

# Beneficial Effects of Two Types of Personal Health Record Services Connected With Electronic Medical Records Within the Hospital Setting

Jisan Lee, MSc, RN, James G. Boram Kim, MSc, Meiling Jin, MSc, RN, Kiwhan Ahn, PhD, Byungjun Kim, MD, Sukwha Kim, MD, PhD, Jeongeun Kim, PhD, RN, INS

Healthcare consumers must be able to make decisions based on accurate health information. To assist with this, we designed and developed an integrated system connected with electronic medical records in hospitals to ensure delivery of accurate health information. The system—called the Consumer-centered Open Personal Health Record platform—is composed of two services: a portal for users with any disease and a mobile application for users with cleft lip/palate. To assess the benefits of these services, we used a quasi-experimental, pretest-posttest design, assigning participants to the portal ( $n = 50$ ) and application ( $n = 52$ ) groups. Both groups showed significantly increased knowledge, both objective (actual knowledge of health information) and subjective (perceived knowledge of health information), after the intervention. Furthermore, while both groups showed higher information needs satisfaction after the intervention, the application group was significantly more satisfied. Knowledge changes were more affected by participant characteristics in the application group. Our results may be due to the application's provision of specific disease information and a personalized treatment plan based on the participant and other users' data. We recommend that services connected with electronic medical records target specific diseases to provide personalized health management to patients in a hospital setting.

**KEY WORDS:** Electronic health records; Health records, personal; Intervention study; Knowledge; Mobile applications

From birth to death, people use numerous types of health-care services. Currently, health-related interests and demands are at an all-time high because in part of the aging of a population with greater life expectancy. Although health consumers have considerable influence on their own health issues, many are not proactive in the health management process. One important method of enabling individuals to become more proactive healthcare users is the personal health record (PHR). The PHR affords numerous benefits to patients, caregivers, and institutions; however, the supporting evidence for the specific benefits and business cases of PHR adoption is limited. In addition, the modern medical environment has fragmented into numerous specialized fields because of the academic complexities of medicine, and as a result, PHRs are typically scattered among various medical specialties.<sup>1</sup> Consequently, when consumers visit a new medical facility, they must often complete unnecessary documents and undergo duplicate tests.<sup>2</sup> This can raise healthcare costs.<sup>3</sup> Exchange of health information via electronic medical record (EMR) systems is expected to help address these issues while simultaneously integrating PHRs. However, to date, information exchange has not met with great success because of the competitive nature of healthcare and an absence of actual compensation for participating.<sup>4</sup>

The disease-centered model of medicine of the past, according to which providers were merely concerned with disease treatment, is transforming into a health-centered model, wherein the focus is on increasing quality of life through health promotion and disease prevention. Furthermore, the beneficiaries of healthcare services are expanding to include potential “consumers” of healthcare services, along with patients with diseases.<sup>5</sup> These consumers have begun actively participating in the decision-making and problem-solving processes related to their own health, shifting away from being merely passive beneficiaries of healthcare services.<sup>6</sup> Indeed, in the United States, half of healthcare consumers want themselves or their families to have the final say in their treatment decisions, and 38% of consumers want to collaborate with a physician in such decisions.<sup>7</sup>

**Author Affiliations:** Interdisciplinary Program of Medical Informatics (Ms Lee, Mr Kim, and Dr J. Kim), College of Nursing (Jin and Dr J. Kim), and Research Institute of Nursing Science (Dr J. Kim), Seoul National University; KT Corporation, Seoul (Dr Ahn); Department of Plastic and Reconstructive Surgery, College of Medicine, Seoul National University; and Department of Plastic and Reconstructive Surgery, Seoul National University Hospital (Drs B. Kim and S. Kim), Korea.

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**Corresponding author:** Jeongeun Kim, PhD, RN, INS, 103 Daehak-ro, Jongno-gu, Seoul 03080, Korea (jeongeunkim0424@gmail.com).

