Shiraz E-Med J. 2022 August; 23(8):e121368. doi: 10.5812/semj-121368.

Published online 2022 June 22. **Research Article**

Mobile Health Could Be a Solution in Overcoming Challenges of Care in Patients Who Need Peritoneal Dialysis

Rita Rezaee [1, 2], Hamidreza Moazzen [3], Shahrokh Ezzatzadegan [4] and Milad Ahmadi Marzaleh [5, *]

[1] Clinical Education Research Center, Shiraz University of Medical Sciences, Shiraz, Iran
[2] Health Human Resources Research Center, School of Health Management and Medical Information Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
[3] Medical Informatics, Student Research Committee, School of Health Management and Medical Information Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
[4] Department of Nephrology, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran
[5] Department of Health in Disasters and Emergencies, Health Human Resources Research Center, Shiraz University of Medical Sciences, Shiraz, Iran

[*] *Corresponding author*: Department of Health in Disasters and Emergencies, School of Health Management and Medical Information Sciences, Shiraz University of Medical Sciences, Shiraz, Iran. Tel: +98-7132340774, Fax: +98-7132340039, Email: miladahmadimarzaleh@yahoo.com

Received 2021 November 27; **Revised** 2022 April 10; **Accepted** 2022 April 20.

Abstract

Background: For patients with end-stage renal disease (ESRD) who undergo peritoneal dialysis (PD) at home or in non-clinical centers, it is crucial to design and implement a hands-on self-care clinical decision aid system (CDAS). To this end, this descriptive work was done to determine the challenges in designing and implementing a mobile health (mHealth)-based self-care CDAS for patients undergoing PD in Iran in 2021.

Methods: This qualitative study was conducted using in-depth semi-structured interviews with 20 key informants chosen by purposeful and snowball sampling. The data were analyzed through thematic analysis to extract the challenges in designing and implementing a mHealth-based self-care CDAS.

Results: The challenges in designing and implementing a mHealth-based self-care CDAS for patients undergoing PD in Iran were divided into six major categories, including problems with insufficient training, patients' visits to clinical centers, prompt access to data and information, data registration/documentation, distribution of PD specialists, and data analysis within the current system.

Conclusions: The self-care CDAS for PD can be useful in many complicated decisions as well as when there is limited access to PD specialists. This system is efficient considering the widespread use of mobile phones, unfair geographical distribution of patients and PD specialists, and huge costs arising from visiting healthcare centers.

Keywords: mHealth, Peritoneal Dialysis, Clinical Decision Aid System, Self-care, Patients

1. Background

Chronic kidney disease (CKD) is a general term used to describe heterogeneous disorders affecting the kidney and its function. CKD is a global health condition that is associated with elevated rates of morbidity and mortality. This condition is widely spread worldwide (1, 2). In PD, patients do not need to visit the hospital and can easily access the therapy. Given the exponential increase in the prevalence of end-stage renal disease (ESRD) and the lack of donated kidneys, patients need one of the two dialysis programs (3). In Iran, PD was first performed in Imam Reza Hospital in Mashhad in 1997, and then, 40 centers for PD were launched all over the country. Among the patients who undergo dialysis, 93.5% are treated with hemodialysis, and 6.5% use PD (4). According to Mahdavi-Mazdeh et al., more than half of the patients who undergo hemodialysis are not informed about PD, which is more affordable (5). Considering the quality of life, studies have shown that PD and hemodialysis can similarly affect the quality of life, or PD can be more effective than hemodialysis and vice versa. Although the number of patients undergoing hemodialysis is more than those using PD, statistics have indicated that a larger number of patients tend to undergo PD rather than hemodialysis (6). Thus, attention to this group of patients can bring them much therapeutic and healthcare benefits and improve their quality of life.

Today, the use of practical Mobile Health (mHealth) applications is rapidly increasing worldwide (7). Novel technologies in medicine, such as mHealth, have helped improve the quality of life. Also, mHealth has been used for improving the quality of education, therapy diagnosis, supporting healthcare services, health data collection, remote medical services, and other healthcare settings (8). Decision aid system (DAS) is among the designed and implemented mHealth applications. Self-care DASs provide

appropriate data and information to patients for improving their clinical performance and their disease implications. These systems are equipped with many tools for many applications, including alarms, reminders, clinical guidelines, reports, training, set of instructions, drug interactions, patient data dashboards, and diagnostic supports. Given many patients' lack of access to specialists for receiving urgent necessary instructions for taking self-care measures, the need for a system to help decision-making under various conditions is strongly perceived (9). The above topics are also valid for patients undergoing PD (10-12).

