Efficiency of Non-COVID-19 Referral Clinical Laboratories in Tuguegarao City Amidst COVID-19 Pandemic

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Abstract*—COVID-19 (Coronavirus disease 2019) became a global pandemic in March 2020, alarming hospitals and the healthcare system. COVID-19 has affected numerous aspects of the health system, especially clinical laboratories. Efficiency means achieving a goal with little waste, effort, or energy. With these, researchers sought to determine the efficiency of non-COVID-19 referral clinical laboratories in Tuguegarao City, Cagayan amidst pandemic. Study participants were limited to hospitals that cater OPD patients and non-COVID-19 referral private secondary and tertiary clinical laboratories. The study utilized a clerical tool, a Likert scale questionnaire which were distributed to (28) qualified respondents which are (3) chief medical technologists, (6) section heads, and (19) medical technologists of the selected tertiary and secondary private clinical laboratories in Tuguegarao City, Cagayan. Analysis of the responses demonstrates in the midst of the COVID-19 pandemic; each clinical laboratory is equipped to provide necessary services. In conclusion, clinical laboratories faced various difficulties during the COVID-19 pandemic, and the rising local incidence of COVID-19 had a significant impact on laboratory operations especially in human resources. Secondary and tertiary clinical laboratory services and hospital laboratory use are necessary for efficient deployment. Thus, hospitals and future researchers can use the study's findings to prepare for unanticipated catastrophes. The researchers recommend expanding the study to include non-COVID-19 referral clinical laboratories, public or government-run and private primary, secondary, and tertiary clinical laboratories, and free-standing laboratories to better determine clinical laboratory efficiency during the COVID-19 pandemic. The researchers also suggest using a qualitative method to conduct the same study; laboratory workers should be interviewed about their experiences and coping mechanisms throughout the epidemic.

Keywords— clinical laboratory, laboratory personnel, secondary, tertiary, COVID-19, pandemic, efficiency, services, human resources, supplies and equipment management, quality assurance

I. INTRODUCTION

Human medical knowledge and understanding of illness diagnosis and management have progressed to an unprecedented level, but COVID-19 (Coronavirus Disease 2019) highlighted people's shortcomings and weaknesses. Consequently, clinical laboratories have experienced significant challenges due to the global spread of the COVID-19. Hospital healthcare professionals and laboratory staff are alarmed about this novel virus's infectivity. Turnaround times may be compromised in terms of operations due to staffing shortages and regular tests (Tan et al., 2021). Patients with and without COVID-19 necessitate round-the-clock laboratory testing to assist their treatment (Chambliss & Tolan, 2020).

Moreover, according to Chambliss & Tolan (2020), the pandemic has increased inpatients, as well as infection exposures and laboratory workers' self-quarantines. As a result, laboratories should work with a reduced workforce, and laboratory tests may need to be prioritized based on clinical necessity. Complete blood counts, routine coagulation, metabolic panels, liver function tests, blood gasses, troponin, and inflammatory indicators such as creatinine reactive protein (CRP), lactate dehydrogenase (LD), and procalcitonin must be monitored regularly. Furthermore, Singh et al. (2021) identified three distinct patterns in laboratory test volumes: (1) a fall during state lockdown, accompanied by near-complete or successful recovery; (2) no modification; and (3) a sustained decline.

Many aspects of the health sector have been impacted by the COVID-19 pandemic, particularly the clinical laboratories, according to Cabel et al. (2021). In the study of Ahmed et al. (2021), the increasing diagnostic requirements of the COVID-19 era have affected laboratory tests. Pandemics have accentuated the importance of clinical laboratories in health care, but laboratory testing is a complex process in and of itself. Due to personnel shortages, transport difficulties, personal protective equipment, delayed supply of requirements, and anxiety and fear among healthcare workers, the COVID-19 pandemic has emphasized laboratory resources. From the pre-pandemic era, sampling and transit logistics have altered dramatically. The overall impact of these updated techniques on sample collection, packaging, and transportation on the testing process is unknown. Additionally, personal protective equipment (PPE) is in low supply due to the sudden emergence

of the novel coronavirus disease 2019 and its increasing prevalence across many healthcare systems worldwide, which cannot be solved by limiting the use or expanding manufacture. With the demands of supplies and scarcity, the cases of COVID-19 around the world have risen (Weaver et al., 2021).

