Barriers to Covid-19 RT-PCR Testing in Indonesia: A Health Policy Perspective

* Purwa Kurnia Sucahya

*Center for Health Research, Faculty of Public Health Universitas Indonesia, Room 211 G Building Kampus Baru UI Depok 16424, Indonesia

Email : purwa.sucahya@gmail.com

Abstract. Indonesia has been facing a hard time accelerating the number of laboratory capacity. This study provides an overview of the data on daily tests, confirmed cases, and the challenge of Covid-19 control associated with government policy. This study utilizes data reported from 2 March to 29 April 2020 by online official sources and regulations. Initially, the government only trusted one lab for the Covid-19 test. As the number of cases increased, referral labs were increased, until 29 April 2020, there were 89 officially appointed laboratories. The daily number of testing results fluctuated and unstable, although the number of reference labs increases. This reflects implementation challenges from different factors: readiness and capacity between labs; availability of swab collection officers; availability of reagents in the lab; rules for lab officers and swab collection officers; and transportation for a specimen from health facility to the referral lab. This study recommends to ensure the lab readiness in terms of human resources, tools, and reagents when appointed; ensure the adequacy and quality of qualified laboratory staff & swab collectors; ensure adequate reagents for RT-PCR, and rearrangement of shift rules for lab & swab collection officers, and improve handling procedures and transport specimen delivery mechanisms.

Keywords: Covid-19, Testing, RT-PCR, Referral Laboratory, Indonesia

Abstrak. *Indonesia kesulitan melakukan percepatan jumlah kapasitas laboratorium (Lab). Tujuan studi mereview hasil testing harian, kasus terkonfirmasi, dan tantangan imlementasi penanganan Covid-19 dikaitkan dengan kebijakan pemerintah. Analisis studi memanfaatkan data sekunder, periode 2 Maret sampai 29 April 2020, yang dilaporkan berbagai website resmi dan kajian regulasi. Awalnya pemerintah hanya percaya satu lab untuk testing Covid-19. Seiring bertambahnya kasus, jumlah lab rujukan ditambah, sampai tanggal 29 April 2020 sudah 89 lab yang ditunjuk resmi. Hasil testing harian memperlihatkan angka yang berfluktuasi. Ini mencerminkan tantangan implementasi dari berbagai faktor: kesiapan dan kapasitas antar laboratorium; ketersediaan & kemampuan petugas pengumpul swab; ketersediaan reagen di laboratorium; aturan untuk petugas lab dan petugas pengumpul swab; dan transportasi untuk spesimen dari fasilitas kesehatan ke laboratorium rujukan. Studi ini merekomendasikan untuk memastikan kesiapan laboratorium dalam hal sumber daya manusia, alat, dan reagen ketika ditunjuk; memastikan kecukupan dan kualitas petugas lab & pengambil swab mumpuni; memastikan kecukupan logistik reagen untuk RT-PCR; dan penataan ulang aturan shift untuk petugas lab & pengumpul swab, dan meningkatkan prosedur penanganan dan mekanisme transportasi pengiriman specimen.*

INTRODUCTION

Covid-19 is a new type of disease that was first discovered in Wuhan, China (1). This disease spread quickly throughout the world. The WHO even declared Covid-19 as a world pandemic. At present 213 countries have contracted Covid-19, one of which is Indonesia (2). Based on publications from Wuhan's condition, the disease is spread by transmission through droplets produced by coughing, sneezing, or talking, with an average incubation period of about 5.2 days (3). The period from the onset of Covid-19 symptoms to death ranges from 6 to 41 days with a median of 14 days (4).

The number of covid-19 cases reached 3.2 million worldwide as of April 29, 2020. The largest number of cases were found in the United States which reached 1 million cases, Spain with 236 thousand cases, and Italy with 203 thousand cases (5). The speed of the disease spread and its pandemic patterns in a country can be done through testing. Without testing, there is no other way to understand this pandemic. Testing is one of the most important tools for determining the reduction in the spread and impact of the disease. With testing, it is possible to identify infected individuals, isolate those who are infected, contact tracing and quarantine, as well as administering infected care (6). It certainly can help allocate medical resources and staff more efficiently.

