A Descriptive Cross-Sectional Study on the Pre-Analytical Procedures Used by Medical Technologists in Metro Manila during the COVID-19 Pandemic

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Abstract: - The COVID-19 Pandemic has affected many sectors of the healthcare system, most especially the laboratory. Adjustments are made in order to cater to this situation, notably the pre-analytical phase, the part of the laboratory procedure most vulnerable to frequent errors. This study aims to determine how medical technologists collect, handle, and transport clinical specimens in laboratories in Metro Manila during the COVID-19 pandemic. A descriptive cross-sectional study was conducted. The survey used was adapted from De Gruyter (2020) and the World Health Organization (WHO). Respondents were recruited through emails to the medical directors of their institutions and contacted through Facebook through posting. Respondents fitting the inclusive criteria were asked for their consent to participate in an online survey given through Google Forms and informed of the nature of said study. The survey questionnaire was divided into five categories, which included the demographic profile, specimen collection, specimen handling, specimen transport, and specimen personal protective equipment. Through quantitative statistics and descriptive analysis, the questions were tallied, weighed, and averaged using the scoring system given by the WHO. Most respondents practice proper documentation, including minimum patient identification, and use special labels for patient samples. They have guidelines in specimen quality, adequate storage for analyzed and unanalyzed specimens. Most laboratory specimens are transported via motorized vehicle, with solid-walled leakproof containers being the most used method of packaging specimens. Respondents have personnel in charge present in receiving infectious substances. Gloves are the most worn personal protective equipment and Class I Biosafety Cabinets, Class 2 Biosafety Cabinets, and negative pressure rooms have the lowest frequency of use. Results from the study have determined that most medical technologists practice proper collection procedures, have guidelines in accepting unqualified specimens, as well as provide adequate storage for analyzed specimens and those with delayed analysis. The most frequent means of specimen delivery is through motorized vehicles, and delivery by hand. The most used packaging used for samples includes solid-walled leakproof containers, single plastic bags, and three layers of plastic bags. The most used laboratory protection practices used are gloves, disposable gowns, and goggles/face shields. The researchers recommend further training for medical technologists in both local/national and international regulations, and the inclusion of BSL I and II cabinets with negative pressure rooms.

Key Words: — ***Pre-analytical, COVID-19, Medical technologists.***

I. INTRODUCTION

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Pandemics are considered as a major public health crisis since it has the capacity to affect all facets of the society. However, there can be significant variations on its effects and approaches to address it, mostly depending on the type or classification of microorganisms that caused such circumstances to occur. [42] This notion can be ideally more noticeable from a modern perspective regarding the recent

pandemics, particularly those that emerged within the last decade.

COVID-19 is transmissible via airborne droplets [1]. This virus primarily infects the epithelial lining of the host's respiratory system causing bronchitis, bronchiolitis, and pneumonia [33]. Center for Disease Control and Prevention (CDC) declared that COVID-19 is contagious, mostly when the individual is symptomatic. Furthermore, CDC identified that individuals who are younger than 5 years old and older than 65 years old are at high risk of being infected. It also includes individuals who have comorbidities and who are pregnant.

The process of receiving samples by the laboratory is known as the pre-analytical phase, where medical technologists centrifuge, aliquot, dilute, and sort biological samples sent by the patient. It is also where biological samples are collected, labelled, and transported as well as choosing and ordering the suitable tests to be done [46]. This phase of laboratory testing is as crucial as the analytical phase, where most errors (48%-68%) usually occur in the pre-analytical testing [51]. Since it is the most error prone phase among the three phases of laboratory testing, it is essential to have strict procedures in place to follow in the laboratory to avoid numerous errors that can occur during this process.

While diagnostic errors can happen anywhere and at any time in healthcare, the risk of laboratory medicine services is increased when staff is expected to work in hostile environments, where they are exposed to high workloads and are under intense stress, especially today in the Philippines, where laboratory facilities are facing large increase of COVID-19 positive cases needing medical support. A healthcare error, regardless of the severity, may have a variety of negative effects on a patient's health, including death. False-positive or false-negative test findings endanger not only the patient's wellbeing, but also the effectiveness of public health programs, emergency plans, and the restrictive and preventive measures required by the national and foreign officials in handling the pandemic [39]. A false-positive test result may lead to unnecessary treatment, financial losses due to isolation, and psychological damage due to isolation and the fear of infecting others. On the other hand, false-negative test findings may result in lack of treatment, unable to monitor infected patients, and increased risk of spread of COVID-19.

