RESEARCH ARTICLE

Impact of the COVID-19 Pandemic on Laboratory Services

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Abstract

The positive impact of the coronavirus disease 2019 (COVID-19) pandemic is that hospital laboratory services are excellent when other services are declining. Aside from molecular biology laboratory (polymerase chain reaction, PCR) services for COVID-19 diagnostics, public demand has dramatically increased. It is a retrospective descriptive study that uses data on the total number and types of results of laboratory examination orders that have been verified from the laboratory information system of a hospital from 2018 to 2022. Data analysis is presented in the frequency of the number and type of results of laboratory examination orders and differences in requests for laboratory services before and during the pandemic since the government established it on March 8, 2020. The total number of laboratory requests between January 2018 and December 2022 was 1,943,539 services. The highest increase in laboratory examination services was in molecular biology (98.4%). As the need for community services increases for the PCR severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) examination, which is used in addition to diagnosing confirmed COVID-19 patients, it is also necessary for the community to conduct tracing if a family member has a COVID infection or travel requirements and follow-up for hospital employee exit tests who contracted COVID-19. In conclusion, the COVID-19 pandemic has positively impacted laboratory performance. There have been changes and an increase in the number and types of laboratory examination services and personal performance and management in laboratories.

Keywords: Biology molecular test, COVID-19 pandemic, laboratory services, PCR SARS-CoV-2

Introduction

A pandemic caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) is a highly contagious pathogen with rapid disease development and impacts all hospital services. Drastic changes in services, especially laboratory services are challenged to meet the need for fast and accurate diagnostics, triage, managing and guide therapy, disease-related monitoring strategies, and limiting the spread of the disease in a community. Many challenges occur in the laboratory regarding management, requirements for personnel trained and courageous in carrying out new and sophisticated tests, procurement of reagents and scarcity of supplies, and the risk of staff shortages due to coronavirus disease 2019 (COVID-19) infection.[1]

Laboratory services, as a result of the pandemic, are trying to carry out tests that were previously not the main examination and referred to, such as the COVID-19 polymerase chain reaction (PCR) molecular biology examination and IL-6 cytokines, which are the superior tests to be carried out, because they have to follow world developments to diagnosis, therapy guidance and monitoring of COVID-19 patients.[2–4]

The positive impact of the COVID-19 PCR molecular biology examination service unexpectedly became the prima donna of services in hospitals when other services declined due to the pandemic. Aside from molecular biology laboratory (PCR) services for COVID-19 diagnostics, public demand has dramatically increased. Different types of tests have also increased because monitoring of patients infected with COVID-19 requires a variety of other tests, so it has increased, as well as the IL-6, cytokine examination, hemostasis, blood sugar, and others. Clinical pathology analysis is challenged to perform routine examination interpretation services (such as hematology, clinical chemistry, immunoserology, and microbiology) and analyze the results of molecular biology examinations in assisting patient diagnostics.

Based on the research of Durant et al.[5] between February 2 and April 11, 2020, in a tertiary hospital in urban USA with 1,541 beds. It has obtained data with increasing local COVID-19 incidents that significantly impacted laboratory

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operations. There has been an apparent increase in laboratory tests for diagnostic purposes, monitoring disease patterns that direct the management of COVID-19, and several types of supporting laboratory tests, which have increased in overall volume. The COVID-19 pandemic also impacted laboratory management, staffing, and recommendations for managing resources and supply availability.[5]

Based on the observations of Dunbar et al.[6] in 2022, during the COVID-19 pandemic, clinical laboratory examinations played a crucial role in making a diagnosis. It is greatly influenced by various factors, including differentiating SARS-CoV-2 from other respiratory infection-causing pathogens; this is important for prompt clinical intervention and infection control. In addition to the incredible patient spike during the COVID-19 pandemic, few diagnostic tests were available initially. Only a few laboratories could develop, validate, and run the RT-PCR as the gold standard test for detecting SARS-CoV-2. Laboratories are challenged to continuously change and adapt to each pandemic and the mitigation strategies implemented to overcome them.

Based on the background above, Al Islam Hospital Bandung is one of the COVID-19 referral hospitals in the East Bandung area. Hence, this study aims to provide analysis relating to comparisons and changes in the number and types of patient services and the efforts made at the Al Islam Hospital Bandung laboratory before (2018–2019) and during (2020–2022) COVID-19 pandemic.