Outpatient PD is a therapy for patients with chronic renal failure in many countries. In Iran, this technique has been recently taken into consideration. The present study aimed to assess the efficacy of persistent PD therapy in patients using this technology in Iran as well as to investigate the side effects of surgery and non-invasive techniques on patients and ways to prevent them. The results indicated that the development of CDASs could help diminish many problems encountered by these patients.

Considering the abovementioned issues and the fact that patients often undergo PD at home and/or in non-clinical centers, it is crucial to design and implement a self-care CDAS for these patients.

2. Objectives

The present descriptive work was conducted in 2021 to study the challenges in designing and implementing a mHealth-based self-care CDAS for patients undergoing PD in Iran.

3. Methods

In this qualitative-descriptive work conducted in 2021, the data were gathered through interviewing key informants and patients with ESRD who underwent PD as a kidney replacement method. The data were analyzed through thematic analysis to extract the challenges in designing and implementing a mHealth-based self-care CDAS for patients undergoing PD.

3.1. Participants

In-depth and semi-structured interviews were conducted with kidney specialists, information technology (IT) experts, and patients undergoing PD. The participants who were rich in information were recognized and chosen through purposeful and snowball sampling. Then, they were informed about the study objectives, and their written informed consent forms were obtained. The study's inclusion criteria were having at least a BSc degree, having work experience in taking care of patients requiring PD, and showing a willingness to cooperate. The participants were named #1, #2, and so on, and no names were included in the demographic forms. The qualitative data were analyzed through thematic analysis.

3.2. Data Collection

In-depth and semi-structured interviews were conducted with key informants. In these interviews, the specialists and key informants were asked to discuss the challenges in designing and implementing a mHealth-based self-care CDAS for PD patients. The main question of the semi-structured interviews was about "the challenges in designing and implementing a mHealth-based self-care CDAS for patients undergoing PD," which was followed by such probing questions as "how," "why," and "explain more." The questions were altered according to the analysis of the initial interviews. Other aspects of the interviewees' opinions were also covered during the interviews, and other probing questions were asked. Totally, 20 interviews were done by the researcher with 20 specialists. The interviews were ended following data saturation. Each interview lasted for 30 to 90 minutes. To avoid any potential mistakes in recording the voices, the interviews were recorded with two separate tape recorders and were transcribed immediately.

3.3. Data Analysis

The data were concurrently gathered and analyzed. All the interviews were immediately transcribed word-by-word. The researchers had taken notes during the interviews, as well. The data were analyzed through thematic analysis, which consisted of six steps, including (1) mastery of data; (2) formulating initial codes; (3) searching for categories; (4) revising the categories and sub-categories; (5) defining and naming the categories and sub-categories; and (6) reporting (13). If required, the interviews were submitted to the participants to alter and/or reform any mistakes and add any required points. Then, the texts of the interviews were analyzed, codes and categories were classified, and sub-categories were extracted. A total of 170 codes were ultimately extracted following the analysis of the interviews, which were divided into six categories and 12 subcategories.

3.4. Rigor

Guba and Lincoln's (14) criteria were utilized to ensure the validity and accuracy of the qualitative data, which included trustworthiness, transformability, dependability, and confirmability. In doing so, the interviews were analyzed several times. In addition, the texts of the interviews

were delivered to the participants for any required correction or completion. Various approaches were also used for coding. Finally, the interviews were analyzed by an expert in qualitative studies.

3.5. Ethical Considerations

Permissions and letters of recommendation were received from the Director of the Research Deputy of the School of Management and Medical Information Sciences, Shiraz University of Medical Sciences (SUMS). Confirmations were also received from the security office of the university.

The researchers presented themselves to the participants, explained the study objectives, assured them about the confidentiality of their data, and selected those who were willing to cooperate. Other ethical considerations included (1) receiving signed consent forms from the specialists and patients; (2) ensuring the participants about receiving the results; if required, (3) respecting ethical considerations for the confidentiality of the data; (4) acknowledging all the individuals contributing to the research; and (5) obtaining permissions from the Ethics Committee of the university (Ethical Code: IR.SUMS.REC.1395.S46).

4. Results

Among the participants (specialist, technician, and patient), seven cases were male. The mean age of the participants was 33.58 years. Additionally, the kidney specialists had 7.31 years of work experience. The demographic and carrier information of the participants has been presented in Table 1.

