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Development of a COVID-19 University-Based Clinic in Indonesia: A Pilot Project of The Gadjah Mada Electronic Nose Center

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Abstract

BACKGROUND: The clinic development of COVID-19 screening is essential during the pandemic.

AIM: This study aimed to explore and elaborate the development process of the Gadjah Mada Electronic Nose (GeNose) Center as a pilot project for a COVID-19 university-based clinic in Indonesia.

METHODS: A narrative and explorative study was conducted. Under the university platform, we initiated the GeNose center through training, simulation, and debriefing. Identification of team member recruitment, location, and apparatus development were described using the retrospective approach.

RESULTS: Fifty-one team members were recruited, including person in charge, verifiers, administrative staffs, hotline team, security staffs, and janitors. Standard operating procedures, service system, and safety measures were developed to maintain the quality. Services include the application of COVID-19 protocols, registration and confirmation, education for using the air bag, collecting the air sample, and analysis of samples using the GeNose machine.

CONCLUSION: The GeNose center, a model for screening test, provides services for the screening of COVID-19.

Introduction

The total number of COVID-19 cases in the world is currently still growing. As of July 15, 2021, the global case count reached 188 million with over 4 million deaths. The majority of cases are from the United States, Brazil and India. Indonesia is ranked twentieth with more than 2.6 million cases, with over 68,000 deaths and 2.14 fully recovered [1], [2]. In June 2020, the prevalence of COVID19 in Indonesia was 0.11%. The majority of COVID-19 cases occurred in the adult group, in which the age of 31–45 dominated (29.3%) the incidence. Following the highest numbers of prevalence, this age group also had the highest recover rate of about 32.21. Meanwhile, the highest mortality proportion was found among the elderly (43.8%). The mortality rate for the elderly reached the highest number (17.69%), compared to other age groups. Men have a slightly higher prevalence (54.6%) of being infected with the COVID-19 virus than women. Men have a cure rate of 31.62% and a mortality rate of 6.84%, which is relatively higher than women (5.01%) [3].

Early detection and appropriate treatment can prevent the spread of the COVID-19. Detection of the COVID-19 can be done by Real Time Polymerase Chain Reaction (RT-PCR) and rapid serological tests [4]. The rapid test is used to screen anybody who is suspected of COVID-19 infection, while the RT-PCR is used as a gold standard for the confirmed diagnosis of COVID-19 [5]. Both tests can detect the COVID-19 virus, but they have limitations in terms of being expensive, invasive, painful, and inconvenient during the procedures [4]. To respond to these limitations, some inventors in Indonesia developed a screening tool that is less painful and more convenient with an affordable price. Under the research direction of Universitas Gadjah Mada (UGM) and support from the Ministry of Research and Technology of Indonesia, a new screening tool for COVID-19 was developed, named the Gadjah Mada Electronic Nose (GeNose). It is applied to human breath as a sample for the screening to identify the volatile organic compound (VOC) as a specific marker to define any diseases using artificial intelligent [6], [7]. Previous research identified that the patients with COVID-19 have specific proteins, metabolic mechanism,

and chemical components [8]. Those biomarkers are potentially recognized using the VOC while they breathe (breath-borne VOC biomarkers) to get a specific breathing pattern. The development of GeNose has become attractive and promising as a screening tool in the community to reach fast, accurate results using a non-invasive screening tool with an affordable price [6], [7].

To date, the existence of GeNose is becoming more common and nation-wide in Indonesia. Several public facilities, such as train stations, airports, hospitals, boarding schools, and universities, have the GeNose to assist as a procedure for early detection of COVID-19 in their community [7]. Beside the machine, the inventors also provide training on how to operate the GeNose and the manual book as guidance [6]. However, several communities are lacking information on how to provide a GeNose service due to limited knowledge and the advanced technology of the machine. Therefore, the Faculty of Medicine, Public Health, and Nursing UGM have developed a university-based clinic and initiated the GeNose Center as a pilot project for GeNose services. This clinic development is expected to provide the necessary information and a model for clinic development for COVID-19 screening and early detection. This study aimed to explore and elaborate the development process of the GeNose Center as a pilot project for a COVID-19 university-based clinic in Indonesia.