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Consumers' active participation in healthcare decision making has been further enabled by their unprecedented access to knowledge about diseases, symptoms, diagnoses, and treatments, which is due in part to easy access to the Internet and the health information that it contains.<sup>8</sup> However, recent articles have indicated that medical information on the Internet or social media presents a high risk of malfeasance and misjudgment in the medical world.<sup>9</sup> With the shift toward consumer-centered healthcare, it is paramount that the information system also changes, ensuring that consumers can make decisions based on the most accurate health information available.<sup>10</sup> In addition, the development of more efficient tools is needed to allow them to easily and safely integrate, manage, and apply health information from various medical facilities.<sup>11</sup> To this end, in the current study, we designed and developed a set of PHR services in the form of efficient tools that can be used to provide accurate health information to healthcare consumers. Furthermore, we conducted a survey to confirm the effectiveness of these services in hospitals via comparison of users' knowledge, information needs satisfaction, and overall satisfaction before and after their use.

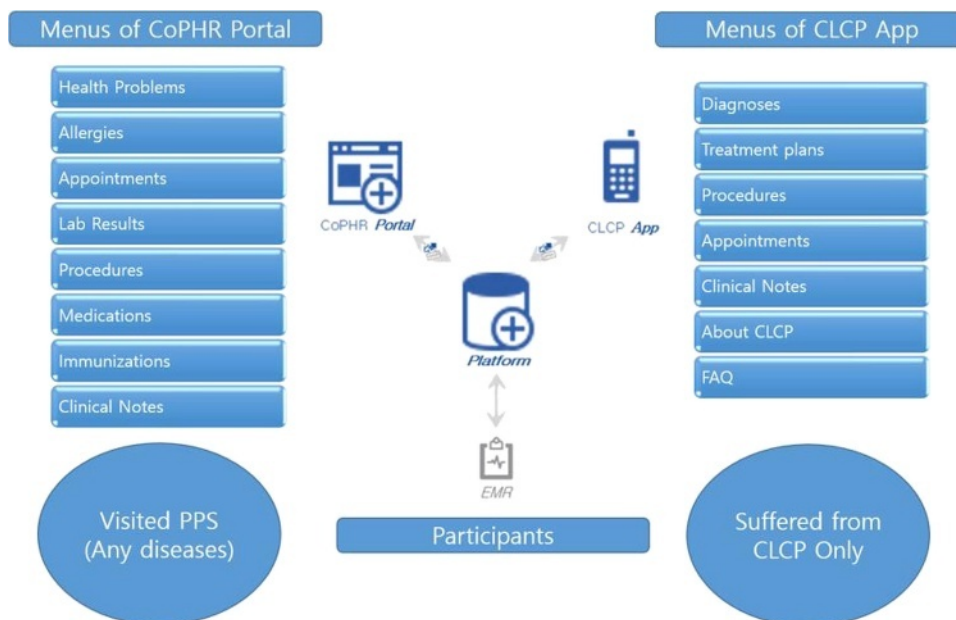
## MATERIALS AND METHODS

### Consumer-centered Open Personal Health Record Portal and Cleft Lip/Cleft Palate App

We designed and developed the Consumer-centered Open PHR (CoPHR) platform for storing and managing PHRs. The data included in the CoPHR platform were selected according to the recommendations of the American Medical

Informatics Association and researchers in related fields, as well as according to PHR-S Functional Model and the Continuity of Care Record standards. Considering the limited resources, data with low consumer demand and forms of data that are difficult to define (eg, videos) were excluded after a pilot user test. The platform can receive data inputs from the EMR systems of hospitals using Continuity of Care Document and Continuity of Care Record standards. In addition, it provides an app programming interface that gives external systems access to stored data, similar to the services described in the study. However, since the CoPHR platform does not have a user interface, we developed the CoPHR portal and cleft lip/cleft palate (CLCP) app as services to input, edit, search, and delete data managed by the platform (Figure 1).

The CoPHR portal was designed for users with any disease. Figure 2 provides an illustration of the first page of the portal. On this page, the user is given an overview of his/her health problems, medication information, vital signs, height, weight, and appointments with physicians. This information is visualized as text, graphs, or a calendar. Furthermore, the page lists eight menus: health problems (ie, diagnoses and signs and symptoms of these diagnoses), allergies (ie, information about allergies the user has), appointments (ie, outpatient, inpatient, and examination appointments), laboratory results (eg, blood and urine tests), procedures (ie, surgeries and procedure history), medications (ie, information about medications the user has taken), immunizations (ie, vaccination history), and clinical notes (ie, any other PHR information). The user can access the CoPHR



