Agree
7. Stool Collection	2.7	Neutral	2.9	Neutral
8. Sputum Collection	3.1	Neutral	3.3	Agree
Overall Weighted Mean Value	3.4	Agree	3.64	Agree

Likert Scale	Likert Scale Interval	Verbal Interpretation
5	4.21-5.00	Strongly Agree
4	3.41-4.20	Agree
3	2.61-3.40	Neutral
2	1.81-2.60	Dis Agree
1	1.00-1.80	Strongly Dis Agree

Table 2. In the nasopharyngeal collection: the weighted mean was 4.0 and verbal interpretation of (agree) among patients while the health worker was 4.16 (agree). In the oropharyngeal collection; the weighted mean was 4 (agree) among patients while the health worker was 4.1 (agree). In both nasopharyngeal and oropharyngeal collections; the weighted mean was 3.7 (agree) among patients while the health worker was 4.26 (strongly agree). In saliva collection; the weighted mean was 3.4 (agree) among patients while the health worker was 3.1 (neutral). In Blood collection; the weighted mean was 3.6 (agree) among patients while the health worker was 3.3 (neutral). In the Endotracheal collection, the weighted mean was 2.9 (neutral) among patients while the health workers were 3.42 (agree). In stool collection, the weighted mean was 2.7 (neutral) among patients while the health worker was 3.3 (agree). In the sputum collection, the weighted mean was 3.1 (neutral) among patients while the health workers were 3.3 (agree).

XII. Interpretation and Analysis of Data

based on the results of the statement of the problem the following results were formulated.

1. In the profile of the participants in terms of age and gender:

Most of the patients were twenty to twenty-four years old 50 (50.5%), most of them were female 71 (71.7%) while most of the health workers were 20-24 years old were 6(31.65) most of them were female 13(68.4%). University of Tabuk, Duba branch was for female students only. The regular and intern medical technologists were all female. These are the reasons why the participants were dominated by females in the study.

2. In the profile of the participants in terms of place of work and occupation:

Most of the patients had no work with 54 (54.5%), most of them were students 42 (42.4%) most of the health workers working in the government hospital, 10 (52.6%), most of them were medical technologists 8 (42.1%).

The Canadian Society of Medical Laboratory Science (CSMLS) is currently preparing national certification exam results allowing more newly certified MLTs to enter the workforce because of the urgency of medical technologists in the laboratory for the diagnosis of COVID-19. *Ponto, J (2015).*

3. In the profile of the participants in terms of nationality and location:

Most patients were Saudi nationality with 88 (88.9%) most of them located in Duba were 6 (52.6%). Most of the nationality of health workers were Saudi with 10 (52.6%), while the location designated as others 9 (47.4%), this means that they are located in other parts of Saudi Arabia like Jissan, Makkah, and Al Ulah

4. In the Reverse Transcription (RT-PCR) method, preferred by health workers weighted mean was 4 (agree).

Tahamtan, A and Ardebili, A (2020) recognize that among nucleic acid tests, the polymerase chain reaction (PCR) method is considered the 'gold standard for the detection of some viruses and has rapid detection, high sensitivity, and specificity. RT-PCR has a sensitivity for diagnosing early infection. RT-PCR assay can be considered as the main method to detect the causative agent of COVID-19, SARS-CoV-2.

RT-PCR or Real-Time PCR is generally a combination of converting m RNA into DNA generally called C-DNA and amplify of DNA with the help of PCR. Real-time RT-PCR is a nuclear-derived method for detecting the presence of specific genetic material from any pathogen, including a virus. It identifies the amount of DNA in each reaction of PCR which is why called RT-PCR.*Gupta, A. (2020).*

MubarakAli, D. (2021) emphasizes that Real-Time PCR (RT qPCR) is a simple qualitative assay used for detecting most human coronaviruses with more specificity and sensitivity than other conventional PCR, and it is also used for early diagnosis of COVID-19.

5. In the Microarray Technique method, health workers' weighted mean was 3 (neutral).

CovidArray, a microarray-based assay, to detect SARS-CoV-2 markers N1 and N2 in the nasopharyngeal swabs. The method is based on solid-phase hybridization of fluorescently-labeled amplicons upon RNA extraction and reverses transcription. This approach combines the physical-optical properties of the silicon substrate with the surface chemistry used to coat the substrate to obtain a diagnostic tool of great sensitivity. An innovative approach, RNAGEM, is to extract and purify viral RNA in less than 15 min. *Damin, et al (2021)* added that CovidArray is the first DNA microarray-based assay to detect viral genes in the swabs.