In this study, the researchers aimed to systematically analyze the methods implemented and the approaches made by Medical Technologists in the pre-analytical phase of laboratories in Metro Manila during the emergence of the COVID-19 pandemic, which can be used as a base of reference for future outbreaks.

II. METHODOLOGY

2.1 Research Design

The researchers conducted a descriptive cross-sectional study, which, according to Setia (2016), involves the observation of participants at a specific time. [57] In relation to the research objective, the study aims to observe and determine how medical technologists handle clinical specimens during the COVID-19 pandemic. In the same study conducted by Setia, the participants, which in this case are registered medical technologists who are in active duty in public and private laboratories and hospitals in Metro Manila, are selected based on the inclusion and exclusion criteria established specifically for the study. The pre-analytical procedures were analyzed based on the answers of registered medical technologists working in public and private laboratories in Metro Manila. The questionnaires were formulated based on a structured survey questionnaire adapted from WHO and the "Laboratory practices to mitigate biohazard risks during the COVID-19 outbreak: an IFCC global survey" by De Gruyter (2020) in the form of an online survey. The online survey was directly distributed through email to medical technologists that are currently in active duty during the COVID-19 pandemic in Metro Manila. The request for the preferred emails of the participants was also included in the letter addressed to the medical or hospital directors regarding the request for permission to conduct data gathering. After their approval, we received their preferred email address and subsequently distributed the questionnaire. Additionally, the researchers also posted infographics containing details of the data gathering on Facebook groups consisting of Filipino Registered Medical Technologists (see Appendix G). Once the data was collected, it was analyzed through quantitative statistics and descriptive analysis to identify and interpret the pre-analytical procedures performed by the medical technologists in public and private laboratories and hospitals in Metro Manila during the COVID-19 pandemic.

2.2 Subjects and Study Site

The study utilized purposive sampling, which was initiated by establishing a general criterion for the population. This was based on the title of the study, indicating medical technologists who are working during the COVID-19 pandemic in Metro Manila. Furthermore, specific criteria that were formulated resulted in the establishment of the inclusion and exclusion criteria, allowing the researchers to specifically identify the target population, where the sample will be drawn. A sample is a small, random portion of the whole population representing the entire population. In this case, the target population was identified as medical technologists who are working in public and private hospitals and laboratories in Metro Manila during the COVID-19 pandemic. Consent forms were given to the selected qualified participants in which they could choose to agree or disagree to participate in the study. There were no gender restrictions, and the preferred age of the participants would be between 21 - 64 years old. Registered medical technologists who are working in public and private hospitals and clinical laboratories outside of Metro Manila were excluded.

2.3 Data and Instrumentation

The study utilized survey questionnaires through Google Forms as the platform to conduct data gathering. The survey questionnaire was constructed with seven sections which can be answered and submitted within five minutes. The sections were organized chronologically into greetings (section I), informed consent (section II), demographics (section III), and survey questions (sections IV, V, VI, and VII). To emphasize, the demographics include participant's full name, age, sex, and the name of the hospital where they are working. All of the questions about the participant's demographics are required, except the participant's full name. Furthermore, the survey questions consist of eleven items in the form of Likert-Scale and select-all-that-apply (SATA) questions. The data collected were then encoded and tallied in Microsoft Excel. In addition, questions consisting of the choices yes, partial, no, or non-applicable, the respective categories these questions were in are averaged and graded accordingly.

Prior to the actual data gathering, the researcher performed pilot testing among 25 registered medical technologists to determine if the study questionnaire is feasible, measurable, attainable, and realistic. The study sample size consists of 94 respondents which was calculated from the established margin of error (10%) approved by the statistician and the research adviser, with a 95% confidence level in a population of 3738 registered medical technologists. The latter population was based on the total population of registered medical technologists in Metro Manila as per DOH 2020.

After conducting pilot testing, the internal consistency of the questionnaire was checked using Cronbach's Alpha. It attained a value of 0.608 which is satisfactory according to Taber [42].

Cronbach's alpha is a statistic commonly quoted by authors to demonstrate that tests and scales that have been constructed or adopted for research projects are fit for purpose.