Methods

This retrospective descriptive research uses data on the number and types of results of laboratory examination orders that have been verified from the Al Islam Hospital Bandung laboratory information system from 2018 to 2022.

Data analysis is presented in terms of frequency, number, and type of results of laboratory examination orders that have been verified. The total volume was calculated two years before and after determining the pandemic period. This total calculates the absolute and relative differences in the volume of inspection orders between the pre-pandemic and the COVID-19 pandemic surge periods. The details of the types of laboratory examination orders analyzed in this study were grouped based on the

service department at the hospital laboratory, namely examinations consisting of hematology, clinical chemistry, immunoserology, routine clinics, microbiology, molecular biology, anatomical pathology, and blood bank. The number and type of laboratory examination order services analyzed is the total number regardless of the origin of the patient's status (from within the hospital, outpatient, and emergency department or requests from outside the hospital). The Health Research Ethics Committee of Al Islam Hospital Bandung approved the study with letter 038/KEPK-RSAI/6/2023.

Results

The total number of types of laboratory requests between January 2018 and December 2022 was 1,943,539 services, with types of requests for clinical pathology laboratory examinations and anatomical pathology having decreased in 2020. Still, there was an increase in 2021–2022 for clinical pathology laboratory examinations. In contrast to the demand for types of anatomical pathology laboratory examinations, it has declined from 2020 to 2022 compared to 2018 to 2019 (Table 1).

The impact of the COVID-19 pandemic since the government established it on March 20, 2020, can be seen in the trend of the number of details for each examination in the laboratory. Since 2018, the types of services can be classified into seven major groups: hematology examination, clinical chemistry, immunoserology, microbiology, molecular biology, routine clinics (and others), anatomical pathology, and blood bank services. During the pre-pandemic period (2018–2019), hematology and clinical chemistry examinations dominated the sequence of laboratory examination services. The last examination is an examination of anatomical pathology. This situation persists during a pandemic (2020–2022).

Hematological examinations increased drastically during the pandemic to post-pandemic (Figure 1) linearly. Clinical chemistry examinations, which had a downward trend during the pre-pandemic, experienced a slight increase during the pandemic but decreased again in 2021 (Figure 2). Previously, immunoserological examination was a type that did not dominate during the pre-pandemic, but this type of examination has an increasing trend during a

Table 1　Types of Laboratory Patient Examination and Visit Services at Al Islam Hospital Bandung for the 2018−2022 Period