Durant et al. (2020) researched the changes in laboratory tests used in the context of rising COVID-19 local incidence, the transmission laboratory section, and the COVID-19 diagnostic and governance tests were overworked. Therefore, the increased local prevalence of COVID-19 had a substantial impact on laboratory operations. While the volume of laboratory tests related to diagnosis and management has increased, total testing volumes have decreased dramatically. Numerous countries have requested medical help, such as laboratory test kits and strips, donated or purchased, as Abdullahi et al. (2020) reported.

According to a study conducted by Aborode et al., (2021), the current COVID-19 pandemic has revealed a laboratory's vulnerability due to inefficient and incompetent health surveillance methods. Because the COVID-19 pandemic had such a devastating effect on health systems, it has highlighted the significance of reconsidering and focusing on the lessons learned during the outbreak; however, the study is limited to the hospitals catering COVID-19 patients. Efficiency is the ability to achieve an end goal with little to no waste, effort, or energy. With these, the researchers seek to determine the efficiency of non-COVID-19 referral clinical laboratories wherein the participants of the study were only limited to hospitals that cater OPD patients and non-COVID-19 referral private secondary and tertiary clinical laboratories around Tuguegarao City, Cagayan amidst pandemic.

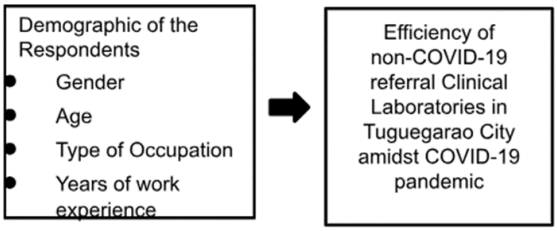

Fig. 1. Research paradigm

Figure 1 illustrates the research paradigm and the flow of the study. As shown in Figure 2, the independent variables were explored by their relationship to the demographic profile through use of surveys. The participants will be grouped according to their gender, age, present occupation, and years of work experience. The process involves the use of a survey, which was grounded to the Likert Scale. The Likert scale will explore the Quality Management System (QMS), specifically services human resources, supplies and management system, and quality assurance system as a basis for efficiency. With this, it is expected to reveal the efficiency of non-Covid-19 referral clinics during the pandemic.

II. METHODS

A. Research Design

The study utilized a descriptive quantitative design. The researchers gathered the necessary information from the private secondary and tertiary clinical laboratories in Tuguegarao City and determined the efficiency of non-COVID-19 referral clinical laboratories amidst COVID-19 pandemic.

B. Locale and Respondents

The researchers conducted the study in non-COVID-19 referral clinical laboratories around Tuguegarao City. Non-COVID-19 referral hospitals are the most visited hospitals that offer medical services because most hospitals that cater to COVID-19 patients do not accept out-patients (OPDs) or non-related COVID-19 diseases. The study has 28 participants and was conducted among the three (3) chief medical technologists, six (6) section heads, and nineteen (19) medical technologists of the selected tertiary and secondary private clinical laboratories in Tuguegarao City, Cagayan. They are the qualified respondents in this study.

C. Instrument

The study utilized a clerical tool, a Likert scale questionnaire. Likert items were used to measure respondents' attitudes to a particular question or statement. The questionnaire was structured by the researchers and validated by Registered Medical Technologists and a Research Statistician. It was tested for reliability and validity before being distributed to respondents as a data-gathering tool. For reliability, the questionnaire received a Cronbach alpha score of 0.816 which is interpreted as "good" and for validity, it obtained an average CVI of 1.000 which is interpreted as "acceptable". The questionnaire is the main data gathering tool and is divided into parts; the first part consists of questions about their socio demographic profile, the second part includes the level of clinical laboratory profile, and the last part consists of questions regarding level of efficiency of clinical laboratories. This was given to the respondents in a conventional hard copy printed on a paper intended for respondents in the locality of the study.