Table.1. Reliability Statistics

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.608	.548	8

Alpha values are described as

- Excellent (0.93–0.94),
- strong (0.91–0.93),
- reliable (0.84–0.90),
- robust (0.81),
- fairly high (0.76–0.95),
- high (0.73–0.95),
- good (0.71–0.91),
- relatively high (0.70–0.77),
- slightly low (0.68),
- reasonable (0.67–0.87),
- adequate (0.64–0.85),
- moderate (0.61–0.65),
- satisfactory (0.58–0.97),
- acceptable (0.45–0.98),
- sufficient (0.45–0.96),
- not satisfactory (0.4–0.55) and
- low (0.11)

2.4 Data Gathering Procedure

The researchers requested permission to administer a survey to the employed medical technologist of public and private hospitals and laboratories from either the hospital or

laboratory director through email, phone, or telephone call of the contact numbers of their respective institutions. The researchers also requested a list of their medical technologist's preferred email addresses to directly distribute the survey questionnaires to the participants. After permission was granted to conduct a survey among the medical technologists of the respective hospitals, a Google form, consisting of the informed consent and the survey questions, was sent directly to the participants (i.e., medical technologists) of the study via email. Additionally, the researchers also posted infographics containing details of their data gathering on Facebook groups consisting of Filipino Registered Medical Technologists (see Appendix G), to request for respondents. The informed consent must be accomplished first prior to answering the demographics and survey questions.

2.5 Ethical Consideration

An initial copy of this study was given to the Ethics Committee for research approval. Before the survey proper, participants were given consent forms for them to be properly informed about the study, as well as for them to understand the information, and have the freedom to choose whether to take part or not. The participants' permission to participate in this study was only received after a detailed explanation of the research process. These participants were specifically informed that they had the right to withdraw from the study at any time, even after agreeing to the informed consent. Participants were kept anonymous and their personal data and responses to the survey were kept confidential by not disclosing their names and identities in the data collection, interpretation, and reporting of the study results. Furthermore, gender neutral pronouns were used to protect their anonymity and confidentiality.

2.6 Data Analysis

All data from the participants were analyzed quantitatively, particularly through descriptive statistics used in conjunction with percentages, weighted mean, and frequency tables. The researchers utilized the accounts and cases of the participants in attempting to form relationships and a framework of knowledge based on their responses. The collected data were tallied by the researchers. Subsequently, the calculations of the data gathered was computed with the help of the hired statistician, alongside the formulation of tables and charts necessary for data illustration and efficient interpretation. The researchers utilized statistical analyses such as weighted mean, and frequencies in gauging the pre-analytical competencies of the respondents. Questions containing the options yes, no, partial, not applicable were calculated accordingly with responses of:

- Yes - giving 1 point or 100% to the question
- Partial - giving 0.5 points or 50% to the question
- No - giving 0 points or 0% to the question
- Non-applicable - excluding the question from the calculation

In summarizing results using the questions above, the responses are averaged per category and assessed using these conditions:

- Below 50% - requires significant improvement
- Between 50% and 80% - some improvement is necessary
- Above 80% - the laboratory is in good standing

III. RESULTS

3.1 Demographic Profile

Table.1. Demographic Profile of the Respondents

Age	**Mean**	**SD**
Age	27.14	6.5
Sex	**f**	**%**
Male	33	42.86
Female	44	57.14
Total	77	100

Table.1. displays the demographic profile of the respondents using frequency and percentage. It shows that there are a total of 77 medical technologists who answered the survey, with majority of the respondents being female (57.14 %) with a mean age of 27.14.

3.2 Specimen Collection

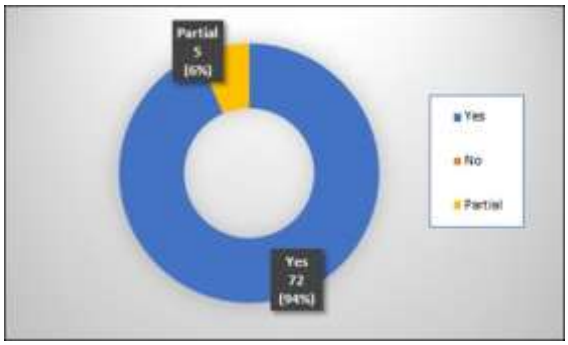

Fig.1. Documentation and availability of collection procedures

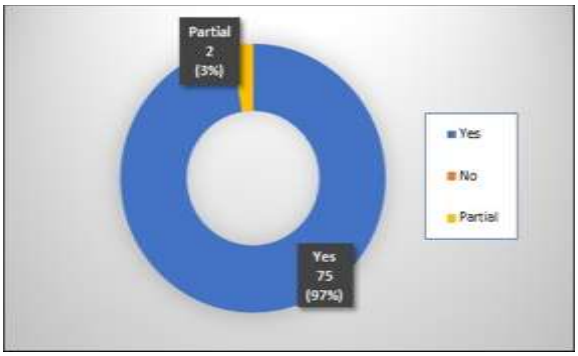

Fig.2. Inclusion of minimum patient identification details in collection procedures