**FIGURE 1.** The relationship among platform, CoPHR portal, CLCP app, and EMR.

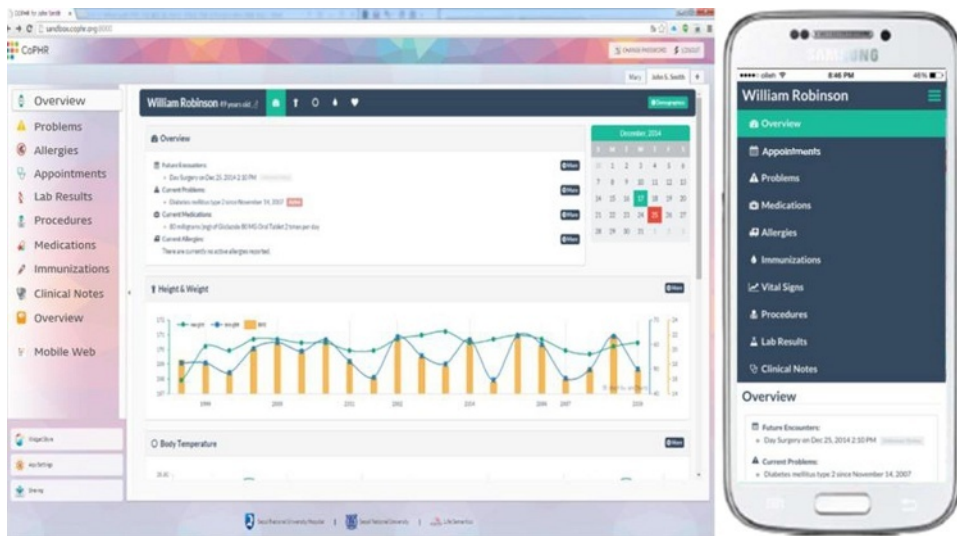


FIGURE 2. A screenshot of the CoPHR Portal (Web and mobile versions).

portal via desktop or mobile Web browsers, as well as through a mobile app. The portal data can be accessed through EMR systems because they are integrated into the CoPHR platform.

We also developed the CLCP app for Android (Google, Mountain View, CA) and iOS (Apple, Cupertino, CA) operating systems. As its name indicates, the CLCP app is explicitly for patients with CLCP and their guardians. Two CLCP specialists advised us in deciding on the app menus. When the prototype was developed, pilot usability tests were performed for five patients and 14 guardians. This helped us better understand users' information needs and identify several usability problems with the prototype. Then, the specialists, researchers, and app developers met to fix and upgrade the app according to the pilot results. This took approximately 2 months to complete. Figure 3 illustrates the first page and menu lists of the app. On the first page, the user is shown the patient's diagnosis, schedule, and treatment information and a frequently asked questions (FAQs) page. The app features seven menus as follows: diagnosis (ie, present diagnosis according to the EMR), treatment plan (ie, the patient's current and planned treatment schedule), procedures (ie, the surgery and procedure history), appointments (ie, outpatient, inpatient, and examination appointments), clinical notes, "about CLCP" (ie, information related to CLCP), and an FAQ (ie, a list of questions and their answers that CLCP specialists are frequently asked). The treatment plan items dealt with future treatment and were constructed by referring to the CLCP guidelines and data of similarly aged patients given a diagnosis of the same disease. The service was developed as a mobile app, and the app data can be accessed through EMRs and the CoPHR portal because they are integrated and managed by the CoPHR platform.

**Study Design**

After developing the CoPHR platform, CoPHR portal, and CLCP app, we linked these with the EMR of the hospital. We then tested the effectiveness of the portal and app using a quasi-experimental, pretest-posttest design. There were two groups: the CoPHR portal group and the CLCP app group.

**Participants**

We recruited patients and their guardians who visited the pediatric plastic and reconstructive surgery (PPS) department of a hospital in Seoul and who used a smartphone. A power analysis using G\*Power version 3.1.5 (Heinrich Heine Universitat, Dusseldorf, Germany) indicated that a sample size of 42 for each group would be sufficient (power, 0.8;



FIGURE 3. A screenshot of the CLCP app (mobile version).