Table 1. Demographic and Carrier Information of the Participants

Variables	No. (%)
Gender	
Male	7 (35)
Female	13 (65)
Marital status	
Single	6 (30)
Married	14 (70)
Education level	
BSc	8 (40)
PhD	4 (20)
Specialist	8 (40)
Field of study	
Health information management specialist	6 (30)
Kidney specialist	6 (30)
Nurse	2 (10)
Others (patients)	6 (30)

The challenges in designing and implementing a mHealth-based self-care CDAS for patients undergoing PD in Iran were classified into six major categories, including problems with insufficient training, patients' visits to clinical centers, prompt access to data and information, data registration/documentation, distribution of PD specialists, and data analysis within the current system. The sub-categories are presented in Table 2.

A summary of the points described by the specialists is presented below:

A 41-year-old male specialist of renal disorders stated: "Not visiting clinical centers is one of the leading problems of therapy teams, which occurs due to huge costs, traffic, difficulty with commuting, and distance. In some cases, patients visit clinical centers under urgent and chronic conditions that hinder ambulatory treatment."

A 41-year-old female Health Information Management (HIM) expert declared: "Given that kidney failure is a chronic condition and the patient's status should be monitored at various times, the current system does not allow examining the conditions of individual patients because all the items related to the patients are not recorded continuously."

A 41-year-old female renal disorder specialist asserted: "One of the main limitations of treating CKD is the geographical distribution of specialists. Specialists often work at certain clinical centers, and patients at other centers are deprived of their knowledge and experience. This is another problem of the current system."

A 52-year-old patient mentioned: "Since data are registered by patients and/or their families, the accuracy of the recorded data is uncertain due to insufficient training."

A 44-year-old female nurse maintained: "Lack of instant access to physicians and medical staff for asking questions had caused some problems in self-care settings."

5. Discussion

Given that mobile system, such as smartphones, tablets, and personal digital assistants (PDAs), are an integral part of human lives, they can be utilized to effectively proceed with self-care programs. Global smartphone users exceeded one billion in 2012 (15). With the advent of the internet and mobile systems and their extension in various fields, such as health sectors, many users tend to use applications based on intelligent digital systems. Today, mobile technologies have been extensively developed so that they have enabled using healthcare services for chronic diseases beyond hospitals (16). In this context,

Table 2. The Categories and Sub-categories of the Results Obtained from Interviewing the Participants to Extract the Challenges Which Necessitate Designing and Implementing A mhealth-Based Self-care CDAS for Patients Undergoing PD in Iran

Category	Sub-category
Problems with insufficient training	Insufficient training due to the paucity of time and human forces
	Patients' unawareness of the critical points of their diseases
	Mistakes in measuring the volume of output liquids to be registered in daily records
Problems with patients visiting the clinical centers	Not visiting clinical centers due to huge costs, traffic, difficulty with commuting, and distance
	Excessively visiting clinical centers due to obsession
Problems with prompt access to data and information	The current system's failure to respond to questions about the disease
	No prompt access to physicians and medical staff
Problems with data registration	Errors in recording data in terms of accuracy
	The lack of form(s) for the on-time recording of emergencies
Problems with the distribution of PD specialists	Geographical distribution of specialists
Problems with data analysis within the current system	Failure to monitor the patients' statuses individually and continuously
	Failure to monitor patients in the current analysis system

applications based on mobile digital devices have been designed and implemented as a new area of electronic health (e-health), which is known as m-health. The m-health is well-known among healthcare users and providers (8). The use of patient-oriented applications that provide clinical services and guidelines through telecommunication can decrease problems with access to specialists and consultants during emergencies through software and applications. The use of m-Health technologies is a way to overcome such barriers.

In the present patient-directed study, the use of special DASs helped patients undergoing PD in their attempts for self-care and self-management. Stevens reported that the implementation strategy was based on both the person and the location, but this issue was not taken into consideration in the present investigation (17).

Griva et al. conducted a study titled "Perspectives of Patients, Families, and Health Care Professionals on Decision-Making about Dialysis Modality-the Good, the Bad, and the Misunderstandings!" to determine the factors influencing decision-making about dialysis modality by integrating the perspectives of patients, their families, and healthcare professionals within an Asian population. That study was conducted on 59 participants, including pre-dialysis patients, dialysis patients, caregivers, and healthcare professionals, using semi-structured interviews to explore the decision-making process as well as their views about various dialysis modalities. The data were thematically analyzed using NVivo9 software (QSR International, Doncaster, Australia) to assess the barriers and facilitators of various dialysis modalities and decisional support demands. The results indicated the necessity to expand the focus of pre-dialysis training to the family as the unit of care and provide interaction opportunities with dialysis patients and peer-led learning (18).

