



# A Mobile Health Application for Monitoring and Educating Covid-19 Patients During Self-quarantine

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**Abstract.** To address the need in monitoring and educating Covid-19 patients during self-quarantine at home in Indonesia, healthcare providers need a mobile health application. This study aimed to develop a mobile health application for monitoring and educating Covid-19 patients during self-quarantine. The current study used R&D design that involved 27 health personnel who handled monitoring Covid-19 patients during self-quarantine and 41 post Covid-19 patients in Malang and Batu Cities. This study was conducted through the steps: investigating the problem and the needs, analyzing the cause of the problem, and designing, creating, and testing a prototype. The study showed that the participants faced problems in monitoring and educating Covid-19 patients during self-quarantine that included three themes of experiences and their needs, namely: 1) the methods and application in monitoring Covid-19 patients during self-quarantine, 2) health education methods for Covid-19 patients, and 3) suggestions for developing an application for Covid-19 patients. Based on the problems and need analysis, a mobile health application for monitoring and educating Covid-19 patients was developed and tested. The evaluation of application showed that men-us of the application can properly work although needed some revisions. We conclude that health personnel who handle in monitoring and educating Covid-19 patients during self-quarantined at home need to develop a mobile health application that can help easier and faster in monitoring and educating Covid-19 patients accurately. A developed mobile health application for monitoring and educating Covid-19 patients during self-quarantine can be implemented for the patients widely.

**Keywords:** Covid-19 · health education · health personnel · quarantine · telehealth

## 1 Introduction

The magnitude of the Covid-19 pandemic has increased the morbidity and mortality rate rapidly in many countries worldwide. Many healthcare facilities become collapsed because insufficiency of healthcare facilities and the number of healthcare providers is very small compared to the increase of Covid-19 cases. As result, this condition becomes a huge burden for healthcare providers in caring for and treating the patients, and

many Covid-19 patients during self-quarantine at home are not monitored and treated well, and many of them have been die during self-quarantine. Widadio report-ed that over 2,700 people have died while undergoing self-quarantine due to Covid-19 since June 2021 in Indonesia [1].

Nurses at the forefront of healthcare services are facing a dilemmatic situation between being high risk to be infected by Covid-19 and maintaining the quality of care. As result, the quality of caring can be reduced. A preliminary study on five people who had been infected by Covid-19 during self-quarantine told that healthcare providers were less pay attention to monitoring their health progress. Surely, this patients' complaint shows the uncaring behavior of nurses. This condition occurred because of the high burden of nurses in handling Covid-19 patients. Therefore, the safe way to maintain the quality of caring for patients can be performed through telehealth technology. So, healthcare services can be delivered at a distance [2].

The existing applications for Covid-19 patients in Indonesia such as Silacak' (Information System for Tracing) and 'Peduli-Lindungi' are only used for tracking, tracing, and reporting for suspected, confirmed, and vaccinated Covid-19 people. Health informatics applications for monitoring the health progress of Covid-19 patients during self-quarantine have not been developed optimally. As result, the patients are less monitored and educated about Covid-19. Whereas they need to be observed routinely to know their health progress and get immediate treatment if their health conditions are being to deteriorate.

Globally, telehealth with highspeed telecommunications systems has been becoming popular in providing healthcare services during this pandemic [3]. Some tele-health applications for Covid-19 patients had been developed such as a remote smart home healthcare support system to check patients' health status. The patients can receive doctor's prescriptions while staying at home. This application is connected to a web-based application, so communication can be carried out in real-time between patients and doctors. Sensors is connected to the system to automatically capture the patient's physiological health parameters [4]. Moreover, a telemedicine tool for remote Covid-19 diagnosis, monitoring, and management for monitoring vital signs and tracing close contacts of Covid-19 patients. This application can check the patient's physiological signs in real-time; so, it can help to monitor the health progress of patients [5]. Furthermore, an emergency system for monitoring pulse oximetry, peak expiratory flow, and body temperature of Covid-19 patients at home. This system allows medical staff to monitor the patient's condition, help, and send medical recommendations, and transmit data from the patient to the hospital using a mobile application, provide real-time monitoring of oxygen saturation (SpO<sub>2</sub>), blood pulse per minute (BPM), body temperature (BT), and peak expiratory flow (PEF) [6].

