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COVID-19 surveillance in educational institution as an early detection in subpopulation

Arief Hargono[1,2], Santi Martini[1,2], Atik Choirul Hidajah[1,2], Erni Astutik[1,2]
[1]Department of Epidemiology, Biostatistics, Population Studies, and Health Promotion, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia
[2]Health Information System Research Group, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia

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ABSTRACT

Since the first time it was discovered in 2019, COVID-19 has been the major threat to public health. Surveillance is considered to be one of the main pillars in dealing with the pandemic as it enhances the efforts of prevention and control of COVID-19. This study aimed to develop COVID-19 surveillance system at Universitas Airlangga that play a great importance in detecting and monitoring of COVID-19 status among its academias. This study refers to system approach which include system analysis and system design. System analysis was conducted by describing it into its components, namely input, process, and output. The results from system analysis are then utilized to the system design. The surveillance system collects and analyzes data which resulted to epidemiological information and recommendation. The result from the monitoring then utilized as an effort to enhance the coordination for epidemic preparedness in the institution. This study concludes that the COVID-19 surveillance system model in this institution monitors the COVID-19 status and associated risk factors of the sub-population within the institution. The information generated is used by decision-makers for early detection and monitoring of COVID-19 status.

Corresponding Author:

Arief Hargono
Department of Epidemiology, Biostatistics, Population Studies, and Health Promotion,
Faculty of Public Health, Universitas Airlangga
Surabaya, Indonesia
E-mail: arief.hargono@fkm.unair.ac.id

1. INTRODUCTION

The first reported case of Coronavirus disease 2019 (COVID-19) in Wuhan, China on December 31, 2019 has spread to various countries. Up to April 27, 2020, the global confirmed cases of COVID-19 have reached to 2,810,325 cases. There were 193,825 deaths due to COVID-19 with a mortality rate of 3.34%. This disease has spread to 213 countries and World Health Organization (WHO) has declared it a public health emergency of international concern [1].

The first case of COVID-19 in Indonesia was officially reported on March 2, 2020. Data on the official website of the Ministry of Health of the Republic of Indonesia shows that the confirmed cases of COVID-19 in Indonesia as of April 27, 2020 have reached 8,882 cases, with a death toll of as much as 743 people and 1,107 people recovered [2]. The death rate for COVID-19 cases in Indonesia is 8.7% of cases and this death rate is higher than the global COVID-19 death rate. COVID-19 cases have been reported by the Provinces in Indonesia (34 Provinces) and the President of the Republic of Indonesia has declared the status of the COVID-19 disease to be an emergency response stage since March 17, 2020 [2].

The number of COVID-19 cases in Indonesia may still increase. On the other hand, COVID-19 tests only reached 703 per 1,000,000 population. This figure is low compared to other countries and is still below the standards set by WHO [3]. In addition, the COVID-19 disease has caused fear and anxiety in the community, which can lead to mental health problems [4], [5]. Increased recognition of the threat to public health posed by the COVID-19 pandemic has prompted the development of strategies for preventing and controlling the disease. The support and participation of community components is expected to play a role in efforts to find and monitor COVID-19 in the community. This collaboration can include the community, government and academia.

Surveillance is one of the main pillars in dealing with the pandemic [6], [7]. Surveillance is a systematic process starting from the collection, processing, analysis, and interpretation of data which plays an important role in decision making. During the pandemic, COVID-19 surveillance is intended as a basic goal in determining public policies which are finally decided to decide on transmission and control and death due to COVID-19.

The surveillance of COVID-19 requires a good quality attribute system, including representativeness [8]. Surveillance with high representativeness indicates that the surveillance data can represent the population being monitored by the surveillance. Representativeness can be achieved through the number of surveillance data sources and multi-sector collaboration, such as government, private sector, academia, media, and society [9]. The development of surveillance systems in these components plays a role as a sub-system of the surveillance program, which is expected to complement surveillance data by monitoring specific sub-populations. Monitoring these sub-populations is expected to complement surveillance program data and improve the representativeness of the system, making COVID-19 prevention and control efforts more effective and efficient [10].

Universitas Airlangga, Indonesia as an educational institution has developed COVID-19 surveillance to unify the health status of its civitas. Established in 1954, Universitas Airlangga in 2020 is ranked #651-700 the best universities in the world and is among the five best universities in Indonesia according to the QS world university ranking. The data profile shows that Universitas Airlangga has 39,414 students, 1,522 lecturers, and 2,002 administrative staff [11]. The mobilization and activities of lecturers and students have a risk of contracting and transmitting COVID-19.