significance level [ $\alpha$ ], .05; effect size [ $d$ ], 0.8). With consideration of dropout rate, we recruited 50 and 52 participants for the CoPHR portal and CLCP app groups, respectively. Of all the participants recruited, we allocated only patients with CLCP and their guardians to the CLCP app group; after fully recruiting the CLCP app group, we assigned the remaining participants to the CoPHR portal group. This resulted in two subgroups in the CoPHR portal group: one of patients with CLCP and their guardians and one of patients and guardians who had other diseases. Patients' ages varied considerably because care for CLCP begins from birth and often continues until adulthood. We enrolled guardians as participants for patients who were too young to participate. In the CoPHR portal group, 33 of the 50 participants were women, 38 were guardians, and 40 were Android users; they had a mean age of 35.5 years. In contrast, the CLCP app group had 37 women, 34 guardians, and 44 Android users and a mean age of 31.5 years. Both groups were composed of various occupations, including students, office workers, professionals, self-employed, unemployed, and others. The CoPHR portal group was composed of patients with any type of condition and their guardians who visited the PPS. In contrast, participants in the CLCP app group were composed of only patients with CLCP and their guardians.

### Procedure

Initially, we explained the purpose of the study to all participants, after which they were asked to provide their written informed consent. Consenting participants then completed a pretest questionnaire comprising objective knowledge, subjective knowledge, and information needs. Thereafter, the CoPHR portal group received an explanation about the Web and app versions of the CoPHR portal, while the CLCP app group received an explanation of the CLCP app. After receiving this explanation, the participants used the service for approximately 30 minutes. Finally, participants completed a posttest questionnaire comprising an assessment of objective and subjective knowledge, which specific information needs were satisfied by the service, and their overall satisfaction with the service. Both surveys were conducted by the researchers and undergraduate nursing students from Seoul National University, who were trained by the researchers in using the CoPHR portal and CLCP app and were given a thorough understanding of the study purpose. We conducted the survey in a separate room inside the hospital. The whole procedure took approximately 60 minutes per participant.

### Measures

Four experts, including professors and doctoral students majoring in nursing informatics or medical informatics,

checked the validity of all items in the questionnaires. When necessary, they partially revised and supplemented the items.

### Objective Knowledge

In the current study, objective knowledge refers to actual knowledge of health information. It was assessed using questions on the patient information contained in the portal and app because we wanted to understand how accurate participants' understanding of their own health information was. Five open-ended questions were directed at participants in the CoPHR portal group, which dealt with their understanding of its menus, including health problems, procedures, laboratory results, appointments, and medications. For example, the question about the procedures was as follows: "Please write down which medications you/your patient have taken recently (including the medication name, dose, and number taken)." Five questions were also directed at the CLCP app group and dealt with the menus, including diagnoses, treatment plans, procedures, appointments, and "about CLCP." For example, the question asking about CLCP was as follows: "Please write down the differences between cleft lip and cleft palate." Total objective knowledge was calculated by counting the number of correctly answered questions, and this was compared between pretest and posttest measurements.

### Subjective Knowledge

Subjective knowledge refers to perceived knowledge of health information in this study. It was composed of three questions assessing participants' subjective feelings regarding how much they perceived themselves to know about patient health information. The questions were obtained from a study on customers' health behavior intention and rated on a 5-point Likert scale ranging from 1 (disagree) to 5 (agree).<sup>12</sup> The three questions were as follows: "I think I more or less know about the patient health information," "I think that I know about the patient health information more than does any other person," and "I think I know about the patient's health information more than specialists do." The Cronbach's  $\alpha$  (internal consistency) of the instrument was .85 in the previous study<sup>12</sup> and .84 in this study.

### Information Needs

Participants initially wrote down their information needs using either a word or a sentence regarding patient health on the prequestionnaire. On the postquestionnaire, they answered whether their needs had been satisfied by the corresponding service using a 3-point scale, with answer options of "not satisfied" (0 point), "partially satisfied" (1 point), and "completely satisfied" (2 points).

**Overall Satisfaction**

To measure participants' overall satisfaction after using the service, we used two items created by the researchers from IBM Corp (IBM, Armonk, NY) and the ISO/IEC FCD 25010 (International Standards Organization and International Electrotechnical Commission, Geneva, Switzerland) to evaluate satisfaction with their products<sup>13</sup> and one item from the System Usability Scale.<sup>14</sup> All three items are rated on a 5-point Likert scale ranging from 1 (disagree) to 5 (agree). The three items were as follows: "Overall, I am satisfied with the ease of using this service"; "Overall, I think that this service is effective"; and "I think that I would like to use this service frequently." The Cronbach's  $\alpha$  of the instrument was .80 in the current study.