Therefore, to address the need for Covid-19 patients during self-quarantine at home specifically in Indonesia, those above applications need to be adopted; however, it needs to be modified to be more suitable for the local situation. Besides, for improving efficiency, effectiveness, the safety of patients and healthcare providers, preventing the Covid-19 transmission, and enhancing the quality of caring expression for patients [7]. Hence, the current study aims to develop a mobile health application for monitoring and educating Covid-19 patients during self-quarantine at home. This study is beneficial to

increasing the development of nursing information technology and implement solutions to unmet clinical needs [8].

## **2 Methods**

### **2.1 Study Design**

This study used Research and Development (R&D) design. This design comprised creative and systematic works to increase the knowledge including knowledge of humankind, culture, and society, and to devise new applications of available knowledge [9]. This design used both qualitative and quantitative approaches. Qualitative approach was used in the step of development of application, and quantitative approach was used in the evaluation of developed application.

### **2.2 Participants and Sampling Technique**

The study involved 27 health personnel who were responsible for monitoring Covid-19 patients during self-quarantine and 41 post Covid-19 patients in Malang & Batu Cities who were selected by purposive sampling technique. The inclusion criteria of participants included the participants who understood the detailed policies and procedures for monitoring Covid-19 patients and had experiences in monitoring and educating the Covid-19 patients and the Covid-19 patients who underwent self-quarantine at home.

### **2.3 Data Collection**

Data collection was conducted from July 2021 to September 2022 by online in-depth interviews to explore the experiences of nurses in monitoring and giving health education for Covid-19 patients during self-quarantine and distributed online questionnaire to evaluate the function of application. The study through the steps: (1) investigating the problem, (2) analyzing the cause of the problem, (3) designing a prototype as a solution, (4) making the prototype of application, and (5) testing the application [7]. In the investigative phase, the researcher assessed the patient's problem in monitoring the Covid-19 patient during self-quarantine. In the analysis phase, the researcher analyzed the factors that caused the problem. In the design solution phase, the researchers design a prototype as a solution. In the prototyping phase, the researchers made the prototype. Finally, in the testing phase, the researcher tested the developed application. The study protocol and informed consent sheet were approved by Research Ethics Committee Poltekkes Kemenkes Malang Reg. No.191/KEPK-POLKESMA/2021. During data collection, the researchers fulfilled trustworthiness criteria that included credibility, dependability, confirmability, transferability, and authenticity criteria [10].

### **2.4 Data Analysis**

The recorded online interviews were transcribed and then analyzed using qualitative content analysis methods. This method was used to analyze the content of narrative

data and to identify the themes of the findings by breaking the data into smaller units (keywords), coding, and naming the units according to their contents, and grouping them based on a similar concept [10]. The result of evaluation the function of application from healthcare personnel and the patients' perspective was analyzed using descriptive analysis.

**Table 1.** Thematic analysis of the findings

No	Themes	Subthemes	Keywords
1	Method in monitoring Covid-19 patients during self-quarantine	Method to monitor Covid-19 patients at home	<ul style="list-style-type: none"> <li>• Sending a certain form via WhatsApp</li> <li>• Visiting the patients</li> <li>• No specific application,</li> <li>• Monitoring via WhatsApp</li> <li>• Monitoring via videocall</li> <li>• Using google form</li> </ul>
		Health information should be monitored for Covid-19 patients	<ul style="list-style-type: none"> <li>• Chief complaints every day</li> <li>• Blood pressure,</li> <li>• Pulse,</li> <li>• Breathing,</li> <li>• SpO2,</li> <li>• Personal identity,</li> <li>• Result of swab test</li> <li>• Close contact information</li> <li>• Age,</li> <li>• Weight,</li> <li>• Medicines,</li> <li>• Patient compliance toward health protocols</li> </ul>
		Barrier in monitoring Covid-19 patient	<ul style="list-style-type: none"> <li>• Lack of tools,</li> <li>• Patients did not provide true information</li> <li>• A negative stigma</li> <li>• Many rejections</li> <li>• Limited manpower</li> <li>• Patients' in compliance toward health protocols</li> </ul>
2	Health education methods for Covid-19 patients	Methods to educate Covid-19 patients	<ul style="list-style-type: none"> <li>• Share video and leaflet via WhatsApp</li> <li>• Using video calls via WhatsApp</li> </ul>