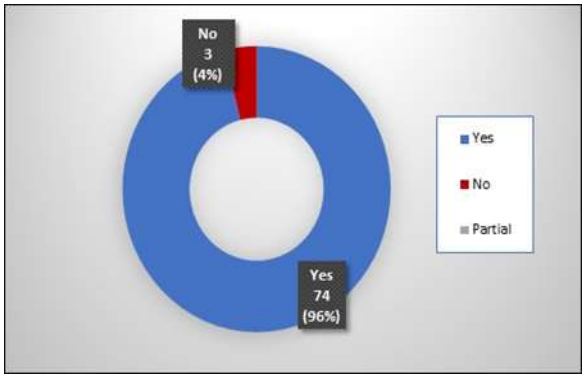

Fig.3. Use of special labels for patient samples

The documentation of collection procedures and its availability to relevant personnel is observed in 72 or 94% of the participants (Figure 1). In 97% of the time, this includes recording the minimum details to identify patients (Figure 2). In terms of labelling samples, 74 or 96% responded that they indicate with special labels using stickers or hand-written symbols or label the samples that they obtained from their patients (Figure 3). Minimum patient identification is observed in most laboratory specimens (97%), while seldom is it partially observed (3%). The average score for specimen collection is 97% which corresponds to a good laboratory standing.

3.3 Specimen Handling

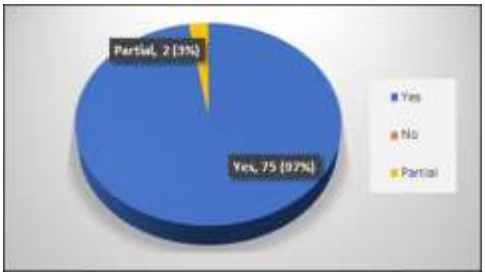

Fig.4. Availability of criteria to accept or reject primary specimens

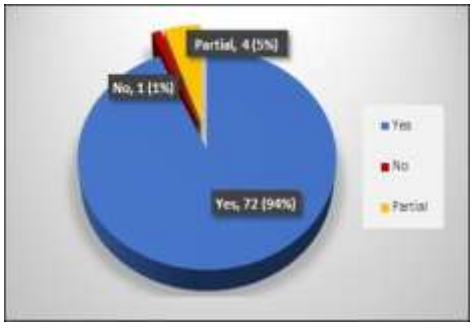

Fig.5. Presence of adequate storage for specimens if not examined immediately

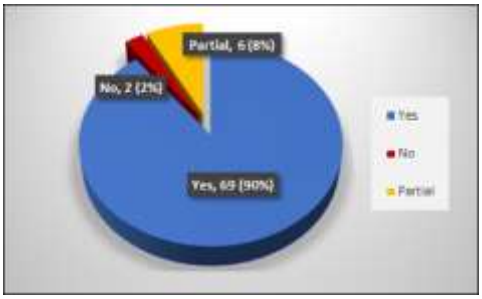

Fig.6. Presence of adequate storage for analyzed specimens

In Figure 4, it can be observed that 97% of the participants are using a set of criteria when accepting or rejecting primary specimens (including potential caution if non-conforming specimens). The storages of primary specimens which are not examined immediately, and which are already analyzed are adequate in 94% and 90% of the time, respectively (Figures 5 and 6). The average score for specimen handling is 96% which corresponds to a good laboratory standing.