This research aims to develop a COVID-19 surveillance model in institutions for early detection and monitoring of COVID-19 status and its risk factors. The development of COVID-19 surveillance at Universitas Airlangga, aims to detect the status and monitoring of COVID-19 in Universitas Airlangga academias which includes students, lecturers and administrative staff. The developed surveillance model monitors COVID-19 cases and their associated risk factors, so that the information generated can be reported to the supra system for prevention and control efforts. The resulting model has the potential to be replicated and applied in other institutions.

2. RESEARCH METHOD

This study refers to system approach which include system analysis and system design. System analysis was conducted by describing into its components, namely input, process, and output. Input analysis was done through the identification of resources needed in order to conduct surveillance activities in the institution. Furthermore, process analysis was done through the identification of stages and activities to obtain information about COVID-19. Output analysis was done through the identification of obtained information about COVID-19 status and recommendation.

This research developed a surveillance system for Universitas Airlangga, Indonesia academia. The development of this system uses qualitative data obtained from the results of online discussions attended by academics from the Department of Epidemiology and the Department of Biostatistics and Population Studies, Faculty of Public Health, Universitas Airlangga, Indonesia.

System design is defined as the design of the system elements which obtained from system analysis to the system flow through context diagram and data flow diagram. Context diagram and data flow diagram are utilized as methods to describe system to the graph that figure the functional relationship and procedural components which include in the system. Data flow diagram provides a clear picture and a comprehensive design regarding the data flow within the software which needed to develop a software. The development of COVID-19 surveillance software was carried out by the Directorate of Information Systems, Universitas Airlangga, Indonesia. The operational definition of COVID-19 status refers to the Guidelines for Prevention and Control of COVID-19 issued by the Ministry of Health of the Republic of Indonesia.

The surveillance system development was a mandatory activity from the rector of the university based on Rector's Decree Number 09/UN3/2021 considering the inauguration of COVID-19 task force in Universitas Airlangga. The subject of this study is surveillance system and not human, thus the ethical review was not required.

3. RESULTS AND DISCUSSION

3.1. Results

The surveillance system development refers to the components which include data collection and data analysis which resulted to epidemiological information and recommendation. This system monitors the COVID-19 status of the academia in Universitas Airlangga, Indonesia. The result from the monitoring then is utilized as an effort to enhance the coordination for epidemic preparedness in the institution. The model of the surveillance system in the institution can be seen in Figure 1.

Data collection was carried out by the civitas based on the recommendation of the university leaders. This civitas data has been recorded in the CyberCampus database which contains a unique identity number and data on the characteristics of Universitas Airlangga, Indonesia academia. They enter a unique identity number based on their status, namely student identification numbers or employee identification numbers for lecturers and staff. After entering the unique identity number, the civitas are obliged to input the data on risk factor of COVID-19 infection which include history on travelling and close contact with infected person. This surveillance system also collects the data on symptoms and comorbidities of the civitas.

The data that have been collected then are analyzed to obtain the information on COVID-19 status. The result is referred to the guidelines for prevention and control of COVID-19 issued by the Ministry of Health of the Republic of Indonesia that classifies the status to five categories: i) healthy, ii) non COVID-19 infection, iii) people without symptoms, iv) people under monitoring, and v) patient under surveillance. This system also describes epidemiological information which include person, place, and time. The information is further categorized based on faculty, comorbidities, and symptoms.

The epidemiological information that has been obtained would be coincided with the recommendations. The recommendations were made specific for every status of COVID-19. The recommendations can be seen in Table 1. The data entry in this surveillance are conducted on a frequent basis. The data entry is also carried out whenever there is any change in the occurrence of risk factor of COVID-19 infection among the civitas, for instance, if the civitas are required to travel to another city or country, or when the civitas are reported to have close contact with infected person.

The epidemiological information that has been obtained then be shown in the dashboard that are accessible to COVID-19 task force and leaders in the university. The information includes the number of civitas that are healthy, non-COVID-19, infected but without symptoms, under monitoring, and under surveillance. This information is then utilized to develop an evidence-based policy in the university, for instance the work from home policy, as a strategy to prevent and control COVID-19 infection in the university.