|	Period					Total
	2018	2019	2020	2021	2022	
Types of laboratory services						
Clinical pathology laboratory	70,435	393,910	347,541	401,596	394,295	1,907,777
Anatomical pathology laboratory	1,597	1,336	1,110	1,122	1,105	6,270
Blood bank	4,650	4,425	5,592	7,642	7,183	29,492
						1,943,539
Patient visit services						
Clinical pathology laboratory	116,109	112,129	116,109	135,380	136,211	615,938
Anatomical pathology laboratory	1,110	1,336	1,110	1,122	1,105	5,783
Blood bank	3,976	3,133	3,976	5,301	4,667	21,053
						642,774
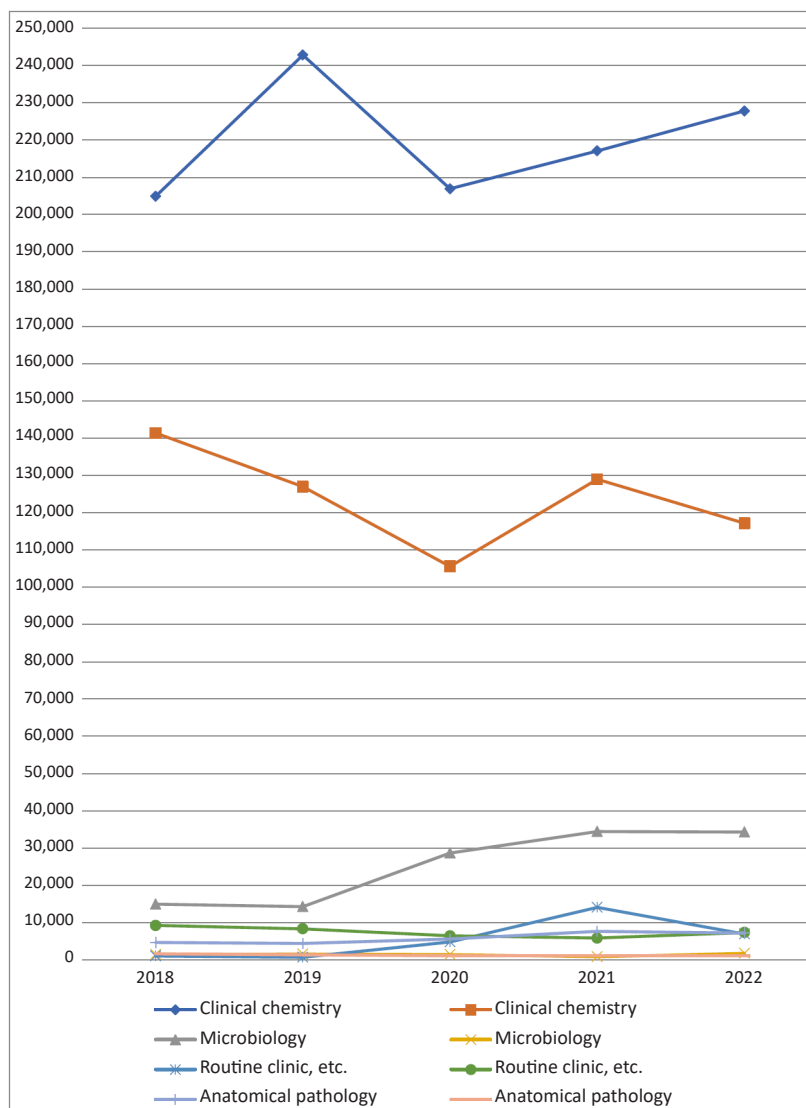
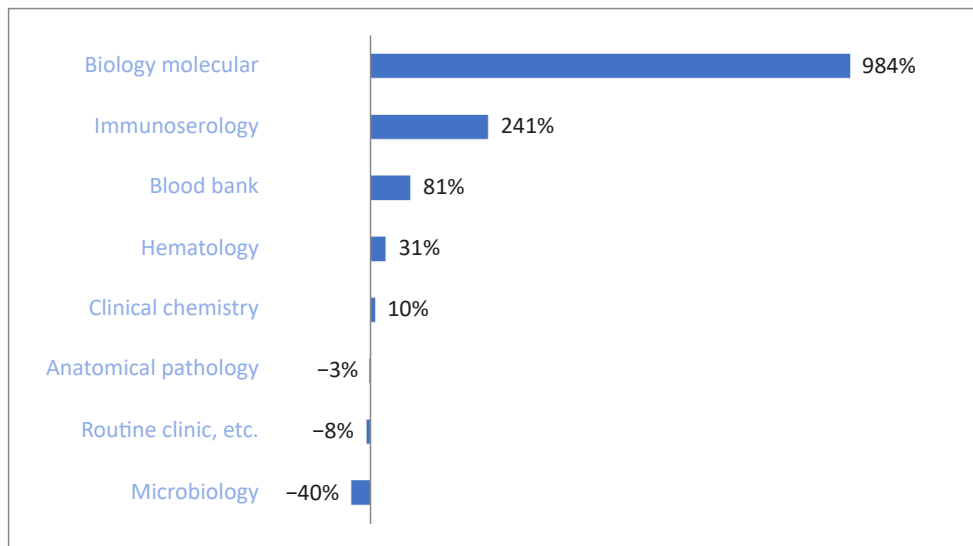**Figure 1　Laboratorium Inspection Type**

Figure 2 Differences Pre- and Post-COVID-19 Pandemic

pandemic (Figure 2). Like immunoserological examinations, molecular biology examinations also experienced a significant increase before and during a pandemic, as shown in Figure 3, even though in 2022, it decreased from the previous year