3.4 Specimen Transport

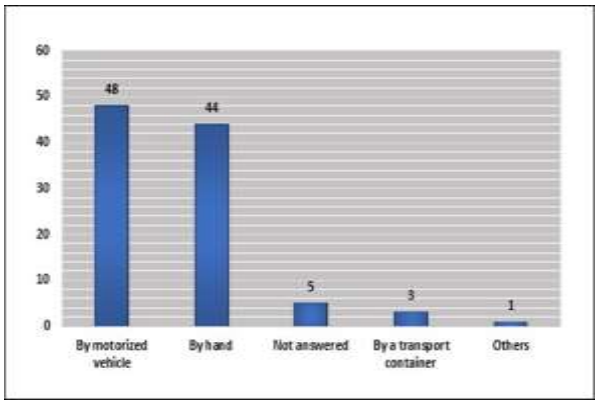

Fig.7. Delivery of biochemistry samples

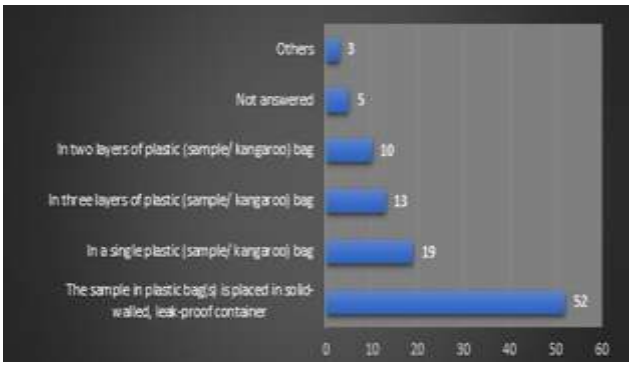

Fig.8. Packaging methods of biochemistry samples

Figure 7 presents the different ways on how clinical specimen samples were delivered. The most frequent way to deliver the biochemistry samples was by motorized vehicle with 48 frequency or 62.3% and followed by transporting by hand with 44 frequency or 57.1%. Figure 8 shows the ways on how the samples were packed for delivery. A total of 52 or 67.5% of respondents reported that the samples in plastic bags were placed in solid-walled, leak-proof containers.

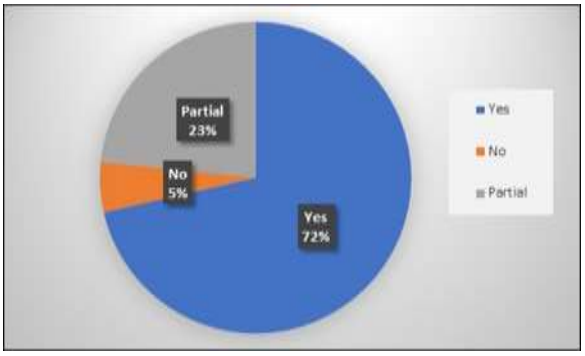

Fig.9. Presence of person/s-in-charge of shipments of infectious substances.

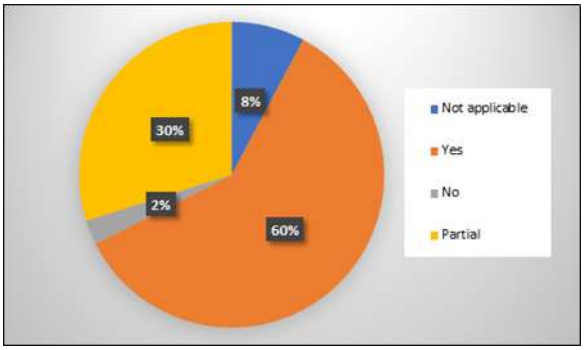

Fig.10. Training of staff for local or national regulations

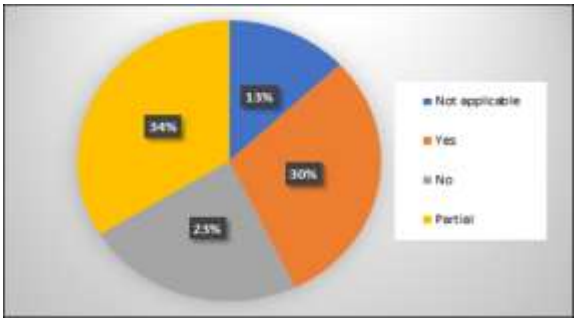

Fig.11. Training of staff for international regulations

Majority (72%) of the participants indicated that there is/are person/s-in-charge of shipments trained for the transport of infectious substances (Figure 9). Among them, 60% have answered "yes" for having training for local or national regulations and 30% have answered "partial" for having training for local or national regulations (Figure 10). Figure 11 shows that only 30% of the respondents have answered "yes" for being trained in international regulations and 34% have answered "partial" for having training in international

regulations. The average indicator for this area of specimen transport is 70%, which implies that some improvements must be made.