Methods

Study design

This research was a narrative and explorative study conducted through investigating the success story of the university-based clinic development. The authors used the retrospective approach to gather the information and describe the development process of the COVID-19 university-based clinic in Indonesia.

GeNose center

Knowing the progress of GeNose research, the faculty leaders initiated a program to develop a GeNose team. The team was responsible to initiate the GeNose center and recruit the staff members as a pilot project. A formal meeting was conducted and continued by formation of team members. All communication and coordination were conducted through WhatsApp®. The team members led an initial launching of the university-based clinic and discussed the development process.

Development of GeNose center

The discussion through WhatsApp® was continued by the initiation phase in developing the GeNose center. The team members had identified the three steps for clinic development: training, simulation, and debriefing.

The training is aimed to equip all team members and ensure they know their duties during the services. This approach was designed in two cohorts: Training for trainers and training for the team members. The first training was conducted by inviting the inventors of GeNose and their team. This training was 1-day training and delivered for the person in charge (PIC) and verifiers. The topics included the GeNose introduction, operating the GeNose machine, GeNose standard operational procedure and specification, personal protective equipment (PPE), handling and decontamination, and troubleshooting [6]. All the materials were based on the manual book of the GeNose machine and delivered by the inventors' team. The training used lecture and case study approach with open discussion. The pre- and post-tests related to GeNose training were done in the beginning and end of the training. Only the passed participants received certification as a GeNose trainer. Next, the second training was planned for administrative staff, hotline team, security staffs, and janitors to support the clinic services. The GeNose trainers provided this second training in 1-day training with the similar approach. This second training covered the following topics: The GeNose introduction, the supporting staff for GeNose center, and roles of each team member. There was no specific test for this second training; however, the trainers ensured that all the participants understood their main roles by reflecting and inquiring about the scenario of the clinic.

Hands-on and simulation approach were conducted thereafter to complete the training. After the first training, PIC and verifiers practiced to operate the GeNose machine. In addition, they also became experienced in the screening process using their own breathing sample. Step by step instructions of the GeNose operation were delivered and finally one to two PIC/verifiers were assigned for rehearsal of the screening procedure. Following the second training, the team members also experienced the role-play simulation of the GeNose clinic. They were assigned to the position in which they would ultimately contribute. This practice let them gain more understanding of their involvement in the GeNose center.

After the two steps, all team members were invited to join the debriefing. This is the step designed to get them more personally involved and explore their expectation and barriers. All members could share their feelings and intention to participate in the GeNose center. Through this step, all team members have the experience to know each other and engage as teammates.

Building the team members

The team members identified for recruitment included: (a) PIC, (b) verifiers, (c) administrative staffs,

(d) hotline team, (e) security staffs, and (f) janitors, before the development process. The PIC has the responsibility of daily GeNose services and provides consultation during the clinic services. Verifiers take a role as operating persons for the GeNose machine, to make sure the outcome is precise, and educate the patients when the outcome is positive as the follow-up. The administrative staff members contribute in handling the documentation, registration, payment confirmation, and education on how to use and collect the air samples. Hotline team has a duty to screen patients' signs and symptoms and arrange the clinic appointments (including personal communication and information). Security staffs keep the safety of the clinic and arrange the clinic flow. Janitors are responsible to clean the GeNose center, providing clean fabricated gowns, and handling the medical or non-medical trash. All the team members then received the official agreement as GeNose team members.

Considering the main roles of each team members, the recruitment was done based on the specific criteria. The PIC, verifiers, and hotline team should hold a medical or health sciences' background, because they have to directly handle the GeNose machine, discern the COVID-19 signs, and are able to provide recommendations based on the clinical situation. The administrative staff was recruited from the administrative office in the college with criteria: no chronic illness, and there was no baby nor elderly living inside of their house. This approach was taken to minimize the spreading of COVID-19 and protect the family members and teammates. The security staff and janitors were from the staffs in the college with specific training in their field.

GeNose center location

The GeNose center should be located in the open space or public area. Optimum airflow and good ventilation are the main criteria for the GeNose machine to be operated. Thus, it is recommended to operate the GeNose clinic in the open space facility.