This surveillance system also serves the monitoring of health of the academia. Surveillance officers in each faculty will contact academia that are stated as people without symptoms, people under monitoring, patience under supervision. People that are considered as people without symptoms, people under monitoring, patient under supervision are asked to fill out a follow-up form. The form contains suggestions for self-isolation for 14 days, checking with a doctor/health center/hospital, reporting health conditions to the district health office, conveying information about health conditions to close contacts for the previous 14 days, and submitting polymerase chain reaction test results. Surveillance officers at the university level will periodically report the results of the surveillance to the District Health Office and provide feedback to each faculty for follow-up.

In implementing this surveillance system, a coordination was carried out with surveillance officers at the university level, faculties, volunteers, and the relevant city and provincial health offices. In each faculty, there are surveillance officers who are assisted by volunteers to implement the surveillance system. Surveillance officers and volunteers will coordinate with surveillance officers at the university level. In addition, they are tasked with monitoring and contacting academics who have people without symptoms, people under monitoring, patience under supervision status. Surveillance officers at the university level will coordinate with the relevant health offices.

3.2. Discussion

3.2.1. Data collection

The surveillance system was developed by using a unique code in accordance with the guidelines developed by WHO [12]. This was also implemented in China to overcome the spread of COVID-19 there [13]. The use of unique codes in surveillance and information systems will provide accurate, timely, and valid data. The existence of a unique code can be used easily to connect to the database [14].

The population monitored in this study was the entire academia, namely students, lecturers, and staffs. Having a clear target population can make it easier to monitor the condition of each individual in the population. The clarity of the population being monitored makes indicators of the impact of the surveillance system easier to achieve [15], [16]. The surveillance developed can be used to monitor the health condition of the academic community at any time.

The data collected by the researcher in the form of individual characteristics, travel history, contact history, health conditions, and comorbid conditions. Consistent recording of epidemiological information is

important for understanding transmission, risks of geographic spread, routes of transmission, and risk factors for infection. In addition, the data collected in such surveillance can provide a basis for epidemiological modeling that can inform the planning of response and containment efforts to reduce the disease burden. In addition, detailed information provided in real time is essential for deciding where to prioritize surveillance [17]. Accurate and evolving collection of surveillance data can be used to build planning, modeling, and epidemiological studies to better inform policy makers. The epidemic is growing rapidly, so it is necessary to build a computing infrastructure that can handle the increase in cases. Sharing accurate and evolving data is essential to evaluate and maintain accurate case reporting during this COVID-19 outbreak [17], [18].