3.5 Specimen Personal Protective Equipment

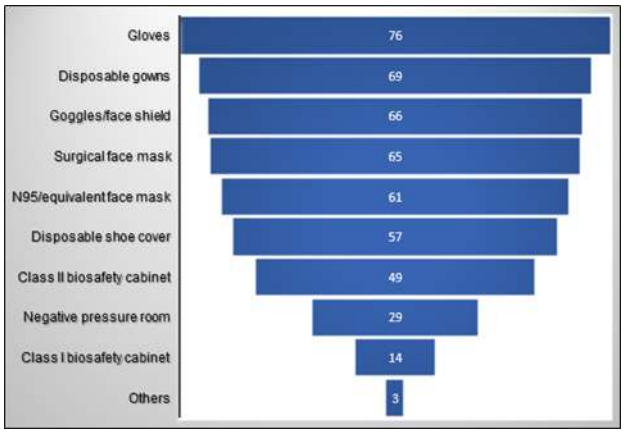

Fig.12. Frequency of protection processes employed when handling clinical specimen samples.

Figure 12 shows the frequency of protection processes utilized by the laboratory staff when manually handling specimen samples during this COVID-19 pandemic. Seventy-six or 98.7% of the medical technologists who participated in this study reported that gloves are the most commonly worn personal protective equipment (PPE) in their protection process. The least employed protection process in the laboratory is the use of class I biosafety cabinets with the frequency of 14 or 18% of the respondents.

IV. DISCUSSION

This study aimed to identify how medical technologists in NCR collect, handle, and transport clinical specimens during the COVID-19 pandemic. The questionnaire used for the study focused on four (4) areas of the pre-analytical phase: specimen collection, specimen handling, specimen transport, and personal protective equipment.

4.1 Demographic Profile

The demographic profile of the respondents in Table 2 corresponds to the requirements of the study which include both sexes and comprises ages ranging from 21-64 years of age. The youngest respondent from the study was 21 years of age and the oldest was 56 years of age at the time of answering. The laboratories wherein the respondents were working ranged from public and private hospitals within NCR.

4.2 Specimen Collection

Among the respondents, the majority observed proper practices of specimen collection which include having an outline of standard collection procedures, pertinent patient identification, and the corresponding labelling with regards to the type of specimen submitted to the laboratory based on the results in Figures 2, 3, and 4. As major sources of pre-analytical errors include identification errors, which may be of the patient or of the specimen, the following and knowledge of correct procedures for specimen collection remains critical to the accuracy of testing [61]. Routine laboratory work includes the following of these guidelines, while still adhering to the standard operating procedures of the given laboratory as advised by the World Health Organization. It is integral that staff are trained with regard to the appropriate specimen collection practices and are adhering to the given infection prevention and control guidelines. Risk assessment should be performed in line and updated with existing guidelines to ensure the good microbiological practices and procedures in the laboratory are held to a high degree. According to the Biosafety in Microbiological and Biomedical Laboratories 6th Edition, released by the Center for Disease Control and Prevention in 2020, the minimization and control of risk factors in a microbiological setting deal with proper infection control to ensure safety together with decontaminating areas of specimen collection. With specimen collection differing in specific sections of the laboratory, procedures and protocols must be known to the laboratory personnel and should be readily accessible. In general, the respondents observed the proper procedures in specimen collection, through proper documentation, labelling and identification.

4.3 Specimen Handling

In the area of specimen handling, the study focused on the availability of a criteria for accepting or rejecting primary specimens, and the presence of adequate storage for laboratory specimens. The results of this study revealed an acquired average indicator score of 96.1% for specimen handling which indicates that the respective laboratories of the participants are generally in “good standing” in this area of the pre-analytical process. To establish the importance of having criteria for specimen rejection, a study by Dikmen et al., stated that

practicing proper rejection and documentation of unacceptable clinical specimens is a fundamental step in improving the quality of work in a laboratory [29]. In figure 5, with the majority or 97% of the respondents attesting that they follow a certain criterion for specimen rejection, it is safe to assume that their laboratories are working to keep the quality of their service at par with the standards and guidelines set by the WHO [70]. Moreover, in terms of specimen storage, 94% of the respondents revealed that their laboratories are well equipped with adequate storage for specimens that cannot be examined immediately, while 90% also allot adequate storage for specimens that are already analyzed. Based on the guidelines for the collection of clinical specimens during field investigation of outbreaks released by the World Health organization, clinical specimens, especially those that cannot be processed immediately must be contained in an appropriate medium and must be stored accordingly depending on the specimen type's recommended storage temperature; these storage guidelines must, at all times, be followed to ensure the viability and integrity of clinical specimens. As shown in Figures 6 and 7, the majority of the medical technologists work in a laboratory that has adequate storage for both analyzed specimens and specimens that cannot be processed immediately, indicating that they observe proper specimen storage in accordance with the WHO guidelines.