The clinic apparatus development

The clinic should have a quality control and guarantee the safety of team members and patients. We developed the standard operating procedures (SOPs), promoting media, and safety measures. The SOPs are required as a platform to work consistently in the clinic. The development process was based on the need of the clinic operation and manual procedures of GeNose machine. We conducted a group discussion to identify the SOPs and promoting media, and then shared them after the training. The results were then consulted to the infectious control experts to get their feedback. Safety measures were applied by providing PPE and maintaining the COVID-19 prevention protocols.

Results

Initiating the university-based clinic

The faculty leaders initiated to support the GeNose team members and coordinated the efforts through a WhatsApp® group. A voluntary recruitment was delivered to faculty members who were invited to join the GeNose training. The trainings were divided into two sections (Figure 1).

Figure 1: Training for GeNose team members. (a) Lecture and case study approach (b) Hand-on with the GeNose machine

a. Training for trainers. The training was for PIC and verifiers. The original inventors' team of GeNose coached the teams through a lecture, case-based study and hands-on training with the machine. It was conducted on February 6, 2021 for full day training. All PIC and verifiers had a background of medical or health sciences. All the invited trainees accomplished the training and received the GeNose certificate as a trainer.

b. Training for other team members. The second training was for administrative staff members, hotline team, security staff, and janitors as the supporting team in the clinic. The administrative staffs were selected by health cadres in the faculty with the criteria: (1) they were not living with children or elderly, (2) no history of comorbidity (i.e. hypertension, diabetes, etc.), and (3) no contact with confirmed COVID-19 patients. The hotline team was recruited from the alumnae with medical and/or health science background. The security staff and janitors were from the existing staffs in the faculty. The GeNose trainers delivered the training on February 11, 2021 as full day training. We used a lecture, discussion, and role-play during the second training.

On the day of training, all the team members got experience with the GeNose machine and clinic operation. The PIC and verifiers tried to operate the machine under supervision of the trainers. In addition, the other team members should conduct role-play with their roles in the clinic (administration, security, hotline and janitors). At the end of the training, all the team members were asked to discuss their involvement in the GeNose center.

The GeNose center was launched in the early weeks of February 2021 through social media (i.e.

Instagram®, Facebook®, and WhatsApp®). The center was officially in operation as the university-based clinic on February 15, 2021 and serves as a center for COVID-19 screening for the university members and laypersons. At the end of February, all the GeNose teams were invited to conduct debriefing as the evaluation and reflection. The debriefing was completed through blended approach, with online and offline meetings. All the members expressed their consent and provided their comments during the clinic operation. The teams decided to have fixed operational procedures, working loads, schedules, and leadership roles.

The GeNose team members and location

The recruitment process resulted in a total of 51 persons as GeNose team members (Table 1). The majorities of team members were verifiers and administrative staffs, males, middle-aged adults (26–45 years), married, and have a bachelor degree. The verifiers and administrative staff were the main components of the GeNose center. The PIC, verifiers, administrative staffs, security staffs, and janitors, work once a week for 5–6 h/day. The hotline teams were on duty in a shift system (7 am–5 pm and 5 pm–6 am), as they provide the requested information through the hotline numbers.

Table 1: Demographic characteristics of GeNose team members (n=51)

Characteristics	Frequency	
	n	%
Sex		
Male	27	52.9
Female	24	47.1
Age (years)		
17–25	5	9.8
26–45	31	60.8
46–65	15	29.4
Education level		
Doctoral degree	3	5.8
Master degree	11	21.6
Bachelor degree	16	31.4
Diploma	3	5.8
High school	18	35.2
Marital status		
Married	40	78.4
Single	11	21.6
Position as team members		
PIC/manager	6	11.7
Administrator	11	21.6
Verifier	15	29.4
Call Center	4	7.8
Security team	10	19.6
Janitor	5	9.9

The GeNose center is located nearby Radiopoetro Building. The area was preferred in order to optimize the GeNose machine that requires appropriate air circulation and open spaces. In addition, the open space was used to maintain the COVID-19 protocols during the clinic services aimed at minimizing overcrowding, keeping safe distance, and collecting the air purposes.

