

An in-depth analysis of prevailing safety precautions against COVID-19 in bioanalytical laboratories during ongoing COVID-19 pandemic – paving the way forward

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Abstract: *Background:* With the onset of COVID-19 pandemic, laboratories all over the world had to follow new precautions. Adhering to strict control measures by laboratory technicians is influenced by their knowledge, attitudes and practices (KAP) towards COVID-19. *Objectives:* To assess the general awareness of lab personnel about COVID-19 related safety precautions by performing a survey. *Methods:* A cross sectional study was conducted in which all laboratory technicians working in specialized labs of a tertiary care center were given a structured KAP questionnaire. This questionnaire was prepared with questions covering different aspects including sample collection, packaging and transport, processing, reporting of samples and specimens as well as about disinfection and discarding biomedical waste. *Result:* A total of 45 technicians were included in the study. The answers to questions from KAP domains were varied indicating the need of specific and objective guidelines for different areas of laboratory functioning. *Conclusion:* COVID-19 pandemic has brought about a dramatic change in the working of different laboratories all over the world. Conducting this survey to determine the KAP toward COVID-19 among the laboratory technicians helped in identifying hazards involved in different lab procedures, resources available and competency level of the personnel. Based on the results, standard operating procedures for COVID-19 related precautions in all aspects of lab work were formulated/ updated. Such policies were customized to the facility and to the local regulatory requirements and would be useful in the future to tackle other outbreaks of infectious diseases.

Keywords: Safety precautions, COVID-19, Pandemic, Laboratory, Technicians.

Introduction

Personnel working in bioanalytical laboratories handle clinical samples and specimens on a daily basis. Different sections and subsections of the medical laboratory receive different types of samples which are variably infectious. With the onset of COVID-19 pandemic, laboratories all over the world, irrespective of their size or specialization, had to follow new precautions, in the event that any of the samples or specimens belonged to SARS-CoV-2 positive patients.

Procedures of handling and processing of these specimens should be based on risk assessment and by personnel with demonstrated capability for the same. In addition, the operations and logistics have to be appropriate in order to minimize exposure risks. Adhering to strict precautions and control measures by laboratory

technicians is influenced by their knowledge, attitudes and practices (KAP) towards COVID-19.

With the sudden onset of the pandemic and surge in cases, general safety precautions were followed by the personnel irrespective of the specialized labs they were working in. The situation would be the same in various other institutes. We planned this study with the aim of assessing the general awareness of lab personnel about COVID-19 related safety precautions by performing a survey. There is paucity of literature on evaluation of precautions followed by lab personnel during handling of COVID-19 samples in the Indian context.

This study will help in evaluating the COVID-19 appropriate behavior and precautions

followed by the health care workers in the lab, which has not been evaluated in the past. It will also give insight into the feasibility of the operations and the hardships faced by the personnel which will help in improving the functioning of the lab during the pandemic. In addition, the results may help in formulating newer guidelines and standard protocols to prevent health care workers from contracting the disease by limiting the risk of exposure of the working staff during collection, processing, reporting and dispatching of biohazardous samples.

Material and Methods

An observational cross sectional descriptive study was conducted by Department of Pathology, HAHC Hospital over a period of one month. This hospital has specialized labs including Pathology, Biochemistry, Microbiology and Blood bank which receive a variety of samples from COVID-19 positive patients. All laboratory technicians working in these different laboratories of the hospital were included in the study (Convenience sampling was done).

Study tool: A structured survey questionnaire was prepared for data collection with questions covering different aspects including sample collection, packaging and transport, processing, reporting of samples and specimens as well as about disinfection and discarding biomedical waste. Questions about equipment care, lab environment as well as COVID-19 appropriate behavior of the staff were also assessed in the survey. The questionnaire was formulated after reviewing literature [1-9] and was divided in 3 domains, one each for Knowledge, Attitude and Practice - based questions respectively. A total of 30 multiple choice questions were included with each domain having 10 questions each. The most appropriate answer for each question was discussed by the faculty and noted.