The country with the highest number of testing is the United States. As of April 28, 2020, it reported 5.7 million testing or an average of around 59 thousand per

day (7). European countries have also tested millions, such as Russia (3.1 million), Germany (2.0 million), Italy (1.7 million), and Spain (1.3 million). Meanwhile, countries in Asia are still under 1 million testing, except the UAE (1 million). Other countries with a high number of testing include India (716 thousand), South Korea (608 thousand), and Iran (442 thousand) (5).

There is no exact number to measure the effectiveness of how many tests must be done. However, we can learn from the experience of other countries regarding the number of testing that is considered successful because the number of active cases of Covid-19 has begun to decline, for example, South Korea. As of April 23, 2020, South Korea had 583,971 tests, with positive results of 10,702 or around 1.8%. It can be learned that countries need a high number of testing quickly, with the expected result of a small portion of a positive test (less than 2%). The number of this testing can be used as a reference, when possible, to get closer to zero, like in Vietnam. This indicates the risk of the population contracting Covid-19 infection has been low.

Table 1. Description of the number of testing, cases, testing per population in the ASEAN countries until April 23, 2020

	Testing	Cases (+)	% positive test	testing/1million population
Indonesia	55.732	7.775	14,0	204
Philippines	72.346	6.981	9,6	660
Malaysia	113.755	5.603	4,9	3.515
Singapore	94.796	11.178	11,8	16.203
Thailand	142.589	2.839	2,0	2.043
Vietnam	206.253	268	0,1	2.119
Brunei	12.149	138	1,1	27.770
South Korea	583.971	10.702	1,8	11.390

The table above shows the performance of Indonesian testing as measured with the ratio of the number of testing per 1 million population. Indonesia is the lowest compared to other ASEAN countries, compared to Vietnam and Thailand which has 3-4 times more than Indonesia. One thing that needs to pay attention is the proportion of the number of positive cases to the number of testing. The higher the proportion of positive test results, the riskier people are exposed to Covid-19 in the region. Among ASEAN countries, Indonesia (14%) and Singapore (12%) had the highest proportion. This may indicate the real number of actual cases is likely to be far greater than the reported ones. Compared with Vietnam, the proportion of positive cases is only 0.1% among those tested.

The question is, why does Indonesia face difficulties in accelerating as many as possible of Covid-19 tests? This study tries to answer this question. It aims at obtaining a description of daily test results, confirmed cases, and the challenges of implementation of the response to Covid-19 pandemic in relation with the government of Indonesia's regulations or interventions.

METHODS

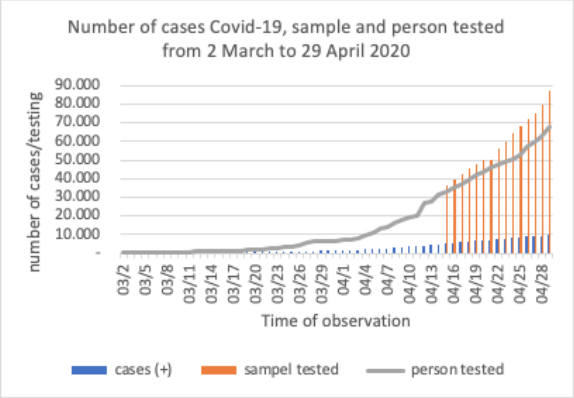
Study Design. This study is an observational study using secondary data from the published Covid-19 daily case report and the RT-PCR tests report. The data were then confirmed to relevant resource persons, and policies or program intervention options taken by the government of Indonesia in response to the Covid-19 pandemic. Secondary data sources were obtained from 4 main data sources, namely worldometers.info, Covid-19.go.id, infectionsemerging.kemkes.go.id, and kawalCovid-19.id. The data period was from the first detected case in Indonesia, which was March 2, to April 29, 2020. While other sources to enrich the study was from the government regulations, daily press conference, and webinar scholar discussions. The data analysis was carried out using statistical software and spreadsheet software, by looking at the magnitude and pattern of the data, then associated with the policy context or intervention choices made by the government.