GeNose services and system

GeNose center provides services from Monday to Thursday from 8 am to 1 pm and Friday from 8 am to 11 am. The daily maximum quotas are 200 patients and 100 patients for Friday. We reduced the services and maximum quota on Friday to respect the Holy Prayer for Muslims in our community. Every day, there were 1 PIC, 2 administrative staffs, 2–4 verifiers, 1 security staff, and 1–2 janitors in the clinic.

To use the GeNose service, patients should register and complete the data at least a day before (http://ugm.id/tesGenose). The data consist of personal information, the scheduled day of services, and the COVID-19 related complains. These data are required as a screening method before the services are provided. The hotline team will screen the data and inform the results as well as the day of assessment. The hotline team will approach the patients through WhatsApp® and notify the specific number, bank account, payment procedures, date, and time of GeNose service. The patients should pay for the service with IDR 25,000 (≈ USD 1.5) for university members (staffs and students) and IDR 40,000 (≈ USD 3) for public citizens. In terms of any required re-analysis, the patients should extra pay IDR 20,000 (≈ USD 1.5) through bank transfers or automatic teller machine services.

On the day of their examination, the patients visit the center as the informed schedule. All the patients are encouraged to wear facial masks, wash their hands, and do thermal checking by the security staff. Next, the patients will visit the administration desk to indicate their names, registration number, and hotline message. After the registration is confirmed, the patients receive the personal air bag to collect the air sample. Patients receive information on how to collect the air in safety manners. They are also screened for fasting at least for 30 min–an hour and are asked about their last meals and drinks. If patients had just consumed coffees, teas, stink foods (durians, jackfruits, pineapples, tomatoes, stink beans, dog fruits, onions, or garlic) and smoking, they should wait for another 30 min and rinse their mouth using tap water before the examination. For those who are fully fasting (8–12 h), they should also rinse their mouths with tap water before the procedures. Then, the patients collect their breathing air in the open space area without opening their mask and put their air bags in the containers. The verifiers take the containers and analyze them using the GeNose machine. In total, it takes about 15–20 min for the whole procedure until they receive the outcome (Figure 2). If the positive outcomes are identified, the verifiers would request the patients to enter the educational corner, confirm the COVID-19's signs, symptoms, and history, and educate the patient about the next assessment and/or recommendation.

The GeNose center also provides a collective sample services. It is mostly for the screening purpose in terms of offline meeting, school re-opening, or tracing procedures. The users should contact our hotline numbers and inform the date and number of participants. The team will prepare the quota and make sure the COVID-19 protocols are obeyed. In terms of a large number of samples, we offer the delivery of collecting samples. The team members would visit the

Figure 2: The clinic services of GeNose Center. (a) Washing hands (b) Thermal check (c) Registration and confirmation (d) Education for using an air bag (e) Collecting the air sample in open space (f) Fully air is collected (g) Put the air bag in the container, and (h) The analysis process

users' location, collect the air samples, and transport the air bags to the center. All the analysis procedures are done in the GeNose center.

The SOPs

The GeNose Center has several SOPs as quality control during the services. The GeNose team developed the SOPs based on the manual book of GeNose [6] and expert recommendations. Recently, eight SOPs were established, including: (1) procedures for operating GeNose machine, (2) HEPA filter replacement, (3) breathing sample collection, (4) machine and staff preparation, (5) decontamination and maintenance, (6) medical and non-medical waste disposal, (7) software installation and update procedures, and (8) breathing curve reading and interpretation. In addition, we also provide GeNose manual guidelines, COVID-19 protocols, and training materials in our center in case of any trouble in understanding the procedures.

Media promotion and safety measures

The launching and marketing media used the university channels. The information about hotline numbers, registration link, and GeNose system are available in university social media. This includes the information for patient's preparation before examination. Further promotion of the clinic is also available in several online and mass media near the university.