4.4 Specimen Transport

In terms of specimen transport, the study is centered on delivery and packaging methods of biochemistry specimens, as well as the presence of person/s in-charge of transport of infectious specimens. Furthermore, the study also determined if the person in-charge of transport is trained for local or national, and international regulations.

The results in Figure 8 showed that the most frequent means of transport of biochemistry samples was by motorized vehicle (62.3%) and by hand (57.1%). During the pandemic, the government had placed the NCR, the region in the Philippines with the most cases of COVID-19 [15], into lockdown under enhanced community quarantine to contain the spread of virus, which also restricted the movements of people residing in the capital region. With that said, patients who wish to submit their samples cannot travel due to restrictions and the risk of being infected. Figure 8 shows that most specimens sent to the laboratory are transported via motorized vehicle, implying that samples are obtained in the homes of patients to reduce the risk of infection or the transmission of the virus if the patient is infected. According to Baclig of Inquirer [4], numerous hospitals in the National Capital Region have declared full capacity for COVID-19 cases, which implies that majority of these hospitals would no longer accept COVID-19 patients, but some are still willing to accept non-COVID-19 cases, either outpatient or inpatient. Regardless of whether some hospitals are still accepting COVID-19 or non-COVID-19 cases, some people are afraid to visit the hospital. As mentioned in the study conducted by Lazerrini et al. [37], people avoid going to the hospitals because of their fear of contracting COVID-19. The fear of COVID-19 can lead people to decline their treatment since they are unable to visit hospitals for their routine checkups. Hence, it can be concluded that patients and healthcare workers came into an agreement that the medical worker would be the one who would visit the houses of the patients to collect specimens needed for the laboratory test requested by the patients and still be able to monitor their health conditions without them going to the hospital. With that, healthcare workers would be needing a motorized vehicle as a courier to be able to transport the collected specimens from one house to their hospital.

Moreover, according to WHO [71], the probability of being infected by COVID-19 increases when people are in proximity for an extended amount of time, confined in an enclosed area with inadequate ventilation or staying in a crowded place. Thus, it can also be interpreted that to avoid

congestion or influx of people in one area and to lessen the spread of the virus, health workers should visit the patient's residence to collect samples for the laboratory test requested by the patient and deliver the collected specimen to the laboratory by a motorized vehicle.

The results in Figure 9 revealed that most biochemistry samples that are sent in the hospitals or laboratories in NCR are placed in solid-walled, leak-proof containers and packed in plastic bags. This is in accordance with CDC standards for the storage and handling of clinical specimens during an outbreak of a respiratory disease when the pathogen is unknown. Also, according to University Hospitals Bristol [66], collected samples should be kept in leak-proof tubes or bottles that are placed inside leak-proof plastic bags to reduce the risk of infection to the public and among those medical workers who transport the sample since the collected specimens could contain infectious agent that is capable of infecting others.

Therefore, it is implied that most hospitals and laboratories in the NCR follow the standards of CDC in terms of packaging and transport of clinical specimens during this time of pandemic to reduce the risk of infecting more people.

As infectious substances always pose a biochemical threat even in transit, regulations must be set into place surrounding the transport for these infectious agents. As expressed by the CDC [70], "...shippers and carriers must be trained on these regulations so that they can properly prepare shipments and recognize and respond to the risks posed by these materials." As such, the individuals in charge of shipping these infectious substances, as well as the training of the staff regarding both national and international regulations, contribute to managing risk in the laboratory and to the surrounding community. The WHO specifically advises that personnel competence and training are among the core requirements for achieving laboratory biosafety. In general, all personnel handling biological agents should be trained on good microbiological practices and procedures. Furthermore, competency and proficiency assessment are used and verified among personnel with corresponding regular review and refresher training. The implementation of new procedures must be communicated to personnel-in-charge as new information regarding practices and standards emerge. As most facilities and laboratories are expected to develop their own respective biosafety program, it is expected that the management and leadership are responsible for its implementation. Figures 10 and 11 depict that laboratory possess adequate competencies in dealing with the shipments of infectious substances on the local or national level. As seen, persons dealing with shipments of infectious substances are mostly present, and the staff are trained at the local or national regulation competency. Regarding international regulations in Figure 12, the majority have received full or partial training in said competency, but almost a quarter of the respondents have not.