Data collection: This questionnaire was validated and self-administered in an anonymized form to all the personnel working in Pathology (Histopathology, Cytopathology, Hematology, Clinical Pathology), Biochemistry and Microbiology (Molecular Biology, Serology,

Virology, Mycology, Bacteriology, Immunology) laboratories.

Statistical analysis: The results were assessed and descriptive statistics were used to summarize the data. the percentage of technicians giving the most appropriate answer was recorded for each question. Feedback given to the personnel after the study was based on these results.

Ethical issues: Informed consent was taken before data collection. Privacy and confidentiality were maintained during the study. No names were recorded. Data was not disclosed to anyone and was accessible only to the investigators.

Results

A total of 45 technicians were included in the study. The average age was 40 years and male to female ratio was 1.8:1. Their work experience ranged from 5 years to 15 years (average=7.5 years). Only 57.8% of the technicians had attended prior formal training on COVID-19 appropriate behavior and precautions before the survey was conducted. The technicians belonged to different subsections of the hospital laboratory (5 were posted in Collection center, 19 in Pathology lab, 9 in Microbiology lab, 7 in Biochemistry lab and 5 in blood bank lab). Table 1 depicts the blueprint of the questionnaire with the summary of the results.

On evaluation of the knowledge domain, it was found that majority of the technicians knew about the appropriate type of mask to be used in the lab (95.6%), about the labelling (60%) and packaging protocol (88.9%) for samples from COVID-19 positive patients and about aerosol generating procedures (73.3%). Questions regarding specific lab procedures like centrifugation were correctly answered by mainly those personnel who daily operate this machine in their labs. Only 28.9% technicians knew that the least likely sample to be infected from a COVID-19 positive patient is urine [10].

Table-1: Blueprint of questionnaire given to the technical staff. The most appropriate answer has been marked as bold text. The percentage mentioned in brackets referring to the percentage of technicians who marked it correctly				
QUESTION	ANS A	ANS B	ANS C	ANS D
KNOWLEDGE				
1. Which type of mask is recommended to be used in the lab handling COVID-19-19 samples?	N95 (95.6%)	Surgical mask (4.4%)	Cloth mask (0%)	Any of the above (0%)
2. Should “COVID-19-19 positive” status be displayed on the sample?	Yes (60%)	No (13.3%)	Not necessary	Only for respiratory samples (26.7%)
3. What is the recommended packaging needed for transporting samples from COVID-19-19 patients?	Same as other samples (4.4%)	Double packaging (88.9%)	Single packaging (0%)	Either B or C (6.7%)
4. Which of the following are aerosol generating procedures in the lab?	Centrifugation of samples in open tubes (15.6%)	Vigorous shaking and mixing (4.4%)	Popping off caps of vacutainers (6.7%)	All of the above (73.3%)
5. While handling COVID-19-19 positive samples, for how much time following centrifugation should the machine be rested before unlocking and opening the lid?	1 min (6.7%)	2 min (2.2%)	5 min (55.6%)	10 min (35.5%)
6. For smaller surfaces, disinfection with which of the following is preferred?	60-70% alcohol (6.7%)	0.5% Hydrogen peroxide (4.4%)	1% sodium Hypochlorite (88.9%)	None of the above (0%)
7. What solution is recommended to disinfect high contact surfaces in the lab (door handles/telephones/mouse pads/office machines)?	1% sodium Hypochlorite (64.4%)	10% sodium Hypochlorite (17.8%)	50% Alcohol (0%)	90% alcohol (17.8%)
8. Which of the following is least likely to be positive for coronavirus in a symptomatic patient?	Urine (35.6%)	Feces (11.1%)	Blood (15.5%)	Throat swab (37.8%)
9. Which of the following method is ineffective in destroying coronavirus?	High temperature (35.6%)	Acidic conditions (11.1%)	Alkaline conditions (2.2%)	Freezing and thawing (51.1%)
10. Syringes used to collect blood samples from suspected COVID-19-19 patients should be discarded in which of the following?	Puncture proof containers (31.1%)	Yellow bag (8.9%)	Red bag (60%)	Black bag (0%)
ATTITUDE				
1. After exposure to COVID-19-19 patient, would you self-isolate and stay at home for 7 days if needed?	Yes (97.8%)	No (2.2%)	-	-
2. After suffering from COVID-19-19, you would prefer to join back after how much minimum time?	7 days (15.6%)	10 days (13.3%)	15 days (68.9%)	30 days (2.2%)
3. How frequently do you handle your mobile phone when working in the lab?	Very frequently (0%)	Only to answer urgent calls (57.8%)	Rarely (4.4%)	Never (37.8%)
4. Should the magnitude of precautions to be taken in the lab depend upon the size of the lab?	Yes (26.7%)	No (44.4%)	Don't know (28.9%)	-