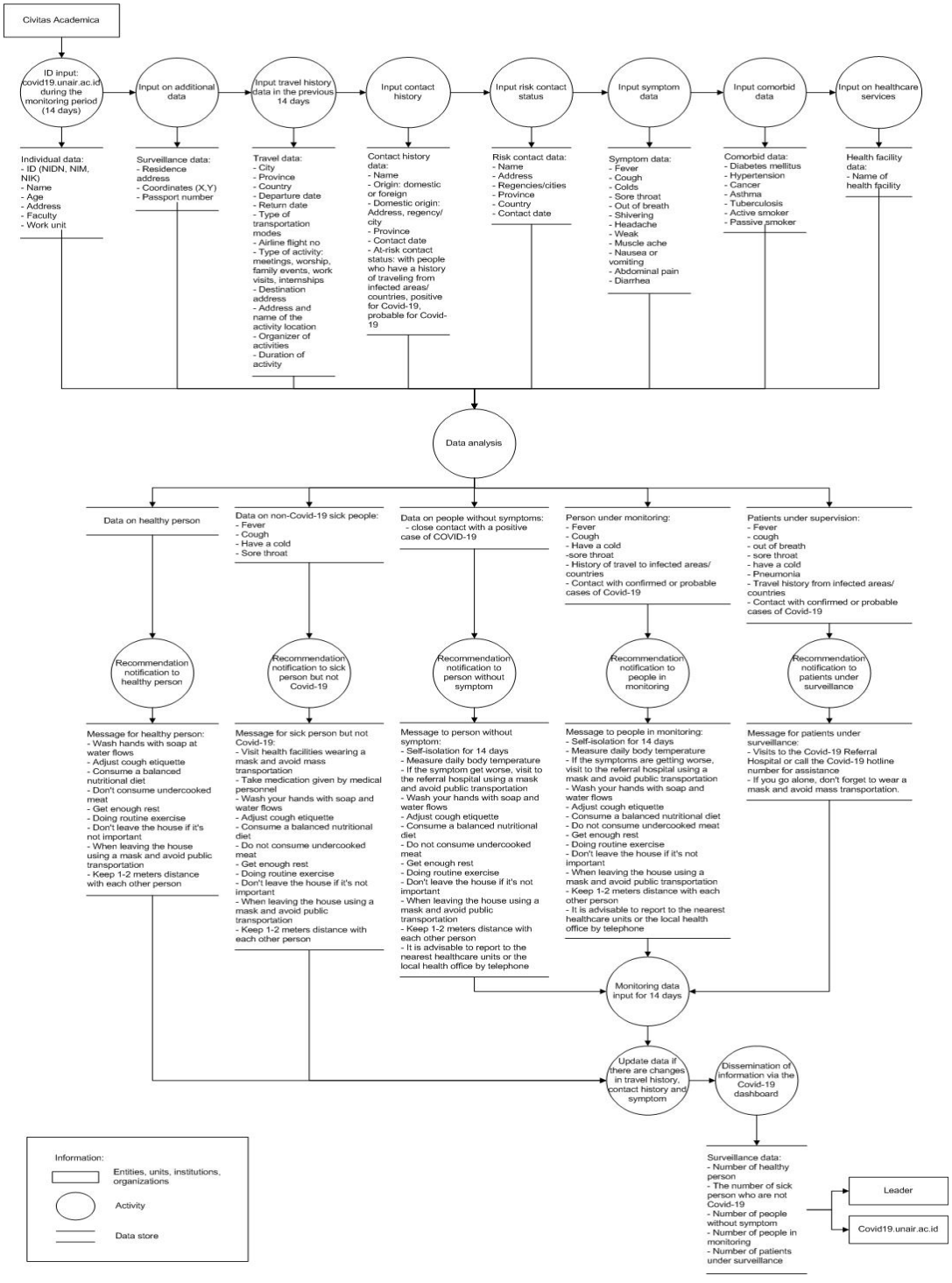

Figure 1. Data flow diagram of COVID-19 surveillance in educational institution

Table 1. Recommendation according to guidelines for prevention and control of COVID-19

Status	Recommendation
Health	1.Wash your hands with soap and running water often 2.Implement cough etiquette 3.Consume foods with balanced nutrition 4.Do not consume undercooked meat 5.Do not smoke 6.Enough rest 7.Get regular exercise 8.If you do not need to, do not leave the house 9.If you leave the house, wear a mask and do not use mass transportation 10.Keep 1-2 meters distance from other people
Pain may not be COVID-19	1.Go to a health care facility wearing a mask and not using mass transportation 2.Take medication given by health workers 3.Wash your hands with soap and running water often 4.Applying cough etiquette 5.Eat a balanced nutritional diet 6.Do not eat undercooked meat 7.Do not smoke 8.Get enough rest 9.Regular exercise 10.If you do not need to, do not leave the house 11.When leaving the house using a mask and not using mass transportation 12.Keep 1-2 meters distance from other people
People without symptoms:	1.Self-quarantine for 14 days. Separate room with sufficient lighting. Separating cutlery, bathing, and worship. Use a mask when leaving the room. 2. If during the quarantine period there are symptoms but are not congested, come to the nearest health service facility wearing a mask and do not take mass public transportation. If there are symptoms of shortness of breath, come to the COVID-19 Referral Hospital or call the COVID-19 hotline for assistance (telemedicine) 3.Wash your hands with soap and running water often 4.Implement cough etiquette 5.Consume foods with balanced nutrition 6.Do not consume undercooked meat 7.Do not smoke 8.Enough rest 1.Get regular exercise 2.Keep 1-2 meters distance from other people
People in monitoring	1. Self-quarantine for 14 days. Separate room with sufficient lighting. Separating cutlery, bathing, and worship. Use a mask when leaving the room 2.Measure daily body temperature 3.If during isolation the symptoms become more severe and short, come to the COVID-19 Referral Hospital or call the COVID-19 hotline for assistance. If you go alone, don't forget to wear a mask and don't take mass public transportation 4.Wash your hands with soap and running water often 5.Implement cough etiquette 6.Consume foods with balanced nutrition 7.Do not consume undercooked meat 8.Do not smoke 9.Enough rest 10.Get regular exercise 11.Keep 1-2 meters distance from other people 12.It is advisable to report to the local Health Office on the hotline number provided for reporting
Patient under surveillance	Come to the COVID-19 Referral Hospital or call the COVID-19 hotline for assistance. If you go alone, don't forget to wear a mask and don't take mass public transportation.