D. Data Analysis

Data gathering through floating survey questionnaires took place in June 2022. Data from the questionnaires were collated and tabulated for frequency and percentage. The data collected were used only for this study, and all the pieces of information provided were kept confidential. The data obtained were inputted and checked for consistency and accuracy in a Microsoft Excel data sheet. Descriptive quantitative findings were presented in simple percentages and frequency, tabulated, interpreted, and explained meaningfully using text obtained from the responses.

The following are the ranges of weighted means for each category of response, which refers to efficiency Level of Clinical Laboratories in terms of services, human resources, supply and equipment management, and quality assurance system:

TABLE I. QUALITATIVE INTERPRETATION FOR MINIMUM INHIBITORY CONCENTRATIONS

Mean Score Range	Qualitative Interpretation
4.50-5.00	Very High Efficiency
3.50-4.49	High Efficiency
2.50-3.49	Acceptable Efficiency

Mean Score Range	Qualitative Interpretation
1.50-2.49	Low Efficiency
1.00-1.49	Very Low Efficiency

E. Ethical Considerations

This research study underwent clearance from the University of Saint Louis Tuguegarao for review, revision, and research approval. The researchers asked for permission from the Dean of the School of Health and Allied Sciences, and Vice President for Academics. All protocols used in conducting this study were subjected to approval by the University Ethics Committee. Afterward, the University Office of the Vice President for Academics sought permission from the office of Ethics Committee, R2TMC-IRB. The researchers asked for permission from the Director of the selected private secondary and tertiary clinical laboratories in Tuguegarao City, Cagayan, to ensure that the study does not cause any harm and have a beneficial outcome.

The researchers sought an informed consent from the respondents, ensuring their privacy in participating in this study. They were not forced in any manner to cooperate with the researchers. The participants were assured that the data gathered are within the researchers' security measures to maintain the data's availability, integrity, and confidentiality. The researchers ensured that all the data collected is regarded as confidential. For the questionnaire that was given personally, the researchers ensured to protect the data by disposing of the forms and burning them after the publication of the study. To respect the privacy of the respondents, the researchers used the information for research purposes only.

III. RESULTS AND DISCUSSION

TABLE II. LEVEL OF EFFICIENCY OF THE DIFFERENT NON-COVID-19 CLINICAL LABORATORIES IN TUGUEGARAO CITY

Categories	Mean	Qualitative Interpretation
Services	4.76	Very High Efficiency
Human Resources	4.23	High Efficiency
Supplies and Equipment Management	4.33	High Efficiency
Quality Assurance System	4.56	Very High Efficiency

Table 2 presents the clinical laboratory efficiency level amidst the COVID-19 pandemic. Services obtained a mean score of 4.76 which is interpreted as “Very High Efficiency”. In addition, human resources obtained a mean score of 4.23 which is interpreted as “High Efficiency”. Moreover, supplies and equipment management has a mean score of 4.33 which is also interpreted as “High Efficiency”, and lastly, quality assurance system has a mean score of 4.56 which is interpreted as “Very High Efficiency”.

Clinical laboratories have experienced significant challenges due to the global spread of the COVID-19. Hospital healthcare professionals and laboratory staff are alarmed about this novel virus's infectivity. According to Cabel et al. (2021), many aspects of the health sector have been impacted by the COVID-19 pandemic, particularly the clinical laboratories.