**Ethical Considerations**

This study was preapproved by the institutional review board of the study hospital before we solicited the written informed consent of participants and performed the data collection (H-1407-095-596). We collected only a minimal amount of personal information for this study, stored the collected data safely in a separate area, and intend to destroy the data after the completion of the study.

**RESULTS**

**Changes in Objective and Subjective Knowledge Between Preintervention and Postintervention**

In the CoPHR portal group, we observed a significant increase in all item scores for objective and subjective knowledge from preintervention to postintervention. For

the CLCP app group, increases in scores were obtained for all items, except those related to appointments (Table 1).

**Effects of Participants' Characteristics on Changes in Objective and Subjective Knowledge**

In the CoPHR group, the results indicated that changes among men (mean, 0.44) in medication-related knowledge were significantly lower than those among women (mean, 0.73). The patients' mean change in knowledge about health problems (mean, 0.92) was significantly higher than that of guardians (mean, 0.61). Occupation similarly influenced changes in knowledge related to health problems, with the biggest differences being seen between office workers (mean, 0.44) and students (mean, 0.95).

In the CLCP app group, we noted a significant correlation between change in knowledge scores and age, with greater changes being found among younger individuals for the objective knowledge scores of diagnosis, procedures, appointments, and about CLCP, as well as for subjective knowledge scores. Moreover, the results revealed that the patients showed greater changes in knowledge about diagnosis (mean, 0.72), procedures (mean, 0.85), appointments (mean, 0.44), and about CLCP (mean, 1.72) than did guardians (means, 0.34, 0.42, 0.00, and 0.79, respectively). The changes among men regarding knowledge of the procedure (mean, 0.78) were higher than those among women (mean, 0.48). For occupation, the largest differences in changes in knowledge about procedures were between office workers (mean, 0.28) and students (mean, 0.81; Table 2).

**Table 1. Changes in Objective and Subjective Knowledge Between Preintervention and Postintervention**

	Preintervention	Postintervention	t	P
	Mean (SD)	Mean (SD)		
<b>Changes in the scores of the CoPHR portal group (n = 50)</b>				
<b>Objective knowledge</b>				
Health problems	0.185 (0.30)	0.870 (0.32)	-11.730	<.001 <sup>a</sup>
Procedures	0.267 (0.27)	0.670 (0.41)	-8.380	<.001 <sup>a</sup>
Laboratory results	0.153 (0.22)	0.770 (0.42)	-11.274	<.001 <sup>a</sup>
Appointments	0.561 (0.35)	0.814 (0.27)	-5.057	<.001 <sup>a</sup>
Medications	0.000 (0.00)	0.630 (0.48)	-9.234	<.001 <sup>a</sup>
<b>Subjective knowledge</b>	10.780 (2.17)	11.420 (2.42)	-2.973	.005 <sup>a</sup>
<b>Changes in the scores of the CLCP app group (n = 52)</b>				
<b>Objective knowledge</b>				
Diagnosis	0.375 (0.28)	0.846 (0.27)	-8.740	<.001 <sup>a</sup>
Treatment plan	0.053 (0.17)	0.611 (0.42)	-9.732	<.001 <sup>a</sup>
Procedures	0.247 (0.38)	0.817 (0.36)	-8.866	<.001 <sup>a</sup>
Appointments	0.690 (0.51)	0.827 (0.38)	-1.413	.164
About CLCP	1.808 (1.30)	2.923 (0.33)	-6.011	<.001 <sup>a</sup>
<b>Subjective knowledge</b>	10.019 (2.62)	11.480 (2.32)	-4.225	<.001 <sup>a</sup>

<sup>a</sup>P < .01.

### Comparison of Needs Satisfaction and Knowledge Between the Portal and App Groups

We found that satisfaction with information needs was significantly higher among those in the CLCP app group than among those in the CoPHR portal group. Changes in subjective knowledge and overall satisfaction were also higher in the CLCP app group, albeit not significant (Table 3).

We then divided the CoPHR portal group into subgroups—participants with CLCP and those with other diseases (or their guardians)—to confirm the benefits of the CoPHR portal for different types of diseases. The results indicated that there were differences in subjective knowledge between the subgroups (Table 4).