*(continued)*

**Table 1.** (continued)

No	Themes	Subthemes	Keywords
		Important topics for educating Covid-19 patients	<ul style="list-style-type: none"> <li>• Disinfection Procedures,</li> <li>• Things to do during self-quarantine</li> <li>• Contraindication to do self-quarantine</li> <li>• Guide to seek to help immediately,</li> <li>• What things do not need to worry about,</li> <li>• Medication for Covid-19 patients</li> </ul>
3	Suggestions for developing an application for Covid-19 patients	Suggestions for better Covid-19 patients monitoring	<ul style="list-style-type: none"> <li>• The application is available for video call</li> <li>• The application is very easy,</li> <li>• The application is very fast, not too complicated</li> <li>• There are questions to trace close contact</li> <li>• Not add burden for healthcare workers</li> <li>• There is a notification for healthcare workers</li> <li>• There is an alert system when the patients are in an emergency condition</li> <li>• Able to find out the patient position</li> </ul>
		Suggestions for better Covid-19 patients health education	<ul style="list-style-type: none"> <li>• Need a short duration video.</li> <li>• Need health education material links</li> <li>• Available ambulance information</li> <li>• Available rental oxygen information</li> <li>• Available hospital information</li> <li>• Available emergency protocol</li> </ul>

## 3 Results

### 3.1 Investigating Problems

Based on the interviews, the participants said that their experiences and their needs in monitoring and educating Covid-19 patients during self-quarantine included three themes, namely: 1) method in monitoring Covid-19 patients during self-quarantine, 2) health education methods for Covid-19 patients, and 3) suggestions for developing an application for Covid-19 patients (see Table 1).

#### **Theme 1: Methods in monitoring Covid-19 patients during self-quarantine**

Subtheme 1: Methods to monitor Covid-19 patients. Healthcare providers in monitoring Covid-19 patients were by sending a chat via WhatsApp, using google forms, or visiting patients. There was no specific application used by participants in monitoring and educating the patients. The existing applications such as 'Silacak' (Information system for tracing) had a function for reporting only, it was not for monitoring and educating patients. These results are as expressed by the following participant.

We traced them via WhatsApp or telephone. If necessary, we visited directly to the patient. We monitored the patient for 14 days; we asked the close contact. On 1st day, we tested the patients by rapid antigen test, if the result was positive, we isolated them for 14 days, if the negative result, on the fifth day, they would be PCR tested. Every day, we monitored them.... There was no special application for monitoring. 'Silacak' application cannot monitor the patients, that was for tracking and reporting only. We monitored the patients via WhatsApp. We sent a format that consist of some questions, for example, please fill your complaints such as cough, fever, diarrhea, etc. (P3).

Subtheme 2: health information that need to be monitored for Covid-19 patients. When monitoring the health progress of patients during self-quarantine at home, nurses assessed the patient's vital signs such as blood pressure, blood pulse, respiratory rate, oxygen saturation (SpO<sub>2</sub>), and body temperature. According to the participants, most of the patients had a device to measure their vital signs such as a digital thermometer, digital sphygmomanometer, an oximeter. Besides that, the patients' identity, age, weight, symptoms, date of a swab test, their close contacts, and their medicines needed to be monitored, as presented in the following participant's statements.

Biodata information was needed, when was the first swab test. We sent a sheet for monitoring that consisted of name, age, weight, symptoms, what medication did you have, what medication had been run out of. If the medicine was available, we gave health education only. (P7).

Subtheme 3: Barriers in monitoring Covid-19 patients. The difficulties of healthcare providers in monitoring Covid-19 patients were lack of technology and most people did not tell their problem honestly, because they did not want to get a social stigma as the following participant's statements.