4.5 Laboratory Protection Processes

In terms of laboratory protection processes, the results show that the most employed protection process in the laboratory is the use of personal protective equipment. This includes the gloves, disposable gowns, goggles/face shields, surgical face masks, N95/equivalent face masks, and disposable shoe covers. According to a study by Liu et al. (2020), the risk of contracting infections among medical professionals during the pandemic cannot be eliminated; however, the use of personal protective equipment appropriate against specific agents can significantly reduce the risk of infection. Additionally, during this COVID-19 pandemic, where the healthcare setting requires stronger infection and control measures, PPEs are considered as a fundamental element that protects health care professionals, patients, and the wider community [25].

As seen in Figure 13, the least worn PPE, which are the disposable shoe covers, are still being worn by the majority or 74% of the respondents. This only implies that generally, medical technologists value the use of personal protective equipment when handling clinical specimens.

However, in Figure 13, it can also be observed that only 18% and 37% of the respondents make use of class I biosafety cabinets and negative pressure rooms in their designated laboratories, respectively. Unlike the PPEs, only a small portion of the participants use these protection processes despite its importance in laboratory safety. Negative pressure rooms, through high-efficiency particulate air filters, are effective in minimizing the exposure of medical professionals to hazardous fumes and air-borne by-products. Moreover, as stated by Qasmi et al. [2], biosafety cabinets have become a standard primary barrier against infectious agents in the laboratory. With the limited frequency of biosafety cabinets and negative pressure rooms among the laboratories of the respondents, the level of safety in their workplace also goes down. With this, it can be assumed that the protection processes implemented by the respondents' laboratories are not completely safe and effective.

4.6 Study Limitations

Due to the pandemic, the researchers encountered limitations in acquiring the desired number of respondents for the study. The researchers were unable to obtain the desired number of respondents. Out of the desired 94 respondents, only 77 agreed to participate and share their data. Despite the efforts of the group in contacting laboratories and hospitals all over Metro Manila, most of them were not responding in both calls and emails most likely due to the increasing demand of health services making laboratories busy during this pandemic. Additionally, each health institution has their own procedures and protocols in terms of approving data gathering in their premises, the urgency of addressing which is different in each institution. Hence, the responses to requests for data collection also vary from weeks to months.

V. CONCLUSION

The results of the study have determined how medical technologists in Metro Manila collect, handle and transport clinical specimens during this COVID-19 pandemic. In terms of the procedures employed, most medical technologists confirmed the practice of collection procedures such as the documentation, inclusion of patient identification and utilization of special labels for patient's samples.

The study has also determined that most medical technologists in Metro Manila have guidelines in accepting unqualified specimens, as well as adequate storage for analyzed specimens and those with delayed analysis.

The most frequent means by which specimens are delivered to the laboratory is through motorized vehicles followed by delivery by hand. In terms of material used for packaging the specimens, the most used according to the medical technologists is the solid-walled leak proof container, followed by a single plastic bag and three layers of plastic bag respectively. The most evident findings can be seen regarding the training for local and international regulations for the staff in charge of transporting infectious substances. Although the majority has had training for local or national regulations, not all have the necessary training for international regulations.

The PPEs being used are similar for all respondents, while some labs have more advanced equipment, such as BSL I and II cabinets and a negative pressure room. The common PPEs being used among the respondents are gloves, followed by disposable gowns, goggles/face shields, surgical face masks, N95/equivalent face masks, and disposable shoe covers respectively.

Given the current circumstances and limitations posed to the researchers during the COVID-19 pandemic, we recommend the following:

For future investigators, they are recommended to focus on the Analytical and Post-Analytical procedures among Medical Technologists during the COVID-19 Pandemic in Manila, expand the scope to determine how different regions were able to handle the pandemic and if there is a difference in analytical procedures among these regions, and include the procedures in collecting nasopharyngeal specimens, bronchoalveolar lavage specimens, and other clinical specimens for COVID-19.

For the improvement of the study, future researchers are advised to increase the number of respondents to provide a more reliable and accurate representation of data. As this study used an online questionnaire, we recommend including interviews with subsequent thematic analysis to provide more insight on the data gathered.

For the improvement of the medical technology profession, further training for local or national and international regulations for specimen transport requires improvements. Laboratories should also include BSL I or II cabinets with negative pressure rooms in the facility to ensure better handling of specimens and further protection for the personnel.

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