Type of Covid-19 Tests. There are two types of tests for COVID-19, the first of which is testing for the presence of antibodies, which aim to determine whether a person has been infected at some point in the past. The most common way to enforce Covid-19 cases with the Real-Time Polymerase Chain Reaction (RT-PCR) test, according to WHO recommendations (8). Second, the serological test, generally still in the research & development stage, is known as a rapid test. The purpose of this test is to determine the extent to which coronavirus has spread to a wider population (9). This rapid test is also used in Indonesia which functions as screening, but confirmation of Covid-19 cases must use RT-PCR. In this study, the data refer to the results of RT-PCR testing that are announced daily by the government.

RESULTS AND DISSCUSION

Testing Condition in Indonesia

The first Covid-19 case in Indonesia was found in two women suspected of being infected by a Japanese citizen living in Malaysia. This case was revealed on March 2, 2020. This case is the mother and daughter (10). The case was revealed because of the initiative of a patient (daughter) who reported her condition after her colleague proved to be positive Covid-19 after returning to Malaysia. Before the case was revealed, the Ministry of Health had examined 64 specimens from 16 provinces, but the results were 62 negative and 2 were under examination (11). Meanwhile, several countries reported positive citizens Covid-19 after returning from Indonesia. Many countries doubt Indonesia's report that there are no cases. Indonesia has direct flights to various cities in China, including Wuhan (12).



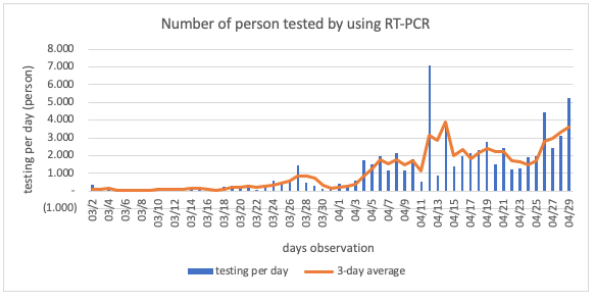
The graph shows the slow progress of the Covid-19 test in Indonesia, since the announcement of the first Covid-19 case, March 2, 2020. The government insists that PCR testing is only conducted at the Ministry of Health's Research and Development Agency. Over time and the increased number of cases, then on March 15, 2020, the government added 3 institutions designated as Covid-19 test referral lab (13). The results of the examination are then sent to MOH Litbangkes Lab, not directly to the hospital, which results in the hospital and the patient taking longer to receive the results. It implies longer patient's length of stay and delayed medical proper treatment for the patient (14). Other regions need to wait longer, until 8 days without the results. Another problem thst needs to resolve is the difference between the results between the local referral lab and MOH Lab (14). To speed up Covid-19 testing, the Ministry of SOEs has ordered 10 PCR tools from one European country (15).

The government of Indonesian finally established the Covid-19 pandemic as a National Disaster on March 14, 2020 (16). To respond to this, MOH added 11 labs that were allowed to do the testing as of March 17, 2020 (17). Two days later it was added to 35 labs (18). Eventually, the number of people tested rose sharply from 1898 tests (March 19) to 11,242 tests (April 5). Whereas previously in the same period time it could only reach 1898 cases. The government continues to increase the capacity of reference laboratories to 48 units as of April 4, 2020. With the addition of B2 level laboratory capacity, starting from day 35, the increase in test examinations from 10 thousand to 30 thousand only needs 8 days.

There are two indicators related to the test announced by GOI, initially, the number of new people tested. Furthermore, starting April 15, the number of tests that have been performed is also displayed, which includes tests for old cases or Covid-19 patients in care. If referring to the initial indicators, then as if the length of time to reach 30 thousand to 60 thousand people tested is 11 days. Even though the total number of tests carried out was 86,985 testing (19). When using the test number indicator, it only takes 5 days to reach 60 thousand testings. The Ministry of Health reports the number of samples tested because all patients in the hospital need to do PCR testing again to make sure it has healed when discharged. So one person can have more than one PCR testing. As of April 29, 2020, there have been about 19,000 additional tests conducted for people with Covid-19 patients or, on average, 1 patient received 2 more additional PCR tests.