Becker et al. evaluated the feasibility of an m-Health application designed for using medications by patients suffering from CKD. That cohort study was conducted on 20 CKD patients who were at the pre-dialysis stage with the estimated glomerular filtration rate (eGFR) < 60 mL/min/1.73 m^2. The patients were divided into two groups and were trained before using m-Health tools. The first group received SMS services, while the second group was provided with an application used in personal digital devices and smartphones. In the second group, the patients sent their questions to the central server and received such answers as "it is safe," "it is not safe for CKD," "use carefully," "talk with your healthcare provider," and "error" for wrong inputs. The patients were required to register both questions and responses in the system. The results showed satisfaction among the patients in both groups, but the rate of satisfaction was slightly higher in the second group than in the first group (19).

Another limitation in the treatment of CKD patients is the number of specialists and their geographical distribution. These specialists normally work at certain centers, and even countries and other centers are deprived of their knowledge and experience (20). Given the rise in the number of patients and limited access to specialists, taking care of patients with such chronic conditions as CKD and diminishing costs are among the major global concerns (21, 22). Furthermore, training patients and self-care

activities have been recommended following state policies and health programs for effective medical interventions (10, 12).

As a limitation, the researchers failed to interview all specialists, but they attempted to effectively interact with specialists to extract the maximum useful data from the interviews.

Future studies are recommended to evaluate self-care systems in a patient-directed manner, (1) design an application for other smartphone operating systems, especially IOS, using Xamarin programming language that enables altering the platform for running the system applications; and (2) add the foremost qualitative clinical factors of PD, including edema and appetite to the system in order to enable more accurate recommendations by defining qualitative measurements.

5.1. Conclusions

The self-care CDAS for PD can be helpful in various complicated decisions as well as when there is limited access to PD specialists. This system can be effective considering the widespread use of mobile phones, unfair geographical distribution of patients and PD specialists, and huge costs arising from visiting healthcare centers. M-health apps should be designed and tested that they can be helpful or not in reducing the problems. However, extensive studies are needed to confirm these hypotheses.

Footnotes

Authors' Contribution: RR and OP were responsible for the study conception and design. RR and MAM supervised the whole thesis. All authors prepared the first draft of the manuscript. All authors did the results analysis and supervised the study. All authors have read and approved the final manuscript.

Conflict of Interests: The authors declare that they have no competing interests.

Data Reproducibility: The data presented in this study are openly available in one of the repositories or will be available on request from the corresponding author by this journal representative at any time during submission or after publication. Otherwise, all consequences of possible withdrawal or future retraction will be with the corresponding author.

Ethical Approval: The Ethics Committee of Shiraz University of Medical Sciences approved this study (approval ID: IR.SUMS.REC.1395.S46).

Funding/Support: This study was derived from a master thesis in Medical Informatics approved by the Shiraz University of Medical Sciences (code: 789981). This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