PathogenDx's novel DetectX-RV technology combines RT-PCR with powerful DNA microarray technology to improve specificity and create new possibilities for multiplex testing. This is especially critical given the multitude of symptoms that cross over in a patient with flu-like symptoms, including a bad cold, influenza A or B or COVID-19 *https://www.labmanager.com/big-picture/during-covid-19/microarray-technology-enhances-covid-19-testing-22575*

6. In the RT Loop-Mediated Isothermal Amplification (RT-LAMP) method health workers weighted mean was 3.6 (agree).

Isothermal nucleic acid amplification assays. Other attractive alternatives for rRT-PCR-based COVID-19 diagnosis are isothermal nucleic acid amplification assays. Based on the enzymes, set of primers, and guiding principle of amplification of nucleic acid and detection methods several isothermal methods such as loop-mediated isothermal amplification (LAMP), Recombinase Polymerase Amplification (RPA), Nicking and Extension Amplification Reaction (NEAR) and Nucleic Acid Sequence Based Amplification (NASBA) have been developed over the time and all of these have been or can potentially be adapted for COVID-19 diagnostics. *Bijina J. et al. (2021)*

7. In the Multiplex Test method preferred by health workers, the weighted mean were 3.5 (agree).

Multiplex test is used to detect and distinguish coronavirus and other viruses. This method is performed in a Mass ARRAY using MALDI-TOF data, and it is highly sensitive and simple to perform. A novel arch-shaped multiple-target sensor involves indirect amplification using primers that readily amplify the multiple targets since it has high sensitivity, accuracy, and specificity. This technique also helps in distinguishing the coronavirus and other respiratory virus in clinical specimens within 20 min. They can be digitized with scanners or cameras and specific software that allows them to be recorded and transmitted across long distances. However, technological advancements will necessitate more complex technology, increasing the cost and duration of analysis in the long run. *MubarakAli, D. (2021).*

The multiplex test serves as a single test to distinguish between COVID-19, the flu, and RSV infection. *https://pwnhealthzendeskcom.zendesk.com/hc/en-us/articles/360053083811-What-is-a-multiplex-test-*. National Center for Immunization and Respiratory Diseases (NCIRD) explained that respiratory syncytial virus, or RSV, is **a** common respiratory virus that usually causes mild, cold-like symptoms**.** Most people recover in a week or two, but RSV can be serious, especially for infants and older adults. RSV is the most common cause of bronchiolitis and pneumonia in children younger than 1 year of age in the United States.
https://www.cdc.gov/rsv/index.html

8. **In Paper -Based Colorimetric test method preferred by health workers weighted mean was 3.6 (agree).**

The paper-based colorimetric is based on the principle of a simple, rapid approach, where the aggregation of pyrrolidinyl peptide nucleic acid-induced silver nanoparticles is used for the detection of CoV2 oligonucleotide**.** The acpcPNA probe is used as an attractive alternative to RNA and DNA probes. They are chemically and biologically stable and effectively hybridized with the cDNA sequence. The color change

indicates the presence of target oligonucleotide by the electrostatic repulsion, where anionic DNA-acpcPNA duplex results in the dispersion of silver nanoparticles. Moreover, this method has some disadvantages concerning sensitivity and selectivity because it depends on pH, the concentration of nanoparticles and DNA probe, and mismatched DNA strands. *MubarakAli, D. (2021).*

9. In the Immunodiagnostic antigen method preferred by health workers, the weighted mean was 4.0 (agree).

These tests closely mimic one of the earliest prototypes – the urine pregnancy test – and as a result, they have gained wide acceptance based on their overall simplicity, low cost, and relative accuracy. Antigen detection systems are based on finding a particular immunogenic component, typically a protein or polysaccharide molecule, that is both unique and an integral part of the pathogen or other biological entity. Because these tests generally provide only qualitative results, they often need to be supplemented with other and sometimes more sophisticated laboratory-based diagnostic procedures to corroborate the initial test result. the extensive description of the merits and limitations of these tests for detecting COVID-19 and, to a lesser extent, for other serious respiratory diseases caused by three *common bacterial pathogens* Streptococcus pyogenes, Streptococcus pneumoniae, and Legionella pneumophila. *Pavia, C., & M. Plummer, M. (2021).*