QUESTION	ANS A	ANS B	ANS C	ANS D
ATTITUDE				
5. Do you wear a lab apron when working in the lab?	Always (100%)	No (0%)	Sometimes (0%)	Only when handling COVID-19 positive samples (0%)
6. Do you keep windows open and use exhaust fan in the lab?	Yes (60%)	No (40%)	-	-
7. How many times do you think high contact surfaces in the lab should be cleaned or disinfected?	Once a day (11.1%)	Twice a day (75.6%)	Once a week (8.9%)	Twice a week (4.4%)
8. Would you disinfect microscope with alcohol solution before use in the lab?	Yes (93.3%)	No (6.7%)	-	-
9. According to you what should the sanitation workers discarding COVID-19-19 waste be provided with?	Gowns and gloves (0%)	3 layered mask (0%)	Boots and safety goggles (2.2%)	All (97.8%)
10. Which type of container would you prefer in the lab to discard COVID-19-19 samples?	Colour coded bins (2.2%)	Colour coded bins with bags (26.7%)	Foot operated Colour coded bins (4.4%)	Foot operated Colour coded bins with bags (66.7%)
PRACTICES				
1. During the pandemic, which method do you employ for collecting blood samples in your lab?	Needle and syringe (15.5%)	Vacutainer (35.6%)	Either A or B (46.7%)	Avoid taking samples (2.2%)
2. Do you use a disposable tourniquet? <i>If NO, tourniquet is sanitized</i>	Yes (22.2%)	No (77.8%) <i>i. at the start of day (1/35)</i> <i>ii. twice a day (1/35)</i> <i>iii. after each patient (23/35)</i> <i>iv. do not sanitize (10/35)</i>	-	-
3. With respect to wearing gloves, which of the following do you do?	Change gloves after every patient contact (55.6%)	Sanitize gloves after every patient contact (44.4%)	Wash gloves with soap and water after every patient contact (0%)	Do not change gloves after every patient contact (0%)
4. How are requisition forms sent to the lab from the collection center?	Packed/rolled with samples (15.6%)	Separate zip pouch (55.5%)	Electronic forms (15.6%)	No specific method (13.3%)
5. How do you disinfect paper forms after receiving them in the lab?	Do not disinfect (26.7%)	Spray alcohol (8.9%)	UV rays (40%)	Baking in oven at 60-65 C for 15-30min (24.4%)

QUESTION	ANS A	ANS B	ANS C	ANS D
PRACTICES				
6. Do you open the vacutainer for sample processing in Biosafety cabinets?	Yes (80%)	No (20%)	-	-
7. How frequently do you disinfect the work station in your lab?	Once a week (8.9%)	Once a day (26.7%)	Twice a day (51.1%)	Whenever there is a spill (13.3%)
8. Do you dry the blood smear in the lab by blowing air or putting it under the fan?	Yes (22.2%)	No (46.7%)	Sometimes (13.3%)	Depends on the ambient temperature (17.8%)
9. Where do you dispose your disposable mask in the lab?	Yellow bag (95.6%)	Red bag (4.4%)	Blue bag (0%)	General waste bag (0%)
10. Is COVID-19 biomedical waste collected and stored separately in a temporary storage room and then shifted directly to BMW storage van?	Yes (73.3%)	No (22.2%)	Sometimes (0%)	No idea (4.5%)

Practice of drying the blood smear after preparation by blowing air or putting it under the fan was performed by 53.3% technical staff. Among those who did air drying (the appropriate technique) were those posted in Hematology and Microbiology labs.