To adhere to the COVID-19 protocols, the team arranged the clinic services to always do hand washing, keep safe distance, avoid close contact, and use facial masks during the services. Our team was also provided the PPE. As the recommendation, the team used level one PPE, including: masks (medical masks or N95), medical gloves, head coverings, gowns and face shields. All the PPE are disposable except the washable head covers and gowns. Before the services, all patients are required to complete online screening sheet. Screening includes: (1) The symptoms of COVID-19, (2) contact history with COVID-19 patient, (3) previous examination of COVID-19 and the results, if available, and their (4) personal data. The data are important as the first line for COVID-19 precaution and prevention for all of the GeNose team members.

Discussion

Accurate screening is essential for identifying and managing COVID-19 patients as well as for implementing outbreak control measures [9]. The World Health Organization (WHO) recommends using

the RT-PCR method as the gold standard for the diagnosis of COVID-19 infection and the United States Food and Drug Administration (FDA) recommends the use of antibody detection to help identify people who may be exposed to the COVID-19 virus [5]. However, the RT-PCR examination requires specific equipment, experienced laboratory personnel, and is relatively expensive and time consuming [10]. Based on these limitations, the researchers in UGM developed the GeNose with the aim of providing a fast, accurate, and non-invasive screening tool for COVID-19 [6], [7].

The GeNose as a screening tool offers several benefits. The advantages of GeNose are it is relatively fast, does not require a specific reagent, and has an affordable price, when compared with the rapid test and RT-PCR examination [7], [11]. The analysis only takes 3–5 min, and only demands an air bag without any specific requirement, and is relatively inexpensive for people from the lower-and middle-income household. This makes the GeNose test more attractive and promising to the public. To date, the Indonesian government accepts the GeNose as a screening test to classify the positive and negative groups of COVID-19. It is applied nation-wide in some countries and is used as a prerequisite for land and air routes of transportation [7].

The initial stage of developing the GeNose Center was training for the team members who had been selected based on specific criteria. Training is a significant driving factor used to assist individuals and organizations in achieving short- or long-term goals and objectives. Through training, there will be an increase in knowledge, skills, and attitudes of participants [12]. The training was held using lecture, case-based study, and direct practice in handling the GeNose machine. Live lectures with presentations are usually conducted during the training, but this does not guarantee the full understanding of the trainees about the topics being discussed [12]. Our approach offers active discussion and clarification. Thus, all the trainees will have a constructive idea before the practice. A case-based study facilitated the trainees to get more engaged with some particular cases or situations. The direct hands-on practice with the GeNose machine provided a chance to get in touch with the real machine. It was considered as an effective approach in helping trainees acquire knowledge, develop and apply the skills, and assist them to increase self-confidence and independence in their job performance [13].

GeNose Center began operating on February 15, 2021 from 8 am to 1 pm. The intended patients should register, and then they would be scheduled by the hotline time and thereafter the screening is based on the inputted data. The system is aimed to avoid crowds at the day of service and better manage the flow of patients. The WHO states that a crowd is a potential spreading method of the COVID-19 virus. In crowds, virus transmission through the air is still possible from infected person to the population, even though they have maintained a safe distance to prevent contact transmission [14]. The risk becomes higher in crowded, poorly ventilated spaces, where infected people spend long periods of time together in close proximity due to the droplets or aerosols in the air [15].

Patients are also required to fill out the self-screening sheet to determine whether they are eligible or non-eligible participants. Patients are identified as an eligible if there were no COVID-19 symptoms such as fevers, coughs, sore throats, no contact with a confirmed COVID-19 patients, and vice versa. If there was at least one “Yes” answer on the screening sheet, the patients were considered as non-eligible patients. It is based on the nature of the GeNose as a screening tool, which is not intended as a diagnostic study. For those who have potential or suspected COVID-19 contact history, symptoms and signs, they are recommended to conduct the diagnostic study, either rapid test or RT-PCR. It also is done with the aim of preventing the spread of COVID-19 around the campus. The probability that an infected person will be detected in a screening program depends on: the incubation period (time from exposure to the onset of detectable symptoms); proportion of subclinical cases (mild cases without fever or cough); the sensitivity of thermal scanners used to detect fever; awareness of individuals that they are at high risk; and honesty in filling out the screening questionnaire [16]. In the practice, there were some patients who were dishonest regarding their contact history, smoking history or previous eating that required them to be disqualified from the services. Dishonesty may result in false negative or false positive results. This was anticipated by doing re-screening at the administration desk to ensure the patients’ examination preparation. When a positive outcome occurred, the team would do confirmation and provide information in the education corner. In terms of the vague response of patients and unclear outcomes (low result, inconclusive, or low signal), the examination is repeated according to the SOPs [6]. Only a positive outcome with high probability (more than or equal to 0.6) did not require re-test. Thus, patients will receive information to apply social isolation, and the date for the diagnostic study in the recommended facilities.