10. In the immunodiagnostic of antibody method preferred by health workers weighted mean was 3.9 (agree).

Antibodies are detected in the blood of people who have been previously infected with or vaccinated against a virus that causes a disease; they show the body's efforts (past infection) or preparedness (past infection or vaccination) to fight off a specific virus. Once they are made, antibodies may protect people from getting that infection or getting severely ill for some time afterward. A positive antibody test indicates a person has antibodies for COVID-19 as a result of Past infection with SARS-CoV-2 or Vaccination against COVID-19. Antibody tests should generally not be used to diagnose current infection. An antibody test may not show if you have a current infection because it can take 1 to 3 weeks after the infection for your body to make antibodies. *https://www.cdc.gov/coronavirus/2019-ncov/lab/resources/antibody-tests.html*

11. Colloidal Gold-Based immuochromatographic Assay (CG-ICG) method, preferred by health workers weighted mean was 3.6 (agree).

The kit has no special requirements for equipment and personnel and shows great potential for rapid and large-scale screening. Although it cannot completely replace RT-PCR technology, it can be used as an important supplementary technology. In response to the problem of false negatives in the detection of nucleic acids by RT-PCR, Pan et al. proposed a gold-based immunochromatographic (ICG) band targeting viral IgM or IgG antibodies However, the IgM/IgG antibody colloidal gold method as serological evidence cannot replace the status of RT-PCR as pathogenic evidence. The test results may be influenced by factors such as sample hemolysis, fibrin, or the patient's autoantibodies, contributing to a high false-positive rate. *Pavia, C., & M. Plummer, M. (2021).*

12. Cobas SARS-CoV2 method, preferred by health workers weighted mean was 3.6 (agree).

The cobas® 6800/8800 system is a qualitative test used for the detection of SARS-CoV2 RNA. Copan or BD™ universal transport systems are used for collecting the sample from the oropharyngeal and nasopharyngeal swabs. The entire sample preparation and PCR are regulated by RNA internal control; some external controls such as low titer positive control and negative control are regulated by this system. Positive results of SARS-CoV2 RNA detection do not confirm the presence of the transmissible virus and negative results do preclude SARS-CoV2 infection, it must be considered along with symptoms, patient's travel host, and epidemiological information. Qualitative assays provide a simple "yes" or "no" answer by measuring the presence or absence of a substance or target. The results are not expressed in numerical values but as descriptive terms such as "positive," "reactive," and "negative," or "non-reactive." *MubarakAli, D. (2021).*

13. In nasopharyngeal collection; the weighted mean was 4.0 and verbal interpretation of (agree) among patients while the health worker was 4.16 (agree).

The SARS-CoV-2 detection rate was significantly higher for Nasopharyngeal swabs [46.7% (56/120)] than oropharyngeal swabs [10.0% (12/120)] ($P < 0.001$). A nasopharyngeal swab should be recommended for diagnosing COVID-19 and monitoring SARS-CoV-2 load. *Wang et al, H. (2020).*

Khiabani, K., & Iranaq, M. H. (2021), aimed to conduct a systemic review and meta-analysis on the reliability and sensitivity of SARS-CoV-2From 1598 studies; we retrieved 33 records, of which 26 studies were included for quantitative analysis. We found an overall sensitivity for nasopharyngeal swabs, of 83% (95%

confidence interval CI, 77-89) Regardless of the type of specimens, the viral load and sensitivity in the severe patients were higher than in mild and in the symptomatic patients higher than asymptomatic cases.

14. In oropharyngeal collection; the weighted mean was 4 (agree) among patients while the health worker was 4.1 (agree).

In the study, *Khiabani, K., & Iranaq, M. H. (2021)*, aimed to conduct a systemic review and meta-analysis on the reliability and sensitivity of SARS-CoV-2. From 1598 studies they found an overall sensitivity for oropharyngeal swabs among symptomatic patients was 44% (95% CI, 35-52).

15. In both nasopharyngeal and oropharyngeal collections; the weighted mean was 3.7 (agree) among patients while the health worker was 4.26 (strongly agree).

Khiabani, K., & Iranaq, M. H. (2021) found out that from 1598 studies; they found 87% (95% CI, 77-95) for double naso/oropharyngeal swabs.

16). In saliva collection; the weighted mean was 3.4 (agree) among patients while the health worker was 3.1 (neutral).

Khiabani, K., & Iranaq, M. H. (2021) found out that from 1598 studies; they found 82% (95% CI, 76-88) for saliva.