3.2.2. Data analysis

Most countries need to significantly strengthen surveillance capacity to rapidly identify COVID-19 cases, follow up on their contacts, and to monitor disease trends over time. Comprehensive national surveillance for COVID-19 will require adaptation and strengthening of existing national systems where necessary and additional surveillance capacity building are needed [16]. This is one of the foundations for developing an institutional-based surveillance system so that it can be synergized with government programs in suppressing the spread of COVID-19 in Indonesia.

The surveillance systems that are developed using digital technology allows us to make quick reports at any time. The use of information technology allows surveillance to provide easy feedback to each faculty for follow-up. The surveillance system produces outputs in the form of the number of academicians who have not filled out surveillance, how many healthy academicians, people without symptoms, people under monitoring, patience under supervision. The use of information technology for rapid reporting, data management, and analysis will greatly assist in strengthening ongoing surveillance systems [16]. Considering the potential for the rapid exponential growth of COVID-19 cases in the population, new cases should be identified, reported, and data

included in the epidemiological analysis within 24 hours. National authorities should consider including COVID-19 as a mandatory notified disease with requirements for prompt reporting [16].

The data flow system shows the existence of several datasets that are connected to form a database. Surveillance relies on accurate and up to date databases [19], [20]. The quality of the database reflects the quality of the surveillance system. In addition, databases collected in surveillance make it easier to identify identified individuals in the population [21]. Databases can be developed for decision making and can estimate the magnitude of the problem and prevention efforts [9].

3.2.3. Epidemiological information

It is important to collect comorbidities data because several studies have shown that individuals with hypertension, respiratory system disease, and cardiovascular disease are risk factors for experiencing severity when suffering from COVID-19 [22]. Knowledge of these risk factors can be a resource for clinicians in the initial medical management of patients according to COVID-19 [23]. Information about the individual's symptoms and history of close contact is also very crucial. COVID-19 presents with non-specific clinical manifestations, so the diagnosis depends on epidemiological factors and a history of close contact. Close contact history can be used to detect asymptomatic people [24]. In addition, the information we collect is travel history. Travel history is important to know because it can predict the spread of disease. Travel history includes whether the individual is from a high-risk area or traveling from an area affected by COVID 19 as we know that travel restrictions can hinder the spread of the COVID-19 disease [25].

COVID-19 surveillance and investigation activities are a series of activities that are aligned to help provide detailed insight into the epidemiological characteristics of COVID-19 [26]. Epidemiological information data can be used to help understand the spread, severity, spectrum of disease and impact on society [26], [27]. Epidemiological information can serve monitor trends and case detection from COVID-19 [28]. In addition, this epidemiological information can be used to conduct risk assessments and prepare for epidemic preparedness and response [16]. Information on trends in endemic diseases can also be used for disease control purposes, and to provide information that can be used to evaluate the impact of disease prevention and control programs [15]. This information can be used to monitor the impact of the COVID-19 pandemic on the national health care system such as the number of beds and the number of ventilators in hospitals [29]. This surveillance can also be used to determine the risk that a person (personal risk assessment) can be declared healthy or low risk so that they are allowed to work from the office or have a high risk so that the person is not highly recommended to work from the office.

3.2.4. Recommendations for each COVID-19 status

The recommendations given in the surveillance system were made specific for every status of COVID-19 based on guidelines from the Indonesian Ministry of Health and WHO [30]–[32]. Recommendations are given with the aim of providing information to the academic community what needs to be done. In addition, the purpose of this recommendation is to improve the surveillance and response system for COVID-19 disease based on priority areas and categories and to inhibit the spread of the COVID-19 pandemic and can be used as a personal risk assessment for screening working directly from campus. Recommendations are very important to improve disease surveillance and response systems [15], [33], [34].

3.2.5. Monitoring

The reporting and feedback system will facilitate and support the implementation of the surveillance system as well as to improve the quality of the surveillance system [15]. In addition to reporting and feedback, a monitoring system is also carried out. The surveillance strategy carried out by Universitas Airlangga, Indonesia can be used as a containment strategy that contributes to the increase in confirmed cases. Rapid identification and active monitoring of other contacts have been effective in suppressing outbreak expansion and have implications for other countries experiencing outbreaks [28], [35]. Strong comprehensive surveillance must be maintained so that new cases and clusters of COVID-19 are detected quickly and before the spread of the disease occurs. Surveillance systems should be geographically comprehensive and cover all people and communities at risk. Surveillance for vulnerable or high-risk populations should be increased [16]. A more in-depth analysis of age, sex, comorbidities and risk factors, symptomatology and severity should also be analyzed periodically. Routine analysis reports should also be reported to the government [36].