The GeNose center is located on the first floor with good air ventilation. Ventilation is one of the most important ways to control cross infection by removing or diluting virus-laden aerosols exhaled by infected patients [17]. Ventilation plays a role in controlling how quickly the air in a place changes [14]. The purpose of ventilation is to supply outside air and remove extra heat, humidity and contaminants from the occupied space to meet health and comfort requirements [17]. Ensuring good ventilation with outside air can help reduce the concentration of airborne contaminants, including viruses [18]. A place with poor ventilation and many people has a high risk of transmission and spreading

the virus. According to the Center Disease Control (CDC) and American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), there are several ways to improve ventilation, including: (1) open the doors and windows when the weather permits, (2) use a fan to increase the effectiveness of air flow, (3) ensure that the ventilation system is operating properly and provides good air quality, and (4) make sure the exhaust fan is functioning properly [19], [20]. On the use of windows for ventilation purposes, the rate of airflow depends on certain conditions, such as the size of the window, the position of the window, the climate and weather. The use of a fan aims to maximize airflow from the window. In a closed room, the placement of supply and exhaust vents will help provide good ventilation to avoid virus transmission [14]. Avoiding air recirculation is important when providing ventilation for the room in the pandemic situation. Recirculation can transmit airborne contamination (including viruses) from one room to another. Air recirculation should be avoided in order to prevent the spread of virus-laden particles throughout the indoor environment [14].

Droplets may come out of during the breath sample collection. The procedure is done in outdoor space to prevent the spread of the virus without taking-off the mask. The emergence of COVID-19 clusters in worship places, supermarkets, restaurants, indicates the evidence that the virus can spread indoors [21]. This is consistent with the CDC's statement that COVID-19 virus will spread more readily indoors rather than outdoors. In addition, the concentration of particles will be higher when indoors than outdoors and potentially serve as a transmission mode. The air circulation helps in reducing the concentration of virus particles in the particular area. The lower the concentration rate of virus in area, the less likely the virus particles to be inhaled into the lungs (potentially lowering the inhaled dose); eye, nose, and mouth contact; or fall on the surface [19].

GeNose Center team members use PPE level 1 in the form of gloves, masks, gowns, head coverings and face shields, according to WHO recommendations. The use of PPE for contact and droplet prevention (medical masks, gowns, gloves, eye protection) are recommended for all healthcare workers when treating patients with suspected, probable or confirmed COVID-19 [14], [22]. The gown can be a disposable gown or a lab coat. Goggles or face shields can be used to protect the eyes. However, the effectiveness of their use has not been tested. Moreover, at present, there are many face shields made by home industries, where it is impossible to test their effectiveness in protecting against exposure to viruses [23].

The obstacles in the implementation of the GeNose center include that there were several participants who were dishonest when the initial screening, either in self-screening sheet or during education prior to breathing sample collection. Mostly, we found they were dishonest about their contact history with confirmed patients, previous smoking or eating after re-assessment in the education corner. It makes the examination to be repeated. Moreover, almost all the procedures used the gadget and online system to minimize the contact and virus transmission. For the elderly patients, it may become a challenge to use the phone or computer.

Conclusion

GeNose center is a university-based clinic in UGM as a pilot project with the aim as a model for clinic services that provides COVID-19 screening test. During the development, the clinic was initiated through training, simulation, and debriefing of the GeNose procedures. To support the clinic operation, the team consisting of PIC, verifiers, administrative staffs, hotline team, security staff, and janitors was recruited and trained. The SOPs were systematically developed and safety measures are conducted using the clinic service system to maintain the COVID-19 protocols. To date, the GeNose center is still in operation to provide the service for COVID-19 screening.

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