The quality of clinical laboratory services is characterized as services that can satisfy each service user in accordance with their level of satisfaction, which is determined by a set of factors. These factors include turn-around time, client satisfaction, and maintaining reliability and accuracy of results. Service quality in the laboratory is related to data from laboratory analysis test results. Moreover, the key to laboratory services is to meet or exceed patient expectations about the quality of service they receive. If the quality of laboratory services is not improved, it is likely that service users will file complaints and, in the end, will not return to use the laboratory services (Letelay et al., 2021). According to the results, clinical laboratories have an efficient turnaround time amidst COVID-19 pandemic, this indicates that laboratory analytical turnaround time is a reliable indicator of laboratory effectiveness (Goswami et al., 2010). TAT is one of the most noticeable signs of a laboratory service and is used by many clinicians to judge the quality of the laboratory. In a similar study conducted by Hawkins (2017), delays in TAT elicit immediate complaints from users while adequate TAT goes unremarked. This implies that turn-around time greatly contributes to the efficiency of clinical laboratories in terms of its services. Consequently, results showed that client satisfaction was met during the COVID-19 pandemic, this confirms the degree of clients’ satisfaction with laboratory services were met. Understanding the clients' level of satisfaction is necessary. Satisfaction is the level of happiness that clients experience having used a service. It therefore reflects the gap between the expected service and the experience of the service from the client’s point of view. The most important baseline for improving the quality of service offered is client satisfaction and identifying the factors hindering clients' satisfaction. Furthermore, a similar study conducted by Mindaye and Taye (2012), in a clinical laboratory, monitoring patients' satisfaction is an important and useful tool required for quality improvement and to maintain their accreditation. The reliability and accuracy of results were maintained, this implies that clinical laboratories have maintained to release and report reliable and accurate results despite the increasing demand of tests due to COVID-19 pandemic. In the study conducted by Westgard & Darcy (2014), clinical reliability, or medical usefulness, should assess the correctness of patient classifications based on stated test interpretation guidelines, taking into account the precision and accuracy of the laboratory method, and allowing for the known within-subject biological variation and the QC needed to detect method instability. These statements support our study. Overall, based on the result presented in table 2 it shows that the Services parameter is very highly efficient.

In addition, human resource describes how an organization manages and develops its personnel. It all comes down to improving employees’ productivity and efficiency. This ascertains employees' recruiting and hiring process, labor shortage, and sustaining high-quality employee performance during pandemic. As all organizations respond to the threat of the new coronavirus crisis, human resources management has to play a crucial role in facilitating organizations and their workforce to cope with and adjust to their newly altered work environment during COVID-19 pandemic (Gigauri, 2020). Moreover, a study conducted by Letelay et al. (2021) stated that

the competence and experience of human resources (HR) in conducting sample examinations affect the speed of laboratory services as a determinant of diagnosis. According to the results, clinical laboratories experienced difficulties recruiting employees during the COVID-19 pandemic, which indicates that the COVID-19 pandemic also disrupted the workforce and may accelerate future shortages in the field of clinical laboratory medicine (Garcia & Kundu, 2021). The pandemic extended worldwide and impacted the nation's health and healthcare systems. Healthcare staff, particularly frontline employees, were entrusted with caring for an increasing number of COVID-19 patients. Despite that, they were also concerned about acquiring the virus and losing or keeping their jobs (Garcia & Kundu, 2021). The hiring process of clinical laboratories was also affected during the COVID-19 pandemic; this indicates that due to the difficulties in recruiting employees, the hiring process was affected. A study of (2020), revealed that the COVID-19 pandemic has brought challenges to the organizations and forced them to change human resource systems to adapt to the new reality. Also, as reported by the American Society for Clinical Pathology (ASCP) Vacancy Survey that supports our study, hiring qualified laboratory professionals and rates of burnout among individuals working in the clinical laboratory were the top concerns for staffing laboratories (Nunez-Argote et al., 2021). Moreover, clinical laboratories experienced labor shortages, which means that in addition to treating patients, hospitals and healthcare laboratory systems, had to deal with reduced human resources (Garcia & Kundu, 2021). Similar study conducted by Nunez-Argote et al (2021), shortages of clinical laboratory resources and trained staff members can critically impact a sufficient response during a pandemic. Even as the number of worldwide coronavirus cases drops, the COVID-19 Pandemic has worsened the scarcity of health workers, leaving many health care laboratories understaffed (Romero & Bhatt, 2021). The cause for this reduction, according to Rohde et al (2022), is the increased stress that healthcare personnel have been experiencing throughout the pandemic. To meet staffing needs, hospitals continue to hire and relocate specialists from other industries and locations, which is beginning to fall short of demand. Despite the difficulties in hiring and recruiting employees and experiencing labor shortages, the clinical laboratories manage to sustain the high-quality performance of each employee. Medical laboratory results are a gauge to account for 60-70 percent of all decisions about treatment, patient diagnosis, hospital admissions, and discharge (Obeta et al., 2019). To help with this, they must maintain competency, excel in their specialty areas, and work together as a holistic team to support the broad spectrum of clinical laboratories. These statements support our study. Overall, based on the result presented in table 2, it shows that the Human Resources parameter is highly efficient.

