

[Material]

# Usability test with medical professionals toward commercialization of a smartphone-based home blood pressure monitor

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## Abstract

The purpose of the present study was to conduct usability tests with home-care nurses and pharmacists toward commercialization of a simple and highly reliable system for measuring and managing blood pressure at home with the use of a smartphone, and to investigate issues for improvement. The prototype home blood pressure monitor was used by eight home-care nurses and five pharmacists, who subsequently participated in semi-structured interviews regarding usability. There were positive opinions of user-friendliness with regard to “preparation and fitting the device,” “blood pressure measurement,” “checking measurement values,” and “emergency stop.” There were negative opinions of user-unfriendliness with regard to “power input,” “pairing,” and “setting the interval between measurements.” Measurement and storage of values are straightforward with this blood pressure monitor, so it may prove beneficial for evaluation of treatment. The results suggest that both the hardware and software components, including user-friendly configuration and application, need to be improved.

Key words : Home blood pressure monitor, Usability test, Hypertension

## 1. Introduction

The Ministry of Health, Labor and Welfare estimates that as many as 40 million people in Japan have hypertension.<sup>1)</sup> The existence of “white coat hypertension,” in which blood pressure increases in the presence of a doctor wearing a white coat, as well as “masked hypertension,” in which blood pressure that is normal in the examining

room is high when measured in the early morning or at other times at home, is now well known, and scientific societies have taken the lead in endorsing daily measurement of blood pressure at home. The results of blood pressure measurements taken at home are major indices for the selection of treatment strategies. There is increasing recognition of the need for blood pressure management and recording at home, but low adherence due to

forgotten measurements or falsified records is problematic when patients measure their own blood pressure.<sup>2,3)</sup> In addition, a blood pressure notebook is usually used for managing records of blood pressure measurement, but obtaining values that are accurate enough for medical care and recording measured values on a continual basis are a considerable burden for the patient. Moreover, measurement results are not always fully used because they are recorded in different formats.

To resolve these issues in clinical settings, we looked at how information and communications technology has permeated domestic life. As a result of the rapid proliferation of smartphones in recent years, smartphones can now be readily operated by anyone, and excel at data accumulation. Through collaborative research involving nursing science, pharmaceuticals, and medical science, we developed a simple and highly reliable prototype system for home blood pressure measurement and management that incorporates these advantages of smartphones. Looking toward commercialization, the purpose of the present study was to conduct usability tests of the prototype with medical professionals to evaluate its user-friendliness as well as potential issues.

## 2. Methods

### 2-1. Smartphone-based home blood pressure monitor

The smartphone-based home blood pressure monitor prototype was developed in collaboration with TSS Co., Ltd., Tokyo. It comprises a main unit that can communicate with a smartphone

via Bluetooth and a cuff (Fig.1). The main unit can be charged via USB, so it can be used outside the home as well.

An application on the smartphone for management of blood pressure measurement (Joint development: Cosmo Summit, Kanazawa) can display blood pressure measurements, record measurement values, and display the results on a graph. It can also be set to take automatic measurements every hour (Fig.2).

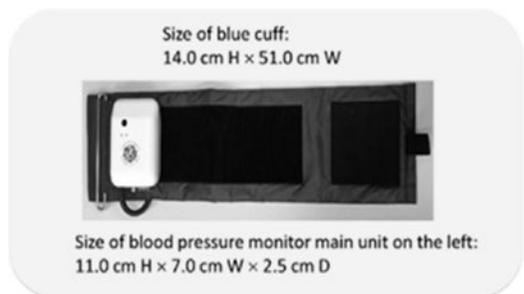


Figure 1. Smartphone-based home blood pressure monitor (with cuff open)

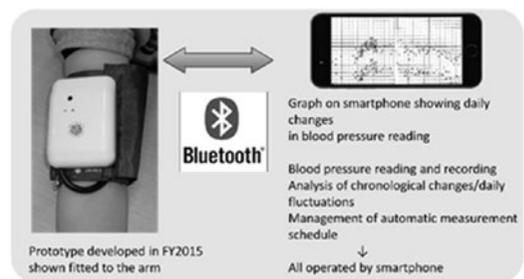


Figure 2. Smartphone-based home blood pressure monitor prototype fitted to the arm and graph of daily changes

### 2-2. Usability test of smartphone-based home blood pressure monitor prototype

**Subjects:** The subjects were eight home-care nurses and five pharmacists working at health

insurance pharmacies. They all carried out health management, including blood pressure management at patients' houses, and were experienced in smartphone use.

**Survey period:** August – October 2016

**Survey method:** The developed smartphone-based blood pressure monitor prototype (hereafter, “blood pressure monitor” ) was provided to the home-care nurses and health insurance pharmacy pharmacists, who were surveyed by means of semi-structured interviews after they had used it to measure their own blood pressure.

**Details of the survey:** The subjects were asked about the ease or difficulty of use and asked to provide reasons for their answers with regard to: (1) fitting the blood pressure monitor, (2) turning on the power, (3) pairing (making the main unit and the smartphone work together), (4) blood pressure measurement and setting the interval between measurements, (5) checking measured values, and (6) emergency stop. In addition, opinions were collected about potential issues when patients or medical practitioners actually use the blood pressure monitor. The data were recorded and verbatim transcriptions were made.

### 2-3. Ethical considerations

For the survey of home-care nurses, leaflets requesting cooperation with the survey were distributed to the managers of home-care nursing stations registered with home-care nursing associations within the Kanto region, and these leaflets were displayed within the facilities. To ensure that cooperation was voluntary, nurses who were interested in cooperating with the study were asked to

contact a dedicated mailing address. The days and places where the subjects could cooperate were coordinated, and subjects were then asked to use the device, after which the interviews were held (Toho University Faculty of Nursing Ethics Committee approval no. 28011).