Daily testing achievements

Daily observations showed fluctuations in the number of testing results, starting on the 23rd day, then reaching a peak on the 27th day and then dropping until the 32nd day. The following days, starting to reach checks above 1000 tests per day, but still fluctuate, which sometimes jumps and falls sharply. The addition of the number of reference laboratories has not helped the achievement of daily testing results to be more stable. With this pattern, it is difficult to measure true capacity. The average of the last 3 days shows the daily capacity tested in 3 days. If the number is stable, it should not be far between the test results and the average number.

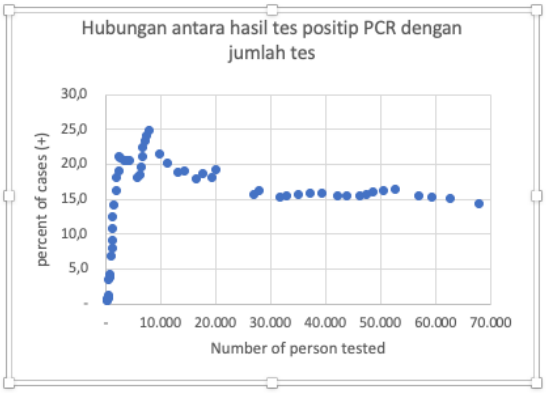


Currently, there is no clear information from the government regarding the number of the testing capacity of all reference laboratories in Indonesia. The information conveyed by each reference laboratory is different in the amount of capacity. On April 29, 2020, the number of appointed reference laboratories was added to 41, bringing the total to 89 (20). It consists of 48 laboratories in hospitals, 15 laboratories in universities, and 18 laboratories in the Ministry of Health laboratory network. Besides, there are five laboratories in the regional health laboratory network and there are three laboratories in the Directorate of Veterinary Laboratories. To illustrate the capacity, one of the designated laboratories is Eikjman, Jakarta. The lab has a PCR test capacity of around 180 tests per day and is expected to be able to conduct 1000 tests per day (21).

As of March 19, 2020, there were 35 referral laboratories, assuming 100 tests per day were used, with a capacity of around 3,500 tests per day. However, until April 25, 2020, it was still far below the capacity of testing per day, except on April 7, 2020, reaching 7,111 tests. This shows that there is still a lot of unused

laboratory capacity than it should (idle). Although the government continues to increase the number of laboratory capacities, the latest regulations reach 89 reference laboratories. Various problems can be raised by this fact. First, no shipment of specimens must be examined by a laboratory, because they have not been sent from the health facility below. The addition of the number of referral laboratories has not been matched by the addition of officers in the field. Swab takers must be specially trained, which is not easy to do. For those who are not trained and not prepared properly, the number of samples examined by laboratory staff cannot increase linearly. Besides, sample delivery equipment must also be available. If there is a shortage, it will cause many laboratories to not be able to work by their capacity. These problems are indicated by fluctuations in the number of samples sent daily to the referral laboratory.

Second, lack of reagent material in the reference laboratory to conduct PCR because it has not been sent from the center, or due to different brand between PCR and the reagent provided by the government (14). This resulted in laboratory personnel unable to work. This was acknowledged by a spokesman for the Covid-19 task force, several laboratories are stopping examining Covid-19 patients to undergo PCR tests due to running out of kit or reagent devices (22). Third, not all laboratories appointed by the referral government were ready to operate. Information obtained from one of the informants, there were still reference laboratories that had not been able to do PCR testing because they had not been trained (23). As a result, the workload between reference labs varied. Fourth, governance or work methods that have not been standardized between referral laboratories and/or between teams of staff at the lower level. The existence of a sharp increase or decrease indicates a buildup of work to be done, it can happen in a laboratory or a health facility. If observed, this happens on holidays. Fifth, Indonesia's vast geographical location and islands. The most difficult challenges are related to distance, delivery time, availability of specimen delivery equipment, and specimen delivery procedures, especially for areas far from the reference laboratory. Transportation problem for transporting specimens from local health facility to reference/central lab, causing negative results (14).