Magnitude of precautions taken by personnel working in the lab should not depend on the size of the lab. However, only 44.4% technicians were found to have this attitude. Assessment of other questions on attitude revealed that hundred percent of the technicians preferred to wear lab aprons while working in the lab and majority (93.3%) disinfected the common microscopes before use. Sixty percent kept windows and doors open and used exhaust fans while working in the lab. Practice of Handling of mobile phones which should be minimal while working in the lab was followed by only 37.8% of the technicians.

Majority agreed to self-isolate after exposure to COVID-19 positive patients. While the government guidelines of mandatory isolation after turning positive keep changing, most technicians preferred to be under isolation for a period of 15 days (68.9%). As far as blood sample collection was concerned, majority (46.7%) of the technicians used either vacutainer or needle and syringe depending on their convenience. Only 35.6% technicians preferred use of only vacutainers which is the

recommended method of blood sample collection in the lab. Disposable tourniquet was used by only 22.2% of technicians and among those who used common tourniquet, 28.5% technicians sanitized it after every patient. Only 55.6% of the technical staff changed gloves after every patient contact. Eighty percent technicians opened vacutainer samples in biosafety cabinets.

Most of the technicians had accurate knowledge of the disinfectant to be used for the lab. Most agreed that high contact surfaces should be disinfected twice a day, which is the recommended norm [1]. Most of the technicians disposed their personal masks correctly in the yellow color bins [9]. However, questions about discarding other biomedical waste were answered appropriately by only 60-73%% technical personnel.

Discussion

COVID-19 pandemic has brought about a dramatic change in the working of different laboratories all over the world. It has prompted the implementation of health protocols at workplace involving social distancing, handwashing and wearing face masks. Preventive measures are initiated by the government but for such measures to be effective, public adherence is essential [11-

14]. However, human behavior is influenced by people's knowledge and perceptions. Beliefs about COVID-19 come from different sources like the government, social media, internet, previous personal experiences and medical sources [15]. Conducting a survey to determine the knowledge level, attitudes and practices toward COVID-19 among the laboratory technicians help in identifying hazards involved in different lab procedures, resources available and the competency level of the personnel.

Since attending formal training for COVID-19 precautionary measures was not mandatory in the institution, only a portion of the technical staff underwent voluntary training. While technicians performed relatively well in the three domains, adherence of precautions was not seen in hundred percent, indicating that many technicians lacked knowledge and therefore did not have the appropriate attitude and practices to follow precautions. In order to minimize the exposure risk of the lab personnel, it is important that mandatory training and formulation of standard operating procedures inclusive of precautionary measures are followed by all technicians to ensure uniformity in the working system and a safe lab environment. It is important to emphasize that staff handling specimens should not underestimate the infectivity of samples and strictly follow the lab biosafety practices [16].

The questionnaire prepared was in accordance with the guidelines issued by Centers of Disease Control and Prevention, World Health Organization, Indian Council of Medical Research and Ministry of Health and Family Welfare [3-6].

The following measures should be followed in all laboratories during the pandemic. All specimens collected for lab investigations should be regarded as potentially infectious. Specimens should be placed in their primary containers and then further packed in secondary containers to minimize the potential for breakage or spill. Finally, all these containers should be put in a large plastic box with biohazard label (COVID-19) for transportation [17].