3.2.6. Coordination for epidemic preparedness

The Department of Health, as a public health authority for decision makers, will coordinate with the central government as a national coordination enabling all levels of the public health response (i.e. local, intermediate and national) to collect and share public health information to detect, monitor, control and prevent the occurrence and spread of public health events [37]. District/city surveillance officers and provincial

surveillance officers are expected to be able to communicate, coordinate and evaluate every day to see developments and make decisions in the field. Notifications to the health office are intended to coordinate close contact/people with symptoms and people under monitoring [30].

One of the challenges in implementing public health surveillance is coordination. The discordance of officers' capacities, duties and responsibilities will disrupt the coordination. Coordination is important to ensure effective coordination between implementers and stakeholders for the implementation of an effective and efficient monitoring and response system [15] through an integrated collaboration to enhance the effort of COVID-19 prevention and control that include government, private sector, academia, mass media, and community members.

4. CONCLUSION

During the pandemic, the development of surveillance system is crucial to ensure the evidence-based decisions and to enhance the coordination between stakeholders for the implementation of an effective and efficient monitoring and response system through an integrated collaboration. The COVID-19 surveillance system model in this institution monitors the COVID-19 status and associated risk factors of the sub-population within the institution. The information generated is used by decision-makers for early detection and monitoring of COVID-19 status. System development which consists of system analysis and design is important to be carried out consecutively in order to meet the need to collect, analyze, and interpret data regarding COVID-19 infection in subpopulation. This project can be applied anywhere to produce surveillance system in subpopulation.

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REFERENCES

[1] WHO, "Rolling updates on Coronavirus disease (COVID-19)," *World Health Organization*, 2020. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen (accessed Jan. 04, 2021).
[2] Ministry of Health of the Republic of Indonesia,"COVID 19," *Ministry of Health of the Republic of Indonesia*, 2020. https://infeksiemerging.kemkes.go.id/dashboard/covid-19 (accessed May 01, 2020).
[3] Our World in Data, "Total COVID-19 test per 1,000 people," *Our World in Data*, 2020. https://ourworldindata.org/grapher/full-list-cumulative-total-tests-per-thousand (accessed Apr. 27, 2020).
[4] I. F. Sholihah, I. Nurmala, M. Sulistyowati, and S. R. Devy, "The impact physical distancing during the COVID-19 pandemic on mental health among adolescents: a systematic literature," *International Journal of Public Health Science (IJPHS)*, vol. 11, no. 1, pp. 69–76, 2022,Mar.2022, doi: 10.11591/ijphs.v11i1.21123
[5] E. Umar, A. Darajat, I. Fiddyanti, and L. Amaliah, "Related factors to fear and stigma of COVID-19," *International Journal of Public Health Science (IJPHS)*, vol. 11, no. 3, pp. 1125–1132, Sep. 2022, doi: 10.11591/ijphs.v11i3.21377
[6] M. French and T. Monahan, "Dis-ease surveillance: How might surveillance studies address COVID-19?," *Surveillance & Society*, Mar. 2020.
[7] R. A. Calvo, S. Deterding, and R. M. Ryan, "Health surveillance during covid-19 pandemic," *BMJ*, Apr. 2020, doi: https://www.bmj.com/content/369/bmj.m1373
[8] H. Y. Amro, S. Najjar, and M. Moreb, "Electronic surveillance system for COVID-19 virus management in Palestine: An observational study," *International Journal of Technology Diffusion*, vol. 12, no. 4, pp. 21–31, Jan. 2021, doi: https://www.igi-global.com/article/electronic-surveillance-system-for-covid-19-virus-management-in-palestine/288525
[9] P. Nsubuga *et al.*, "Public health surveillance: a tool for targeting and monitoring interventions," *Disease Control Priorities in Developing Countries*, 2006, doi: https://www.ncbi.nlm.nih.gov/books/NBK11770/
[10] N. K. Ibrahim, "Epidemiologic surveillance for controlling Covid-19 pandemic: types, challenges and implications," *Journal Infect. Public Health*, vol. 13, no. 11, pp. 1630–1638, Nov. 2020, doi: 10.1016/j.jiph.2020.07.019.
[11] Universitas Airlangga, "One Airlangga University Data (in Indonesia: Satu Data Universits Airlangga)," *Universitas Airlangga*, 2021. https://unair.ac.id/ (accessed Sep. 21, 2021)
[12] WHO, "Revised case report form for Confirmed Novel Coronavirus COVID-19," WHO, 2020. https://www.who.int/publications-detail-redirect/WHO-2019-nCoV-SurveillanceCRF-2022.1 (accessed Nov. 23, 2022).
[13] D. Lu, "China uses mass surveillance tech to fight spread of Coronavirus," *New Scientist.*, vol. 245, no. 3270, p. 7, Feb. 2020, doi: 10.1016/s0262-4079(20)30378-x.
[14] L. Solomon, C. Flynn, L. Eldred, E. Caldeira, M. P. Wasserman, and G. Benjamin, "Evaluation of a statewide non-name-based HIV surveillance system," *JAIDS Journal of Acquired Immune Deficiency Syndromes*, vol. 22, no. 3, p. 272, Nov. 1999, doi: 10.1097/00126334-199911010-00009.
[15] WHO, "Communicable Disease Surveillance and Response Systems: Guide to monitoring and evaluating," *World Health Organization*, 2006. https://apps.who.int/iris/handle/10665/69331 (accessed Nov. 22, 2021).
[16] WHO, "Surveillance strategies for COVID-19 human infection," *WHO*, 2020. https://pesquisa.bvsalud.org/global-literature-on-novel-coronavirus-2019-ncov/resource/pt/grc-741121 (accessed Sep. 24, 2021).
[17] B. Xu *et al.*, "Open access epidemiological data from the COVID-19 outbreak," *The Lancet Infectious Disease.*, vol. 20, no. 5, p. 534, May. 2020, doi: 10.1016/s1473-3099(20)30119-5.
[18] D. L. Heymann, "Data sharing and outbreaks: best practice exemplified," *The Lancet*, vol. 395, no. 10223, pp. 469–470, Feb. 2020, doi: 10.1016/s0140-6736(20)30184-7.
[19] CDC, "Interactive Database System*," Center for Disease Control*, 2019. https://www.cdc.gov/surveillancepractice/data.html (accessed Mar. 01, 2021).
[20] E. Groot, "Database of Public Health Surveillance Systems," 2016. https://www.phpc-mspc.ca/resources/Documents/Resident