The supplies and equipment management consists of personal protective equipment, reagents supply, testing equipment, and equipment maintenance log. These supplies are primarily designed specifically for utilization in laboratory studies (Abdullahi et al., 2020). Majority of the respondents in the study have sufficient supplies of personal protective equipment (PPE) amidst COVID-19 pandemic. PPE is significantly important for laboratory workers in the clinical laboratory because of evidence that the use of PPE does reduce rates of disease transmission (Cook, 2020). A similar study conducted by Sureka et al., (2020) preventing the spread of infection to and from health care workers (HCWs) and patients relies on the effective use of personal protective equipment (PPE)—gowns, gloves, masks, air purifying respirators, goggles, and face shields. This implies that the most critical part in due course of managing this pandemic is an adequate supply of PPEs (Livingston et al., 2020). Additionally, there is sufficient reagent supplies which are covered during the COVID-19. This means that they have the monthly inventory and weekly checking of reagent supplies and re-stocking in their respective institution. Similar study conducted by Sisay, 2019 that the management of reagents and supplies in the laboratory is often a challenging task. Having an adequate supply of reagents is crucial in covering all the tests required to ensure the quality of services in the clinical laboratories (Albarune et al., 2015). Also testing equipment is adequate during the COVID-19 pandemic. This confirms that their respective clinical laboratories that all equipment were available which can provide the test requested by their patients. Adequate supplies of laboratory equipment are an integral element in covering all the test demands by the patients (Sisay, 2019). Enough supplies of laboratory equipment will ensure that the result will be provided in a timely manner that will avoid patient dissatisfaction (Sureka et al., 2020). Moreover, the equipment maintenance log is met amidst COVID-19 pandemic. This confirms that the equipment maintenance log achieves the standard guidelines set by their institution such as, calibration, preventative maintenance and have running controls. Properly functioning laboratory equipment is a critical component for clinical laboratories Fonjungo et al., (2011). Similar study conducted by the World Health Organization (2011) found that the maintenance of laboratory equipment is essential to ensure that it functions correctly and efficiently and ultimately to ensure accurate and reliable results. These statements support our study. Overall, based on the result presented in table 2, it shows that the Supplies and equipment management parameter is highly efficient.

Quality assurance has become very important to the continued delivery of quality healthcare and remains a driving force for harmonization and standardization for laboratory medicine. It emphasizes providing confidence that quality requirements will be met. It reacts to imperfections in the system to achieve ideal outcomes. This is important both to internal stakeholders such as leadership as well as to patients, accreditors, and other concerned external parties (Taylor, 2022). According to the result, the clinical laboratory includes all the measures taken to ensure that the results of laboratory instruments or point-of care tests are correct and reliable during COVID-19 pandemic, as stated by CDC (2021), guidelines for collecting and handling clinical specimens for COVID-19 testing, which is for storing respiratory specimens at 2-8°C for up to 72 hours after collection. If a delay in testing or shipping is expected, store specimens at -70°C or below. Store extracted nucleic acid samples at -70°C or lower. Viruses are sensitive to unfavorable environmental conditions and necessitate specialized transport media to sustain viability during travel to the laboratory. The safety of sample collection, storage, and transportation has never been more crucial than in the era of