Our problem was that sometimes the patients did not respond to my messages, besides that, we were difficult to trace close contact, oftentimes they were not willing to talk, so we were difficult to know their close contact. They did not want to be swab tested because they were afraid diagnosed Covid-19. (P2).

### **Theme 2: Health Education for Covid-19 patients**

Subtheme 1: Method to educate Covid-19 patients. Participants said that health education method for Covid-19 patients was carried out via WhatsApp. It also could be done by visiting the patients at home if they did not have a communication tool. This result is shown in participants' statements below.

The most effective to monitor them (Covid-19 patients) is using video calls, but it needed to spend a lot of time. We wrote our suggestions, then we shared them via WhatsApp. If the patients needed our visit, we would visit directly to monitor them. (P7).

Subtheme 2: Important topics for educating Covid-19 patients. The topics that were provided by the nurse for Covid-19 patients during self-quarantine at home included what should the patients do during self-quarantine, disinfection procedures, what should the patients do when finished self-quarantine, what the emergency condition they should seek a helping immediately, what conditions no need to be worried, and what the medicines they need, as the following participant statements below.

We shared health education material via WhatsApp about what should they do during self-quarantine, the procedures of disinfection. What should they do when self-quarantine at the end. What condition they were not allowed to self-quarantine, when they should seek a helping immediately, what important things no needed to be worried about, and the medicines that they needed. (P3).

### **Theme 3: Suggestions for developing an application for Covid-19 patients**

Subtheme 1: Suggestions for better monitoring Covid-19 patients. The suggestion for better monitoring was in the next application available a video call feature, but it needed much time to do. The expected application should be very easy, very fast, not be too complicated, available short videos, easy to share, and it should have some questions to trace close contact persons as told by the following participants.

The patients preferred using video calls, but we did not have much time for that. We could not monitor one by one. We did not have time to do it. We were very busy taking care of critical patients. If an application would be developed, it should be very easy and very fast to monitor patient's condition every day un-til up to 14 days. (P3).

Subtheme 2: Suggestions for better Covid-19 patients health education. Suggestions for better Covid-19 patient education was that the application should be available short videos that were easy to be shared for patients as participants statement below.

The patients hoped the next application available video calls, available a video but not too long duration and I can share it. The next application should have an ambulance call center, oxygen rental telephone, emergency unit call center. (P6).