The lower the percentage of positive cases the better, because more and more positive cases were not found from the results of testing. The graph shows a sharp increase in the proportion of cases at the beginning of testing, to a peak of around 25% of the results of positive Covid-19 testing. This is understandable because cases are still small, so contact tracing from positive patients is still easy to do and look for. However, as time goes by and cases increase and spread, the capacity and speed of tracing cases become increasingly difficult. On the other hand, there is limited capacity of the laboratory, field staff, and the availability of reagents for PCR. Although the trend has begun to decline, a positive proportion has begun to stabilize at around 15%. But the real number of cases is certainly far greater than officially reported by the government. The target to be achieved is around 2% as happened in South Korea, or Vietnam under 1%. At present, for the calculation of the magnitude of Covid-19 cases, the suspects number can be used as a proxy for the magnitude of Covid-19 cases in Indonesia, which reaches 21,827 cases. Unfortunately, those with PDP status cannot all be done by PCR because of the limitations of testing.

Reagents are the main component for conducting RT-PCR and are a struggle throughout the world because all countries want to do testing as quickly and as much as possible. However, the government has promised to bring reagents from other countries and is expected to arrive in waves from South Korea and China. According to a spokesman for the Covid-19 task force, "Indonesia has brought at least several reagents from abroad. For example, on April 16 there were 10 thousand reagents, 19 April as many as 50 thousand reagents, 21 April 12,300 reagents, 23 April 15 thousand reagents, and 24 April we hoping that we can receive 400 thousand (reagents) of tests" (24). If that promise can be fulfilled, then in the next few days there will be an increase in the number of tests and positive cases detected. Adequate treatment and logistical space must be prepared for treatment, especially ventilators.

Efforts to Produce Own RT-PCR Test Kits

Indonesia is highly dependent on other countries to be able to do RT-PCR testing. This is because PCR-based specimens for throat swabs are imported from other countries, while PCR test kits are limited in number, and are sought by all countries in the world. So, Indonesia is difficult to get the desired amount. As a result, the capacity of the number of tests that can be carried out by the government every day is low compared to other countries in Southeast Asia. To overcome this problem, researchers have developed a project called the Indonesian Task Force for Research and Technological Innovation for Handling COVID-19 (TFRIC19). The team is coordinated by the Technology Assessment & Application Agency

(BPPT), which involves various parties including government elements (National Research and Development Agency and Eijkman Molecular Biological Institute), private elements (Nusantics & East Venture), and BUMN (Bio Farma). One of the outputs from the team's work was to independently produce Real-Time Polymerase Chain Reaction (RT-PCR) test kits (25).

The development of RT-PCR test kits is now entering the preparation stage for mass production, executed by a pharmaceutical SOE, Biofarma. This PCR test kit will be named Indonesia TFRIC19, previously named Nusantara TRFIC19. This test kit is expected to be able to be produced by Biofarma in the 3rd week of May 2020. At present, the installed capacity at the Biofarma factory in Bandung is 15,000 test kits which are packed in 600 boxes per day (26). The plan will be produced as many as 100,000 units. Meanwhile, Biofarma will also bear the costs of the production process, while a distribution from the factory to the user will be assisted by the Indonesian movement PASTI BISA. If this can be realized immediately, then the limitations of the test-kit limitations can be overcome immediately.

DISCUSSION

The Indonesian government is facing a hard time accelerating PCR testing, at first, it wanted to be careful in testing standards so that it only appointed one lab. Over time and as cases increased, the number of Covid-19 reference labs was increased to 46 referral labs until 28 April 2020. Daily testing indicated a fluctuation of achievements per day. This may reflect implementation challenges from some factors: 1) readiness and capacity between labs; 2) availability of swab collection officers; 3) availability of reagents in the lab; 4) rules for lab officers and swab collection officers; 5) transportation for a specimen from health facility to the referral lab. In overcoming the scarcity of reagents, the government in collaboration with various parties in the country has made its PCR test kits. The PCR test kit is expected to have been produced by mid-May 2020. If that can be realized, then the acceleration of testing can be carried out immediately.