There are differences in laboratory examination services during the pre-pandemic and intra-pandemic periods (separation in March 2020), where laboratory services were decreased and added during the pandemic compared to before the pandemic. The decline in services in the anatomical pathology laboratory fell by 3%, and routine clinical laboratories and others decreased by 8%. Laboratory examination services that increased during the pandemic were the clinical chemistry laboratory, which increased by 10%. The hematology laboratory, which
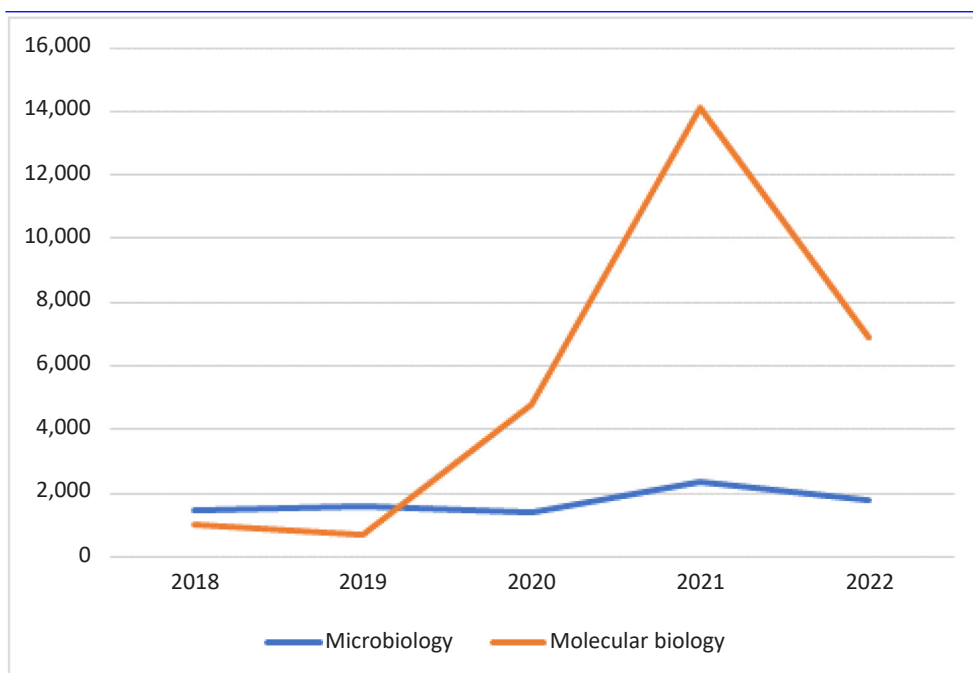

Figure 3 Comparison of Types of Pathogen Identification Tests

increased by 31%. The blood services laboratory, which increased by 81%. The immunoserology laboratory increased by 241%, and the molecular biology laboratory increased by 984%.

According to developments, types of laboratory examination services for diagnosing infectious diseases require changes in methods for identifying pathogens, as seen in Figure 3.

Examining pathogens grouped in the microbiology section at Al Islam Hospital consists of examining fungal preparations (KOH), gram staining, smear staining (with independent and DOTS programs), smear culture, and microorganism culture. In contrast, molecular biology examination consists of TCM TB and PCR SARS-CoV-2. Figure 3 shows a significant change in the number of molecular biology tests in 2020 when the pandemic occurred. A comparison of molecular biology examinations to microbiological examinations is shown in Table 2. Before the pandemic, molecular biology examinations were always less (ratio below 1). Still, at the beginning of the pandemic, molecular biology examinations were 3.37 times greater than microbiological examinations. During the pandemic, molecular biology examinations peaked almost six times more than microbiological examinations.

We found the highest services from each laboratory section, and each department varied. The ones that experienced the most changes were molecular biology services, immunoserology, and blood bank services, while laboratory examination services for other sections mostly stayed the same. Services ranked fifth most from the immunoserology examination, as seen in Table 3.

Discussion

The types of requests for clinical pathology laboratory examination services and blood banks have continued to increase from 2020 to 2023. The total number of laboratory patient visits differs from the number of laboratory

Table 2 Examination of Microorganism Identification

Types of Services	2018	2019	2020	2021	2022
Microbiology					
Fungi (KOH)	254	326	223	216	214
Gram	287	348	241	198	249
AFB stain	427	435	276	405	332
AFB culture	7	9	5	6	4
Microorganism culture	469	455	677	1,524	970
Molecular biology					
RT-PCR TB	1,037	706	187	680	939
RT-PCR SARS-CoV-2	0	0	4,615	13,407	5,988
Ratio molecular biology/microbiology service	0.71	0.44	3.37	5.99	3.91