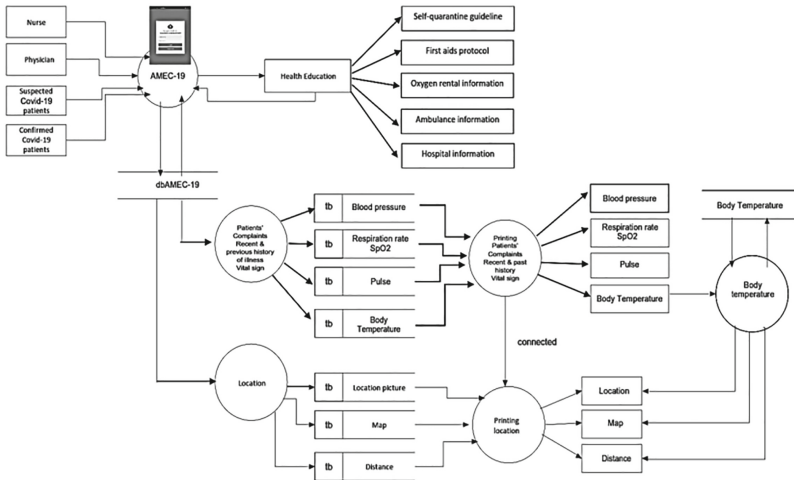


Fig. 1. Digital Flow Diagram of AMEC-19

3.2 Designing a Prototype Design 3.3 Creating a Prototype

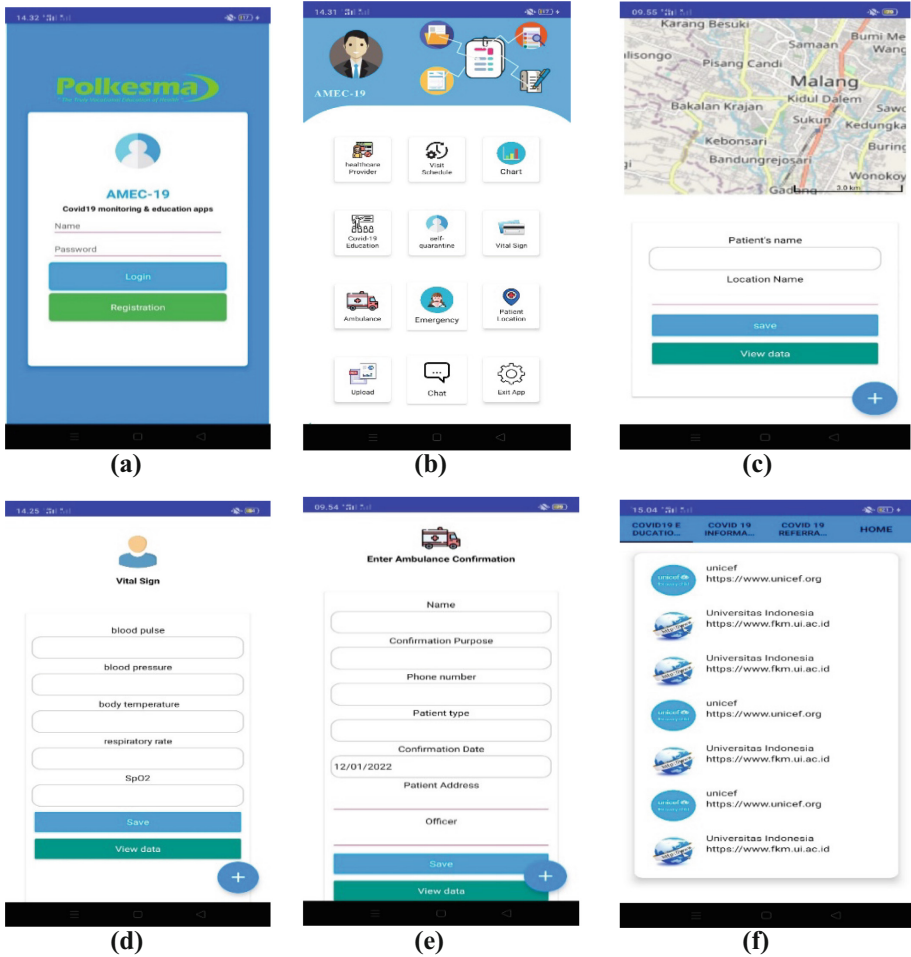
Based on the problem and needs analysis of the nurses who monitored Covid-19 patients during self-quarantine, there was a need to develop an application for monitoring and educating Covid-19 patients (AMEC-19) during self-quarantine as a solution. The conceptual design of the digital flow diagram of the system is presented in Fig. 1.

3.3 Creating a Prototype 3.4 Testing of Application

The application design had some features for monitoring and educating Covid-19 patients. There were some menus that included input their chief complaints, recent and history of illness, and their vital signs that included blood pressure, respiratory rate, oxygen saturation, body temperature, and blood pulse per minute. The health progress of patients could be monitored by the healthcare providers based on the inputted data by the patients or their families. The health provider could give health education or communicate with the patients anytime. This application also had some information about the self-quarantine guideline, first aids protocol, oxygen rental information, ambulance, and hospitals information, able to record the location of the patient’s position, map, and distance of the patient’s location; so, the Covid-19 patients can be traced accurately.

Some examples of User Interface (UI) designs of the application are presented in Fig. 2. Figure 2a showed the UI of registration and login. Figure 2b showed UI of main menus that included health care providers, visiting schedule, patient’s chart, health education, ambulance, chart figure, etc. Figure 2c showed the UI map of the patients’ location. Figure 2d showed UI for inputting patients’ vital sign examination. Figure 2e showed the UI ambulance services. Figure 2f showed the UI of health education sources including guidelines for the patients during self-quarantine.