References

1. Hosseinpanah F, Kasraei F, Nassiri AA, Azizi F. High prevalence of chronic kidney disease in Iran: a large population-based study. *BMC Public Health*. 2009;**9**:44. doi: 10.1186/1471-2458-9-44. [PubMed: 19183493]. [PubMed Central: PMC2658666].
2. Kovarik JJ, Morisawa N, Wild J, Marton A, Takase-Minegishi K, Minegishi S, et al. Adaptive physiological water conservation explains hypertension and muscle catabolism in experimental chronic renal failure. *Acta Physiol (Oxf)*. 2021;**232**(1). e13629. doi: 10.1111/apha.13629. [PubMed: 33590667]. [PubMed Central: PMC8244025].
3. Beladi Mousavi SS, Hayati F, Valavi E, Rekabi F, Mousavi MB. Comparison of survival in patients with end-stage renal disease receiving hemodialysis versus peritoneal dialysis. *Saudi J Kidney Dis Transpl*. 2015;**26**(2):392–7. doi: 10.4103/1319-2442.152559. [PubMed: 25758900].
4. Aghighi M, Heidary Rouchi A, Zamyadi M, Mahdavi-Mazdeh M, Rajolani H, Ahrabi S, et al. Dialysis in Iran. *Iran J Kidney Dis*. 2008;**2**(1):11–5. [PubMed: 19367003].
5. Mahdavi-Mazdeh M, Zamyadi M, Nafar M. Assessment of management and treatment responses in haemodialysis patients from Tehran province, Iran. *Nephrol Dial Transplant*. 2008;**23**(1):288–93. doi: 10.1093/ndt/gfm580. [PubMed: 17965435].
6. Moradpour A, Hadian M, Tavakkoli M. Challenges and future recommendation for kidney transplantation in iran: A narrative review. *Nephro-Urol Mon*. 2019;**11**(1). e87026. doi: 10.5812/numonthly.87026.
7. Laal M. Technology in medical science. *Procedia Soc Behav Sci*. 2013;**81**:384–8.
8. Albabtain AF, AlMulhim DA, Yunus F, Househ MS. The role of mobile health in the developing world: a review of current knowledge and future trends. *Journal of Selected Areas in Health Informatics42*. 2014;**4**(2):10–5.
9. O'Connor A. Using patient decision aids to promote evidence-based decision making. *ACP J Club*. 2001;**135**(1):A11–2. [PubMed: 11471526].
10. Motorny S, Sarnikar S, Noteboom C. Design of an Intelligent Patient Decision aid Based on Individual Decision-Making Styles and Information Need Preferences. *Inf Syst Front*. 2021. doi: 10.1007/s10796-021-10125-9.
11. Tarver ME, Neuland C. Integrating Patient Perspectives into Medical Device Regulatory Decision Making to Advance Innovation in Kidney Disease. *Clin J Am Soc Nephrol*. 2021;**16**(4):636–8. doi: 10.2215/CJN.11510720. [PubMed: 33658182]. [PubMed Central: PMC8092069].
12. Al-Hyari AY, Al-Taee AM, Al-Taee MA, editors. Clinical decision support system for diagnosis and management of Chronic Renal Failure. *Conference on Applied Electrical Engineering and Computing Technologies*. 2013; Jordan. IEEE; 2013. p. 1–6.
13. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol*. 2006;**3**(2):77–101. doi: 10.1191/1478088706qp063oa.
14. Schwandt TA, Lincoln YS, Guba EG. Judging interpretations: But is it rigorous? trustworthiness and authenticity in naturalistic evaluation. *New Dir Eval*. 2007;**2007**(114):11–25. doi: 10.1002/ev.223.
15. eMarketer. *Smartphone users worldwide will total 1.75 billion in 2014*. New York, USA: eMarketer; 2014, [cited 2021]. Available from: https://www.insiderintelligence.com/insights/mobile-users-smartphone-usage/.
16. Guo SH, Chang H, Lin C. Impact of Mobile Diabetes Self-Care System on patients' knowledge, behavior and efficacy. *Comput Ind*. 2015;**69**:22–9.
17. Stevens G, Thompson R, Watson B, Miller YD. Patient decision aids in routine maternity care: Benefits, barriers, and new opportuni-

ties. *Women Birth*. 2016;**29**(1):30–4. doi: 10.1016/j.wombi.2015.08.002. [PubMed: 26342759].
18. Griva K, Li ZH, Lai AY, Choong MC, Foo MW. Perspectives of patients, families, and health care professionals on decision-making about dialysis modality-the good, the bad, and the misunderstandings!. *Perit Dial Int*. 2013;**33**(3):280–9. doi: 10.3747/pdi.2011.00308. [PubMed: 23123668]. [PubMed Central: PMC3649897].
19. Becker S, Miron-Shatz T, Schumacher N, Krocza J, Diamantidis C, Albrecht UV. mHealth 2.0: Experiences, Possibilities, and Perspectives. *JMIR Mhealth Uhealth*. 2014;**2**(2). e24. doi: 10.2196/mhealth.3328. [PubMed: 25099752]. [PubMed Central: PMC4114478].
20. Cafazzo JA, Casselman M, Hamming N, Katzman DK, Palmert MR. Design of an mHealth app for the self-management of adolescent type 1 diabetes: a pilot study. *J Med Internet Res*. 2012;**14**(3). e70. doi: 10.2196/jmir.2058. [PubMed: 22564332]. [PubMed Central: PMC3799540].
21. Kennedy A, Rogers A, Bower P. Support for self care for patients with chronic disease. *BMJ*. 2007;**335**(7627):968–70. doi: 10.1136/bmj.39372.540903.94. [PubMed: 17991978]. [PubMed Central: PMC2071971].
22. Diabetes Prevention Program Research G. The 10-year cost-effectiveness of lifestyle intervention or metformin for diabetes prevention: an intent-to-treat analysis of the DPP/DPPOS. *Diabetes Care*. 2012;**35**(4):723–30. doi: 10.2337/dc11-1468. [PubMed: 22442395]. [PubMed Central: PMC3308273].