RECOMMENDATIONS

There are several suggestions based on this study, namely: First, ensuring that the reference labs designated are under standards both in terms of human resources, availability of tools, and reagents so that when appointed by the government they can immediately operate. Second, ensuring the additional adequacy of swab-taking field officers as the number of designated reference labs increases, especially in the red zone or areas that are confirmed positive for Covid-19. If this is not met, then the lab capacity will be idle. To that end, recruit officers for swab collection and provide adequate training. Third, the shift rules for the lab team in the lab and swab collectors need to be improved, especially working hours on holidays. The goal is to avoid fluctuations in daily test results so that actual lab capacity can be measured. Fourth, ensure adequate logistical PCR reagents for all referral labs. For this reason, a monitoring system for qualified logistical requests and deliveries must be made by using an information technology system. Also, pay attention to the time lag of purchasing reagents from the supplier so that there is no delay. Fifth, Indonesia's geographical location is very broad and the position of the reference lab may not be all easily accessible to certain regions. For this reason, a specimen's delivery and packaging procedures need to be considered. Sixth, encourage and strengthen the ability of existing resources in the country to be able to produce logistics needs and the needs of medical devices independently.

REFERENCES

1. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. N Engl J Med. 2020;382(13):1199–207.
2. PHEOC K. Covid19: Update [Internet]. Jakarta; 2020. p. 1. Available from: https://infeksiemerging.kemkes.go.id/
3. Rothan HA, Byrareddy SN. The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. J Autoimmun [Internet]. 2020;109(February):102433. Available from: https://doi.org/10.1016/j.jaut.2020.102433
4. Wang W, Tang J, Wei F. Updated understanding of the outbreak of 2019 novel coronavirus (2019-nCoV) in Wuhan, China. J Med Virol. 2020;92(4):441–7.
5. Worldometers. Covid-19 Coronavirus Pandemic [Internet]. 2020. Available from: https://www.worldometers.info/coronavirus/
6. Wu D, Wu T, Liu Q, Yang Z. The SARS-CoV-2 outbreak: What we know. Int J Infect Dis. 2020;94:44–8.
7. The Atlantic. US Historical Data [Internet]. 2020. Available from:

https://covidtracking.com/data/us-daily
8. Corman V, Bleicker T, Brunink S, Drosten C. Diagnostic detection of Wuhan coronavirus 2019 by real-time RT-PCR. Public Heal Engl. 2020;1–12.
9. Winter AK, Hegde ST. The important role of serology for COVID-19 control. Lancet Infect Dis [Internet]. 2020;2019(20):2019–20. Available from: http://dx.doi.org/10.1016/S1473-3099(20)30322-4%0Ahttps://linkinghub.elsevier.com/retrieve/pii/S1473309920303224
10. Ratna N. Kasus Covid-19 Pertama, Masyarakat Jangan Panik [Internet]. Jakarta: Indonesia.go.id; 2020. Available from: https://indonesia.go.id/narasi/indonesia-dalam-angka/ekonomi/kasus-covid-19-pertama-masyarakat-jangan-panik
11. Vania R. Litbangkes Akhirnya Publikasikan Proses Pemeriksaan Virus Corona Covid-19 [Internet]. Jakarta: Suara.com; 2020. Available from: https://www.suara.com/health/2020/02/12/115426/litbangkes-akhirnya-publikasikan-proses-pemeriksaan-virus-corona-covid-19
12. Dea. Beda Cara RI dan Negara Lain Tangani Virus Corona [Internet]. Jakarta: CNN Indonesia; 2020. Available from: https://www.cnnindonesia.com/internasional/20200303155023-106-480140/beda-cara-ri-dan-negara-lain-tangani-virus-corona
13. Restu P. Coronavirus di Indonesia: 3 Lembaga Jadi Lab Pemeriksaan COVID-19. Jakarta: Tirto.id; 2020.
14. Dina M. Banyak Hasil Tes yang Tidak Akurat, Begini Kompleksnya Pemeriksaan Sampel Pasien Covid-19 [Internet]. Jakarta: Beritasatu.com; 2020. Available from: https://www.beritasatu.com/kesehatan/619851-banyak-hasil-tes-yang-tidak-akurat-begini-kompleksnya-pemeriksaan-sampel-pasien-covid19
15. Kontan. BUMN Datangkan Alat Tes Covid-19 PCR Produksi Roche Swiss [Internet]. Jakarta: Kontan.co.id; 2020. Available from: https://insight.kontan.co.id/news/bumn-datangkan-alat-tes-covid-19-pcr-produksi-roche-swiss?page=all
16. Dipna P. Update Corona Indonesia: COVID-19 Bencana Nasional, Kasus Capai 117 [Internet]. Jakarta: Tirto.id; 2020. Available from: https://tirto.id/update-corona-indonesia-covid-19-bencana-nasional-kasus-capai-117-eFq1
17. Andrian T. Kementerian Kesehatan menyatakan ada 11 lembaga yang bisa melakukan pemeriksaan COVID-19 [Internet]. Jakarta: Tirto.id; 2020. Available from: https://tirto.id/kemenkes-sebut-11-lembaga-yang-bisa-lakukan-pemeriksaan-covid-19-eFKn
18. Fitri H. Hari Ini, 35 Laboratorium di Indonesia Periksa Spesimen Corona COVID-19 [Internet]. Jakarta: Liputan6.com; 2020. Available from: https://www.liputan6.com/health/read/4231757/hari-ini-35-laboratorium-di-indonesia-periksa-spesimen-corona-covid-19
19. Covid19 K. Kasus COVID-19 di Indonesia [Internet]. Jakarta: Kawalcovid19.id; 2020. Available from: https://experience.arcgis.com/experience/bf4eb5d76e98423c865678e32c8937d4
20. Sania M. Pemerintah Tambah 41 Laboratorium untuk Covid-19 [Internet]. Jakarta: Kompas.com; 2020. Available from: https://nasional.kompas.com/read/2020/04/29/17120861/pemerintah-tambah-41-laboratorium-untuk-covid-19-kini-jadi-89
21. Ameidyo Daud. Akan Tambah Alat, LBM Eijkman Targetkan 1.000 Tes Covid-19 per Hari [Internet]. Jakarta: katadata.co.id; 2020. Available from: https://katadata.co.id/berita/2020/04/09/akan-tambah-alat-lbm-eijkman-targetkan-1000-tes-covid-19-per-hari
22. Ronald. Kehabisan Reagen, Beberapa Laboratorium untuk Tes Corona Covid-19 Tutup [Internet]. Jakarta: Liputan6.com; 2020. Available from: https://www.liputan6.com/news/read/4233883/kehabisan-reagen-beberapa-laboratorium-untuk-tes-corona-covid-19-tutup
23. Tom A, Kate L. Exclusive: More than 2,200 Indonesians have died with coronavirus symptoms, data shows [Internet]. New York: Reuters.com; 2020. Available from: https://www.reuters.com/article/us-health-coronavirus-indonesia-casualti-idUSKCN22A04N
24. Kumparan. 15 Ribu Reagen PCR Corona dari Korsel Akan Tiba di Jakarta Malam Ini

[Internet]. Jakarta: Kumparan.com; 2020. Available from: https://kumparan.com/kumparannews/15-ribu-reagen-pcr-corona-dari-korsel-akan-tiba-di-jakarta-malam-ini-1tHNDByF5cN/full

25. Kumparan. Alat Tes PCR Virus Corona Buatan Indonesia Siap Diproduksi Massal [Internet]. Jakarta: Kumparan.com; 2020. Available from: https://kumparan.com/kumparansains/alat-tes-pcr-virus-corona-buatan-indonesia-siap-diproduksi-massal-1tGkHe2CkzM/full
26. Zhafira C. Alat tes corona BPPT mulai diproduksi massal [Internet]. Jakarta: Tek.id; 2020. Available from: https://www.tek.id/future/alat-tes-corona-bppt-mulai-diproduksi-massal-b1ZL09hCp