**Fig. 2.** User Interface Designs of AMEC-19. (a) UI login and registration, (b) UI main menu, (c) UI patients' map location, (d) UI vital sign, (e) UI ambulance service, (f) UI health education sources

### 3.4 Testing of Application

The testing of the application of monitoring and health education for Covid-19 patient who underwent self-quarantine as presented in Table 2. Table 2 shows that most of the participants evaluated that registration menus, logins, patient data input, visit schedules, vital sign charts, patient education, patient location detection, patient complaints, ambulance order, and logout menus can be operated easily. However, most of the participants (63.4%) stated that the chat menu was very difficult to be operated and need much time.

Based on the participants opinion, most of the participants stated that the AMEC-19 application was very important and useful for Covid-19 patients during self-quarantine. However, there are some important suggestions for the development of this application

**Table 2.** Participants evaluation to menus function of the application

Menu	Participants' evaluation											
	Cannot work		Very difficult		Difficult		Easy		Very easy		Total	
	n	%	n	%	n	%	N	%	n	%	n	%
Registration	1	2,4	1	2,4	3	7,3	32	78,0	4	9,8	41	100
Login	1	2,4	0	0	4	9,8	30	73,2	6	14,6	41	100
Input biodata	4	9,8	1	2,4	7	17,1	25	61	4	9,8	41	100
Visiting schedule	3	7,3	0	0	2	4,9	33	80,5	3	7,3	41	100
Vital Sign Chart	5	12,2	0	0	7	17,1	25	61	4	9,8	41	100
Health education link	2	4,9	0	0	1	2,4	27	65,9	11	2,68	41	100
Patient's location	4	9,8	0	0	3	7,3	29	70,7	5	12,2	41	100
Patient's complaint	3	7,3	4	9,8	7	17,1	23	56,1	4	9,8	41	100
Ambulance order	2	4,9	3	7,3	2	4,9	30	73,2	4	9,8	41	100
Chat	5	12,5	26	63,4	10	24,4	0	0	0	0	41	100
Logout	14	34,1	0	0	0	0	19	46,3	8	19,5	41	100

such as the application will be better if available consolation menu that can give quick respond, the application should be designed more simple for the patients, the chat menu need to be revised so it will be more easy, and the application should be compatible for all type of android devices.

The evaluation of health personnel on the application menu as listed in the following Table 3. Table 3 shows that more than 50% of healthcare personnel who monitor Covid-19 patients during self-quarantine evaluated that the Registration menu, Login, Report, patient locations, patients' biodata, Patients' Chart, Health education material edited, patients list, ambulance order, Patients vital signs, Print menu, and the Logout menu were easy to be operated. However, the chat menu needs to be improved because it needs much time to work.

Based on health personals opinion that most of them said that this application is very important to help their work; however, it needed to be developed. Some of them suggested that patient data should be set by region, so it would be easier to search patients' data. They also suggested to provide search/filter patient menu by region according to the area of healthcare providers.

**Table 3.** Health personnel evaluation on menus function of the application

Menu	Health personnel's evaluation											
	Cannot work		Very difficult		Difficult		Easy		Very easy		Total	
	n	%	n	%	n	%	n	%	n	%	N	%
Registration	31	15,8	0	0	21	10,5	11	57,9	3	15,8	19	100
Login	2	10,5	0	0	1	5,3	11	57,9	5	26,3	19	100
Report	2	10,5	0	0	2	10,5	13	68,4	2	10,5	19	100
Patient's location	4	21,1	0	0	2	10,5	10	52,6	3	15,8	19	100
Patient's data	2	10,5	0	0	2	10,5	12	63,2	3	15,8	19	100
Patients Chart	3	15,8	0	0	1	5,3	12	63,2	3	15,8	19	100
Health Education material	3	15,8	0	0	2	10,5	11	57,9	3	15,8	19	100
List of patients	2	10,5	1	5,3	2	10,5	11	57,9	3	15,8	19	100
Vital sign of patients	2	10,5	0	0	2	10,5	12	63,2	3	15,8	19	100
Print menu	5	26,3	0	0	1	5,3	10	52,6	3	15,3	19	100
Chat	4	21,1	1	5,3	11	57,9	3	15,8	0	0	19	100
Logout	2	10,5	0	0	1	5,3	11	57,9	5	26,3	19	100