Section/Emily Groot - Public Health Surveillance Systems.pdf (accessed Mar. 01, 2021).
[21] A. X. Garg, M. Mamdani, D. N. Juurlink, and C. van Walraven, "Identifying individuals with a reduced GFR using ambulatory laboratory database surveillance," *Journal of the American Society of Nephrology*, vol. 16, no. 5, pp. 1433–1439, May 2005, doi: 10.1681/asn.2004080697.
[22] J. Yang *et al.*, "Prevalence of comorbidities and its effects in patients infected with SARS-CoV-2: a systematic review and meta-analysis," *International Journal of Infectious Diseases*, vol. 94, pp. 91–95, May 2020, doi: 10.1016/j.ijid.2020.03.017.
[23] B. Wang, R. Li, Z. Lu, and Y. Huang, "Does comorbidity increase the risk of patients with COVID-19: evidence from meta-analysis," *Aging*, vol. 12, no. 7, pp. 6049–6057, Apr. 2020, doi: 10.18632/aging.103000.
[24] Z. Y. Zu *et al.*, "Coronavirus disease 2019 (COVID-19): a perspective from China," *Radiology*, vol. 296, no. 2, pp. 15--25, Aug. 2020, doi: 10.1148/radiol.2020200490.
[25] M. U. G. Kraemer *et al.*, "The effect of human mobility and control measures on the COVID-19 epidemic in China," *Science*, vol. 368, no. 6490, pp. 493–497, May 2020, doi: 10.1126/science.abb4218.
[26] WHO, "Protocol for assessment of potential risk factors for coronavirus disease 2019 (COVID-19) among health workers in a health care setting, 23 March 2020," *World Health Organization*, 2020. https://www.who.int/publications/i/item/protocol-for-assessment-of-potential-risk-factors-for-2019-novel-coronavirus-(2019-ncov)-infection-among-health-care-workers-in-a-health-care-setting (accessed Mar. 01, 2021).
[27] R. Pung *et al.*, "Investigation of three clusters of COVID-19 in Singapore: implications for surveillance and response measures," *The Lancet*, vol. 395, no. 10229, pp. 1039-1046, 2020.
[28] V. J. Lee, C. J. Chiew, and W. X. Khong, "Interrupting transmission of COVID-19: lessons from containment efforts in Singapore," *Ournal of Travel Medicine*, vol. 27, no. 3, Mar. 2020, doi: 10.1093/jtm/taaa039.
[29] European Centre for Disease Prevention and Control "Strategies for the surveillance of COVID-19," *European Centre for Disease Prevention and Control*, 2020. https://www.ecdc.europa.eu/en/publications-data/strategies-surveillance-covid-19 (accessed Mar. 01, 2021).
[30] Ministry of Health of the Republic of Indonesia "Guidelines for prevention and control of coronavirus disease," *Ministry of Health of the Republic of Indonesia*, 2020.
[31] World Health Organization, "Coronavirus disease (COVID-19) advice for the public," 2020. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public (accessed Jul. 16, 2023).
[32] WHO, "Rational use of personal protective equipment for coronavirus disease (COVID-19) and considerations during severe shortages," *World Health Organization*, 2020. https://www.who.int/publications/i/item/rational-use-of-personal-protective-equipment-for-coronavirus-disease-(covid-19)-and-considerations-during-severe-shortages (accessed Mar. 01, 2021).
[33] G. P. Wormser, N. J. M. Dailey, and A. T. Fleischauer, "Sustaining global surveillance and response to emerging zoonotic diseases," *Sustaining Global Surveillance and Response to Emerging Zoonotic Diseases*, pp. 1–340, 2010, doi: 10.17226/12625.
[34] WHO, "Interim surveillance recommendations for human infection with Middle East respiratory syndrome coronavirus," *World Health Organization*, 2014. https://essentialhospitals.org/wp-content/uploads/2015/06/InterimRevisedSurveillanceRecommendations_nCoVinfection_27Jun13.pdf (accessed Mar. 01, 2021).
[35] Y. Ng *et al.*, "Evaluation of the effectiveness of surveillance and containment measures for the first 100 patients with COVID-19 in Singapore–January 2–February 29, 2020," *{MMWR} Morbidity and Mortality Weekly Report*, vol. 69, no. 11, pp. 307–311, Mar. 2020, doi: 10.15585/mmwr.mm6911e1.
[36] WHO, "Global surveillance for COVID-19 disease caused by human infection with the 2019 novel Coronavirus," *World Health Organization*, 2020. https://apps.who.int/iris/handle/10665/331506 (accessed Mar. 01, 2021).
[37] WHO, "Coordination of public health surveillance between points of entry and the national public health surveillance system: advising principles, 2nd ed.," *World Health Organization*, 2018. https://apps.who.int/iris/handle/10665/274366 (accessed Mar. 01, 2021).