Finally, we analyzed data about information needs in more detail. Before the intervention, 29 participants in the CoPHR portal group (58%) and 12 participants in the CLCP app group (30.8%) answered that “I don't have any information needs.” In other words, only 21 participants in the CoPHR portal group (42%) and 40 participants in the

**Table 3.** Comparison of Changes in Subjective Knowledge, Information Needs Satisfaction, and Overall Satisfaction Between the CoPHR Portal and CLCP App Groups

N = 102	CoPHR Portal Group (n = 50)	CLCP App Group (n = 52)	t	P
	Mean (SD)	Mean (SD)		
Subjective knowledge	0.64 (1.52)	1.29 (2.20)	-1.737	.086
Information needs satisfied	1.14 (1.00)	1.54 (0.78)	-2.284	.025 <sup>a</sup>
Overall satisfaction	12.82 (2.30)	13.42 (1.83)	-1.468	.145

<sup>a</sup>P < .05.

CLCP app group (69.2%) reported having information needs. The participants' information needs were categorized as follows: about surgeries (n = 13), about treatment plan

**Table 2.** Effects of Participants' Characteristics on Changes in Objective and Subjective Knowledge

		CoPHR Portal Group (n = 50)					
		Changes in Scores of Objective Knowledge					Changes in Subjective Knowledge
		Health Problems	Procedures	Laboratory Results	Appointments	Medications	
Age, y	r	-0.078	0.067	0.029	0.164	0.026	-0.053
	P	.588	.645	.844	.255	.856	.716
Sex	t	0.614	-0.448	-0.542	1.453	-2.050	-0.365
	P	.542	.656	.591	.153	.046 <sup>a</sup>	.716
Participant status	t	3.367	0.719	0.618	-0.959	-0.381	1.161
	P	.002 <sup>b</sup>	.476	.539	.350	.705	.251
Occupation	F	2.887	1.179	0.022	0.419	0.188	1.988
	P	.025 <sup>a</sup>	.335	1.000	.833	.996	.099
Type of smartphone used	F	0.751	0.135	1.580	0.795	0.137	1.050
	P	.447	.874	.217	.458	.872	.358
		CLCP App Group (n = 52)					
		Changes in Scores of Objective Knowledge					Changes in Subjective Knowledge
		Diagnosis	Treatment Plan	Procedures	Appointments	About CLCP	
Age, y	r	-0.481	0.090	-0.380	-0.493	-0.362	-0.362
	P	<.001 <sup>b</sup>	.527	.006 <sup>b</sup>	<.001 <sup>b</sup>	.008 <sup>b</sup>	.008 <sup>b</sup>
Sex	t	-0.052	1.183	2.186	1.300	1.524	-0.598
	P	.958	.242	.034 <sup>a</sup>	.200	.142	.552
Participant status	t	3.812	-1.638	3.944	2.326	2.308	1.588
	P	<.001 <sup>b</sup>	.113	<.001 <sup>b</sup>	.027 <sup>a</sup>	.029 <sup>a</sup>	.119
Occupation	F	1.803	0.729	3.004	1.306	1.070	0.885
	P	.131	.606	.020 <sup>a</sup>	.278	.389	.499
Type of smartphone used	F	0.527	0.871	1.833	1.591	1.028	2.599
	P	.593	.425	.171	.214	.365	.085

<sup>a</sup>P < .05.

<sup>b</sup>P < .01.

**Table 4.** Comparison of Changes in Subjective Knowledge, Information Needs Satisfaction, and Overall Satisfaction Between the Two Subgroups of the CoPHR Portal Group

N = 50	Cleft Lip and Palate Subgroup (n = 36)	Other Disease Subgroup (n = 14)	t	P
	Mean (SD)	Mean (SD)		
Subjective knowledge	0.31 (1.33)	1.50 (1.70)	-2.366	.028 <sup>a</sup>
Information needs satisfied	1.19 (0.95)	1.00 (1.04)	-1.329	.193
Overall satisfaction	12.58 (2.44)	13.43 (1.83)	0.609	.549

<sup>a</sup>P < .05.

(n = 26), about dental services and language training (n = 8), about medication (n = 1), about disease (n = 4), and other (n = 8). However, after the intervention, 30 participants in the CoPHR portal group (60%) and 43 participants in the CLCP app group (82.7%) answered that their information needs had been satisfied.