All technicians should be wearing appropriate personal protective equipment (PPE) including eye protection, N95 mask, long sleeve gown and

gloves. Local risk assessment should be conducted to determine the use of PPE for performing technical procedures which are performed outside bio-safety cabinets like grossing, loading and unloading centrifuge cups, grinding, blending, vigorous shaking or mixing, sonic disruption, opening pressurized containers.

Regular hand washing should be rigorously followed. Procedures involving manipulation of potentially infectious specimens which may cause aerosol generation should be performed by trained and competent personnel. Specimens and sample should not be received if they have been rolled up in requisition forms.

Work surfaces and equipment must be decontaminated after specimen processing irrespective of the containment level. WHO recommends that disinfectants known to act against enveloped viruses be used in all laboratories (Hypochlorite, alcohol, hydrogen peroxide, quaternary ammonium compounds, phenolic compounds) [18]. The preferred disinfectant solution with proven activity against enveloped RNA viruses is 0.1% sodium hypochlorite, the contact time being 30 minutes. The others include alcohol, hydrogen peroxide, quaternary ammonium compounds and phenolic compounds.

Results among technicians in different laboratories as far as general precautions were concerned were similar. Most of them knew about recommended mask usage, labelling and packaging of COVID-19 positive specimens and samples and regarding aerosol generating procedures. It was however observed that technicians performed well in questions which were specifically related to their areas of daily work and expertise.

These questions pertaining to laboratory specific precautions were appropriately answered by specific technicians working in those laboratories. For instance, very few technicians knew that the specimen from known COVID-19 positive patient with the least chance of being infectious for coronavirus is urine. Questions related to Precautions while centrifuging sample from

COVID-19 positive patient were correctly answered by majority of technicians working with this machine routinely. However, very few technicians answered these questions in other laboratories. Therefore, it is necessary to train all technicians about precautions in all types of laboratory work.

It was found that knowledge and practices followed by technicians for sample collection were not satisfactory. The recommended method for phlebotomy for sample collection is vacutainer, knowledge of which was lacking among the technicians including those posted in collection center. Also, disposable tourniquet should be used for the procedure, and if unavailable it is preferred to use sanitize the tourniquet after every use. Most technicians used reusable tourniquets and only 28.5% sanitized them before each patient. Only around 56% technicians changed gloves after handling every patient.

Biomedical waste management is a very important aspect of lab work and cannot be ignored even slightly because of the stringent regulations. Therefore, technicians who regularly handle biohazardous samples and waste in their lab should be well aware of waste segregation, especially about discarding COVID-19 positive waste and masks. While performance in this regard was satisfactory among majority of the technical staff, it is necessary that hundred percent of the technicians answer questions pertaining to biomedical waste management correctly. Regular training in this aspect is mandatory and should be according to the new guidelines which are issued from time to time. KAP for disinfection procedures in the lab was found to be satisfactory, it is important to have

ongoing training in this aspect as well to maintain a continuity of such procedures.

Training should be an ongoing process in all aspects of the laboratory. Though it was found that fairly good level of overall knowledge existed among the technical staff, the need for a uniform policy standard for laboratory training was also realized. Strict adherence to universal guidelines is not the best approach and institutional policies made should be based on the needs of the specific facility [19].

Standard operating procedures for COVID-19 related precautions in all aspects of lab work including preanalytical, analytical and post analytical were formulated/updated. This also included disinfection procedures and management of biomedical waste. The feasibility of precautionary measures and the logistics was kept in mind. These policies and procedures have to be regularly maintained and updated as per the latest guidelines. The main limitation of the study was that the practices were self-reported and not directly observed. Social desirability bias may exist in the data, the participants may have overreported compliance with recommended preventive behavior.

Conclusion

Maintaining a safe workplace is the cornerstone of good laboratory practices and this is particularly important during a communicable disease outbreak [20]. The policies and procedures formulated must be customized to the existing facility and to the local regulatory requirements. Such policies will be useful in the future to tackle other outbreaks of infectious diseases.

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