Table 3 Services Ranked Five Most from Immunoserology Examination

Rank	2018	2019	2020	2021	2022
1	HBsAg	HBsAg	Rapid antibody SARS-CoV-2	Rapid antigen SARS-CoV-2	Rapid antigen SARS-CoV-2
2	Anti-HIV (screening)	Widal	HBsAg	Rapid antibody SARS-CoV-2	HBsAg
3	Widal	Anti-HIV (screening)	Anti-HIV (screening)	HBsAg	Widal
4	IgM *Salmonella typhi*	IgM *Salmonella typhi*	Widal	CRP	Rapid antibody SARS-CoV-2
5	CRP	NS1	CRP	Anti-HIV (screening)	Anti-HIV (screening)

examination services because a patient can perform more than one type of laboratory examination service. An average patient has 3 to 4 types of laboratory tests. This explanation can be seen in Table 1. During a pandemic, laboratory examination services increased the types of routine examinations carried out, as well as screening, diagnosis, therapy guidance, and follow-up therapy types of laboratory services for molecular biology examination services. Before the pandemic, the molecular biology examination service at the hospital was only for pathogen detection in diagnosing tuberculosis infectious disease, known as the molecular rapid test for tuberculosis, assisted by the provincial government in 2017. Since 2017, the Al Islam Hospital laboratory has begun providing molecular biology examination services. The molecular rapid test for tuberculosis (TCM TB) covered the eastern Bandung area and is the first private hospital in east Bandung to receive this equipment. At the beginning of the COVID-19 pandemic, molecular biology examinations for the identification of SARS-CoV-2 until December 2020 were still being referred to various nearby laboratories that already had RT-PCR equipment. Along with the increasing need for community services for the PCR SARS-CoV-2 examination, which is used in addition to diagnosing confirmed COVID-19 patients, it is also necessary for the community to conduct tracing if a family member has a COVID infection or travel requirements and follow-up for employee exit tests hospitals infected with COVID-19, this is the reason for the rapid increase in the number of molecular biology laboratory examinations.[7,8] This shows that the impact of the pandemic is not only on the type and number of examination services in the laboratory but also on innovation and creativity management, staffing arrangements, supervision of types of recommendation examinations, and availability of supplies in the laboratory.[1,5,9].

Procurement of molecular biology services during a pandemic requires increased knowledge and skills starting from the pre-analytical, analytical, and post-analytical stages. At the pre-analytical stage, specimen collection of oro swabs and nasopharynx of patients with COVID-19 infection was new in the laboratory. Still, during a pandemic, this became a routine examination. During a pandemic, compared to before the pandemic, immunoserology examination service of SARS-CoV-2 antigen is the most common

from 2021–2022.[10,11] In addition to monitoring the mild degree of disease and therapeutic response, the interleukin-6 (IL-6) examination, an examination of inflammatory cytokines that is most in demand is also used.[12–14]

Laboratory examination services in the clinical pathology department that were dominant before and during the pandemic, namely hematology and clinical chemistry, were still the same. This is because these two laboratory examination sections are widely used to determine the patient's baseline condition, including whether with or without comorbidities and monitoring of a disease, both infectious and non-infectious.[15–17] This is due to the type of hematological examination other than routine hematology that is carried out (hemoglobin, leukocytes, platelets, hematocrit and specific count), hemostasis examination for PT, aPTT and D-dimer during a pandemic is the type of examination that is mainly carried out due to COVID-19 infection caused by a virus that has been shown to enter cells via binding to the angiotensin-converting enzyme 2 (ACE-2), found primarily in the alveolar epithelium and endothelium. Endothelial cell activation is a significant driver of the increasingly recognized complications of thrombosis. Viral inclusion bodies have been identified in endothelial cells in various organs, from the lung to the gastrointestinal tract.[11,18]

Conclusions

The COVID-19 pandemic has had a significant impact on laboratory performance. There have been changes and an increase in the number and types of laboratory examination services related to the diagnosis and management of COVID-19, and the type of laboratory examination that has undergone the most drastic changes in the type of molecular biology examination for the pathogens detection of SARS-CoV-2.

Conflict of Interest

All authors declared there was no conflict of interest.

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