**DISCUSSION**

**About Our Services**

Effective information systems aimed at supporting consumer-centered healthcare must meet several criteria: they must (1) provide accurate and appropriate health information that consumers can understand, (2) assist in communicating with other consumers or providers, (3) provide tools that can assist self-monitoring and decision making, and (4) guarantee access to the patient's own health information whenever and wherever possible.<sup>15</sup> The services developed herein satisfy these criteria: namely, they (1) provide health information in a language that participants can understand, (2) were developed as an open platform to enable communications with other services, (3) provided input and editing functions to help patients/guardians in managing appointments or medication records, and (4) were developed to work in multiple formats (Web browsers or an app) to allow access whenever and wherever needed. In conclusion, both CoPHR portal and CLCP app satisfy the conditions of information system services supporting consumer-centered healthcare.

**Changes in Objective and Subjective Knowledge Between Preintervention and Postintervention**

We found that participants' objective and subjective knowledge increased significantly after using the CoPHR portal or CLCP app. This shows that these tools may help in reducing the information asymmetry between consumers and medical professionals,<sup>16</sup> along with enabling active involvement in

consumers' own healthcare management. Such active involvement in healthcare is exceedingly important because people are the best agents for managing their own health directly and continuously.<sup>17</sup>

**Effects of Participants' Characteristics on Changes in Objective and Subjective Knowledge**

We observed differences between the groups in terms of what characteristics influenced changes in objective and subjective knowledge. Whereas only three characteristics significantly affected changes in the CoPHR portal group, 11 did so in the CLCP app group. We can infer from these results that disease-specific services are more influenced by participants' characteristics than are general health targeted services. This implies that services aimed at specific diseases must be designed more carefully. Among the particular characteristics, knowledge increases were influenced by occupation type and whether the participant was a patient or a guardian. In particular, one of the biggest gaps was found between office workers and students. These findings suggest that researchers or developers aim to create knowledge-based services to consider target users' occupation and status (ie, whether the participant is a patient or a guardian).

**Comparison of Needs Satisfaction and Knowledge Between the Portal and App Groups**

The increase in subjective knowledge in the CLCP group (mean, 1.29) was more than twice that of the CoPHR portal group (mean, 0.64). We observed another interesting finding for subjective knowledge: that is, the subjective knowledge of individuals in the CLCP subgroup of the CoPHR portal group (mean, 0.31) showed a smaller increase compared with participants in the CLCP app group (mean, 1.29). This is perhaps because participants with CLCP desire information specific to that condition rather than general health information. This accords with previous research, which indicated that PHRs must contain information that consumers consider important,<sup>18</sup> as well as the type of diseases or problems that consumers experience.<sup>1</sup> The result indicated that patients and guardians in hospitals require services targeting their specific disease—rather than their general health—to improve their subjective sense of health knowledge.

Regarding information needs satisfaction, the scores significantly differed between the two groups. The lower satisfaction rate in the CoPHR portal is perhaps because it mainly supplied historical information such as health problems and procedures. However, the CLCP app displayed both historical information and prospective information about the treatment plan. It was designed to present treatment plans based on similarly aged patients' data given a diagnosis of the same disease. In actual clinical

settings, patients and guardians are often excluded from deciding on treatment plans. However, the treatment plan item in the CLCP app may help participants communicate with physicians and nurses about potential care plans.

Another interesting finding is that 61 individuals reported having information needs in the prequestionnaire, whereas 73 reported that their information needs had been partially or completely satisfied by the service in the postquestionnaire. As such, our services may have satisfied needs for information that users did not even recognize having.

## CONCLUSIONS

The main strength of this study is that we evaluated the effectiveness of a PHR system with two integrated services that we designed and developed and that is linked to the EMR systems within a hospital setting. The services provided accurate patient health information to help patients and guardians make decisions more efficiently. Furthermore, the knowledge of the participants showed improvements after using the services.

The CLCP app contains information about what the participant experienced and provides EMR/PHR-based personalized treatment plans. This last function—namely, creation of EMR-based treatment plans for patients and guardians in hospitals—is what distinguishes our services from others. We believe that this is a key factor in what led to the greater fulfillment of the information needs and satisfaction of the CLCP app users compared with the CoPHR portal users.

However, there are also two limitations to this study. First, we proposed a system that is only applicable to patients (and their guardians) being treated at the Department of PPS in a hospital. Second, the effectiveness study was conducted only once. In future studies, the long-term impact of the proposed system should be investigated for both PPS patients and patients in other facilities. Furthermore, we recommend designing a service connected with EMRs that provides personalized health management for patients who have more than two diseases in a hospital setting.

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