COVID-19. As the pandemic spreads, the global demand for viral transport medium (VTM) to maintain sample integrity also increases. Samples can become contaminated, reducing their viability and ineffectiveness and perhaps raising the likelihood of COVID-19 false-negative results if these three essential procedures are not carried out with the proper equipment. Hence, integrity of the specimens-to-be processed and transferred/transported to referral hospitals should be well maintained. This proves how transportation of specimen integrity during COVID-19 is very crucial. Furthermore, results show that clinical laboratories include all the measures taken to ensure that the results of laboratory instruments or point-of care tests are correct and reliable during COVID-19 pandemic, this demonstrates how these clinical laboratories ensure the integrity of the equipment and materials used for testing during covid-19. Similar study conducted by Vandenberg et al., 2020 that diagnostic testing without all stages of quality control (from design to final usage) is ineffective and wastes important and possibly scarce resources. Consequently, a preventive maintenance system is essential to increase the dependability of medical equipment and greatly enhance safety and cost-effectiveness. Moreover, clinical laboratories maintain records and documentation of the personnel responsible for corrective actions when problems are identified. Results show that each clinical laboratory keeps these records and documentation well-maintained. Incident reporting is often used to improve patient safety. The pre-analytical phase of laboratory testing comprises various manual, error-prone processes where mistakes can affect patient outcomes (Soderberg et al., 2009). According to Heaton et al. (2021), integral components of a records management program include processes to maintain records, including retention and storage of records, as well as transport records, when applicable. Proper records maintenance includes requirements that both physically and electronically stored records remain retrievable and usable during the time they are retained and that confidentiality is protected. Meanwhile, in terms of progress report it is associated with meetings and administration of a certain laboratory. This affirms that efficiency of one laboratory will not be achieved without proper documentation and reports. It was stated in the study of Shirts et al. (2015) that the purpose of the meeting and reports was to discuss the current practices and future directions for clinical laboratory analytics. It is crucial that a clinical laboratory must be updated and directed to troubleshoot future problems. Also, statements from Calzon (2022) supported our study that a report can provide objective insight into the performance of your practitioners and staff, which is a crucial aspect of how management reporting can help enhance the hospital's operations. It is feasible to precisely evaluate staff performance, efficiency, and efficacy at the point of delivery using a report from the healthcare business.

Hence, based on the results, it was confirmed that the functionality of the private secondary and tertiary laboratories significantly affects their efficiency. In the study conducted by Plebani (2018), to provide efficiency, the laboratory must maximize its quality of services such as accuracy and reliability of analytical results, and timelines, especially in this time of COVID-19 pandemic. Private laboratories were generally affected in terms of laboratory efficiency because they provided the demands of the patients by providing them with an alternate method of obtaining diagnostic services (Mfinanga et al., 2020). These statements support our study. Overall, based on the result presented in table 2, it shows that the Quality assurance system parameter is very highly efficient.

IV. CONCLUSION

According to the findings, all clinical laboratories have adequate services offered amidst COVID-19 Pandemic. Non-COVID referral laboratories were able to handle workload efficiently amidst the pandemic. Having high-quality services in a clinical laboratory would lead to maintaining accreditation. The human resource parameter concludes that the COVID-19 pandemic impacted the hiring process, experiencing difficulties recruiting employees and labor shortages. Despite changes in human resource parameters, the clinical laboratories managed to sustain the high-quality performance of each employee. The supplies and equipment management met its high efficiency during the COVID-19 pandemic. The quality assurance system emphasizes that they met providing quality requirements during the COVID-19 Pandemic; overall, the functionality of the private secondary and tertiary clinical laboratories significantly affects their efficiency. In conclusion, not all parameters in clinical laboratories are met with high efficiency due to different challenges that were encountered in clinical laboratories during the COVID-19 pandemic, and the increasing local incidence of COVID-19 profoundly impacted laboratory operations specially in human resources. Secondary and tertiary clinical laboratories' services and laboratory utilization in the hospital are essential when identifying how to deploy efficient utilization optimally. Thus, the clinical laboratories and future researchers can use the study's findings to provide in-depth findings to prepare for such unpredicted crises.

V. RECOMMENDATIONS

The researchers recommend extending the study to include additional non-COVID-19 referral clinical laboratories, public or government-run and private primary, secondary, and tertiary clinical laboratories, as well as free-standing laboratories, in order to better determine the efficiency of clinical laboratories during the pandemic. The researchers also suggest utilizing a qualitative method to conduct the same study; interviews with laboratory personnel should be undertaken in order to gather information about their experiences and coping mechanisms while working in clinical laboratories during this pandemic.

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