## 4 Discussion

The study found that monitoring and educating Covid-19 patients was conducted by nurses using WhatsApp or telephone and visiting the patients. Monitoring by WhatsApp had some limitations, the data collected is not stored in the database and the data is difficult to be organized. Whereas, visiting the patients can spread the infections to the healthcare providers. Therefore, to reduce this risk, it can be minimized by using telehealth. Taiwo and Ezugwu explained that using smart healthcare can reduce physical contact between health providers and patients, prevented the risk of transmission, assist the community in achieving a healthy life, facilitate communication between healthcare providers and Covid-19 patients, and it can examine the patients' health condition well [4]. Telehealth can provide services at any time, minimize transmission of infection, and protect physicians and patients [11]. The use of Remote Patient Monitoring for COVID-19 patients can monitor and reduce the number of patients admitted to the hospital [12]. Furthermore, telehealth for Covid-19 patients can be used for teleconsultation, telediagnosis, telemonitoring, tele-regulation, and tele-education [13, 14]. Additionally, nurses

can perform care for remote patients easily, provide convenience for patients, and conduct nursing care processes [15], and also help remote assessment and the provision of care, enable people to navigate the health system and access routine care [16]. Furthermore, it can improve patient care, effectiveness, and efficiency [17], enhancing nurses' communication with other healthcare providers, and documentation [18, 19]. Besides that, nurses can deliver better care and store patient files [20]. Patients can access their medical records and test results [21], encourage outpatient teleconsultations, and reduce patient visits to the hospital [22]. Additionally, telehealth can offer opportunities for effective teamwork [23].

The current study showed that patients' complaints and vital signs were very important to be monitored routinely during undergoing self-quarantine. Similarly, Lukas et al. stated that the important patients' conditions that must be monitored through telehealth are vital signs, signs, and symptoms such as fever, cough, shortness of breath, fatigue, and other physiological signs. So, it can improve a better understanding of the progress of Covid-19 infection, and able to take immediate intervention if there is a sudden decline in the patient's health condition, thereby reducing the mortality rate [5].

The participants suggested that important topics of health education for the Covid-19 patients included procedures for self-disinfection, the protocol of self-quarantine, how to seek help immediately, what situations are no need to be worried about, and what medicines that they need. Similarly, the Center for Disease Control and Prevention (CDC) provides some advice that caregivers should know in caring for Covid-19 patients at home namely helping fulfill basic needs, paying attention to the emergency, how to protect themselves, how to eat, use utensils, use masks, wash hands, and monitor their health from caregivers [24].

The study found that the barrier of nurses in monitoring Covid-19 patients during self-quarantine were that many people did not tell honestly; because if they were diagnosed with Covid-19, they could not do their daily activities freely, they will be isolated by the other ones. This finding is congruent with Chopra and Aruro's study which explained that many people suffering from Covid-19 got labeled, stereotyped, discriminated against, treated separately, and/or experienced loss of status-related disease. So, it can be harmful to patients, caregivers, their families, friends, and communities [25].

The participants suggested for better monitoring Covid-19 patients, the application should have some features such as available a video call feature, very easy, fast, and not too complicated to use. Therefore, it needs to design an interesting User Interface (UI) and simple to operate everywhere; so, designing a mobile UI should be considering context, screen, and mobility of user input and output [26]. A good application should meet acceptable criteria for quality, content, or functionality, highlight esthetic, interesting features to be welcomed by users [27], be easy to use, and have higher quality [28]. The self-care application of Covid-19 required elements of the used medication and history and type of underlying disease [29]. Additionally, the use of Artificial Intelligence in an application can automatically monitor and prediction of the spread of this virus quickly [30]. Miller stated that cannot work well can be caused by the application not updated, insufficient phone memory and storage, corrupted app cache and data, bugs and crashes in apps, temporary system errors, outdated phone apps or software, and incompatibility and many more [31].

## 5 Conclusion

We conclude that health personnel who have a responsibility for monitoring and educating Covid-19 patients during self-quarantined at home need a mobile health application that can help them to work well. Therefore, a mobile health application for monitoring and educating Covid-19 patients during self-quarantine needs to be developed based on the participants' needs. The developed application can be implemented for the Covid-19 patients widely.

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