For the survey of pharmacists working at health insurance pharmacies, cooperation was requested from pharmacists who attended training courses held by pharmacists' associations in the Kanto region. Subjects who agreed to cooperate with the study were loaned the blood pressure monitor and used it for about a week, after which interviews were held (Chiba University Graduate School of Pharmaceutical Sciences Ethics Committee approval no. 243-6).

## 3. Results

### 3-1. Usability test

Opinions regarding the usability of the blood pressure monitor were classified and ordered into user-friendly points and user-unfriendly points by operation, and these are shown in Table 1.

In the investigation of user-friendliness and user-unfriendliness by operation, the opinions for “preparation and fitting the device,” “blood pressure measurement,” “checking measurement values,” and “emergency stop” included positive opinions. However, the opinions for “power input,” “pairing,” and “setting the interval between measurements” were all negative, indicating user-unfriendliness.

Table 1 Opinions on the usability of the smartphone-capable blood pressure monitor

Operation	Classification
Preparation and fitting of blood pressure monitor	<ul style="list-style-type: none"> <li>○ Small, manageable</li> <li>○ Experience using a smartphone affects use</li> <li>○ The cuff fits on the arm easily</li> <li>● The cuff does not stay firmly in place</li> <li>● Depending on physical and mental function, some people may be unable to fit it alone</li> <li>● There is discomfort with long-term use</li> </ul>
Power input (main unit and smartphone)	<ul style="list-style-type: none"> <li>● A charger is needed when carrying it around</li> <li>● The power button is confusing to operate</li> </ul>
Pairing (Coupling main unit and	<ul style="list-style-type: none"> <li>● It is difficult to pair the devices</li> <li>● There should be specific guidance on operation</li> </ul>
Blood pressure measurement/setting interval between measurements	<ul style="list-style-type: none"> <li>○ Blood pressure measurement and recording is simple</li> <li>○ There is no discomfort during measurement</li> <li>● Values should also be displayed during 24 h measurement</li> <li>● It should be able to show the blood pressure on the main unit</li> <li>● It should be possible to set the measurement time/alarm sound at will</li> </ul>
Checking measured values	<ul style="list-style-type: none"> <li>○ It is easy to understand the blood pressure values; this can be used for care</li> <li>● It is difficult to operate the icons</li> <li>● The graph of blood pressure values is hard to read</li> <li>● There should be an indication of abnormal blood pressure values and how to deal with them</li> <li>● It should be possible to share blood pressure values among different professionals</li> </ul>
Emergency stop	<ul style="list-style-type: none"> <li>○ Emergency stop is good, as it releases the pressure</li> <li>● Cannot stop immediately in an emergency</li> </ul>

○ User-friendly points ● User-unfriendly points

### 3-2. Potential issues upon commercialization

The present subjects were able to use the blood pressure monitor with a single explanation of handling and operation. The following opinions were given concerning issues when medical professionals or patients use the device themselves in the future. When patients use the device, they need to be aware of the following potential issues: “People who are accustomed to using smartphones, computers, and automatic blood pressure monitors can use this device, but it is difficult to use for those with no experience of operating such devices” ; “It is difficult for persons with cognitive impairment or paralysis to use it on their own” ; “Consideration needs to be given to the economic burden of

purchase and communications expenses” ; and “Personal data must be handled carefully.”

## 4. Discussion

Usability as characterized by the users was examined and considered for each operation. At the same time, with regard to potential issues when the device is released, points for improvement were investigated from medical, pharmaceutical, and nursing perspectives on the basis of the opinions that were gathered. The details of these are as follows.

### 4-1. Usability as characterized by the users

The blood pressure monitor is characterized as being small and light, and the ease of

handling was highly regarded by the users. Moreover, it was noted in the interviews that accurate measurement is unaffected by environmental noise because vascular sound does not need to be checked. Finally, the device was characterized as simple to use. These may have been latent needs of users, and therefore linked to a positive evaluation.

This blood pressure monitor automatically records blood pressure without the need for a doctor or nurse to be present, and the recorded data can be displayed on the smartphone easily. This suggests that the system will be useful for the evaluation of treatment of users who find it difficult to remember things, such as individuals with memory impairment due to aging.

#### **4-2. Issues that came to light through this study, and points for improvement**

Improvement of the cuff by changing the position of the hook and loop fastener in order to reduce the width of the cuff would be desirable, as there are expected to be users with reduced arm strength.

The power button is multi-functional and therefore different from the ones elderly people usually use, which has a one-to-one relationship between the button and the function. The medical professionals in the

present study suggest that such users belong to the generation that is not accustomed to smartphones or smartphone applications. Thus, we believe that automatic pairing is needed between the application and the blood pressure monitor.

Furthermore, there is a need to enhance the functionality of the system and incorporate individuality to stimulate user interest in the device. However, as this would increase the complexity of the system, a new system with icons that facilitate intuitive operation is needed.

#### **Study limitations and future issues**

The subjects in the present study were limited to medical professionals. In the future it will be necessary to request the cooperation of healthy persons and others in order to verify improvements in usability as well as efficient and stable data collection.

#### **Acknowledgements**

The authors wish to express their sincere gratitude to all those who cooperated in the implementation of this study. This study was carried out with the support of the FY2016 Toho University Collaborative Research Support Grant as an Initiative for Realizing Diversity in the Research Environment (Collaboration Type).

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