17. In Blood collection; the weighted mean was 3.6 (agree) among patients while the health worker was 3.3 (neutral).

Using RT-PCR and viral gene sequencing. 132 the results of 2019-nCoV nucleic acid test of various biological samples during the treatment of confirmed COVID-19 cases the positive rate of blood 2019-nCoV nucleic acid test is 3.03%, nasopharyngeal swab is 38.13% (180/472 times), the positive rate of 2019-nCoV nucleic acid test of sputum is 48.68% (148/304 times), the positive rate of blood 2019-nCoV nucleic acid test is 3.03% (4/132 times) *Khiabani, K., & Iranaq, M. H. (2021*)

18. In the Endotracheal collection, the weighted mean was 2.9 (neutral) among patients while the health worker was 3.42 (agree).

The COVID-19 pandemic has required new protocols for endotracheal intubation mandating cumbersome personal protective equipment and modifications to prior intubation procedures. We assessed the success and complications of endotracheal intubation under such protocols. Overall, they collected 1534 patients Staff endotracheal intubation increased from 37 to 63%. First pass success was 1262/1534 (82.3%) pre versus 195/227 (85.9%) post, for a difference of 3.6% (95% CI − 1.8–8.0%). *Khiabani, K., & Iranaq, M. H. (2021*)

19). In stool collection, the weighted mean was 2.7 (neutral) among patients while the health worker was 3.3 (agree).

This study investigated the clinical significance of viral shedding duration and viral load dynamics of positive fecal SARS-CoV-2 signals in COVID-19. A total of 69 patients with laboratory-confirmed SARS-CoV-2 infection were included, with 29 (42.03 %) females and 40 (57.97 %) males, 20(28.99 %) of the 69 patients tested positive for viral RNA in fecal samples. Wang et al, X. (2020).

20). In sputum collection, the weighted mean was 3.1 (neutral) among patients while the health worker was 3.3 (agree).

RT-PCR and viral gene sequencing are the gold standard for the diagnosis of COVID-19. At present, upper respiratory tract nasopharyngeal swabs are mostly used as nucleic acid detection samples in China.132 The results of the 2019-nCoV nucleic acid test of various biological samples during the treatment of confirmed COVID-19 cases are as follows: the positive rate of 2019-nCoV nucleic acid test of nasopharyngeal swab is 38.13%. Simple detection of nasopharyngeal swab 2019-nCoV nucleic acid detection positive rate is not high. The positive rate of the 2019-nCoV nucleic acid test of sputum is 48.68%. In this study, it was found that the positive rate of 2019-nCoV nucleic acid in the sputum of 132 patients with COVID-19 was higher than that of nasopharyngeal swabs. Multi-sample 2019-nCoV nucleic acid detection can improve the accuracy, reduce the false negative rate, better guide clinical treatment, and evaluate the therapeutic effect. *Wu, Jianguo, et al (2020).*

XIII. Conclusions and Recommendations

Based on the findings of the study, the following conclusions were formulated such as: the participants who participated in the study are mostly, 20-25 years old for the patient and most of them are female. For health workers, most of them are 20-24 years old. Most of the patients who participated have no work and most of

them are students. For health workers, most of them worked in the government hospital and most of them are Medical Technologists. Most of the patients are Saudi nationals from Duba while the health workers are mostly Saudi and located in other parts of Saudi Arabia. Among the nine laboratory methods, Reverse Transcription (RT-PCR and Immunodiagnostic antigens are preferred by the Medical Technologist and other health workers with 4 weighted mean and verbal interpretation of agreement. For the eight types of collection of specimens, the patient preferred the nasopharyngeal 4.05 (agree) and Immunodiagnostic antigen 4 (agree). While the health workers preferred the nasopharyngeal and oropharyngeal collection with 4.26 (strongly agree).

The following recommendations are presented: It is a great challenge for healthcare workers to diagnose appropriately. Students Medical Technologists and Health practitioners should continue to study the principles of other methods for the diagnosis of COVID-19 to become aware of the application of each method. They should continue to conduct other research about COVID-19 to become aware of the latest trend in the diagnosis of COVID-19 in the laboratory setting. They should attend seminars about the laboratory diagnosis of COVID-19 and preferred specimen collection to become aware of other trends and mutants of COVID-19. Finally, they should also be aware of how to effectively prevent the transmission of COVID-19 so that they can share it with their families and the community.

XIV. Limitation:

Health workers include Doctors, Nurses, Medical Technologists, and others who are exposed only to the laboratory in the diagnosis of COVID-19 and specimen collection. Those who were not exposed were not included in the study.

The patient involved in the study was those who were exposed only to the collection of the specimen of COVID-19. Those who have no experience in the collection of the specimen of COVID-19 were excluded from the study.

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