BIOGRAPHIES OF AUTHORS

Arief Hargono is a lecturer and researcher in the Division of Epidemiology, Faculty of Public Health, Universitas Airlangga. He is an Epidemiologist and has experience in research on Epidemiology Surveillance and Health Information Systems. He has copyright on health applications such as Community-Based COVID-19 Surveillance, Epidemiology Surveillance in School-Age Children, and Integrated Community-Based Public Health Information Systems. He can be contacted at email: arief.hargono@fkm.unair.ac.id.

Santi Martini is a lecturer and researcher in the Division of Epidemiology, Faculty of Public Health, Universitas Airlangga. She has experience in collaborative research with universities and researchers from abroad related to COVID-19 and the Tobacco Control. Several studies on COVID-19 include analysis of COVID-19 policies and the epidemiology of COVID-19 based on data from health facilities. She can be contacted at email: santi-m@fkm.unair.ac.id.

Atik Choirul Hidajah is a lecturer and researcher in the Division of Epidemiology, Faculty of Public Health, Universitas Airlangga. She is an Epidemiologist and has experience in research on Epidemiology Surveillance. She is became a part of the researcher who conducted the national survey on COVID-19. She is also a member of the COVID-19 task force and has experience in assisting several cities in efforts to control COVID-19 in Indonesia. She can be contacted at email: atik-c-h@fkm.unair.ac.id.

Erni Astutik is a lecturer and researcher in the Division of Epidemiology of the Faculty of Public Health Universitas Airlangga. She is an Epidemiologist and has had field and analytical experience with health studies in Indonesia. She also has experience in conducting statistical data analysis using nationally representative data such as Demographic and Health Survey (DHS) and Indonesia Family Life Survey (IFLS). She has written book about COVID-19. She can be contacted at email: erniastutik@fkm.unair.ac.id.