Usability Testing of HD-SEMA Apps For Hemodialysis Patients

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Abstract
Objective: The objective of this study is to conduct usability testing on the HD-SEMA application.
Method: This study is quantitative in nature. The design used is a cross-sectional study with a nonequivalent control group design. The research sample consists of 30 respondents selected through convenience sampling. The instrument used is the System Usability Scale (SUS).
Results: The results of the descriptive analysis of the questionnaire responses from 30 respondents indicate that the highest average score was for question no. 5, with a mean value of 4.6 (SD = 0.5). The lowest average score was for question no. 8, with a mean value of 1.4 (SD = 0.6). The total average score was 82.17 (SD = 175.867), with a minimum score of 62.5 and a maximum score of 95.0.
Conclusion: The study results revealed an average SUS score of 82.17, reflecting the usability level of the HD-SEMA application. The findings indicate that the HD-SEMA application falls into the "Acceptable" category, with a grade scale of B (Excellent), signifying that the score is good and the application is suitable for use.

Keywords: usability, mobile application, hemodialysis, HD-SEMA

INTRODUCTION

The global public health issue that continues to grow is chronic kidney disease. According to WHO data in 2021, there were 165,158,285 confirmed cases and 3,425,017 deaths across more than 216 countries (Sinta et al., 2023). According to the latest data from the 7th Report of the Indonesian Renal Registry, Indonesia experiences an annual increase in patients undergoing hemodialysis. It is estimated that there were 17,193 new patients and 11,689 active patients, with a death toll reaching 2,221 in 2019 (Lubis & Thristy, 2023). Hemodialysis has become one of the routine and safe therapeutic options to replace some kidney function, reduce morbidity, and improve the quality of life in patients with end-stage chronic kidney disease (CKD) (Armiyati et al., 2021). The success of hemodialysis cannot be achieved by relying solely on the healthcare team; the self-management ability of hemodialysis patients is one of the factors that influence the success of hemodialysis therapy (Husain et al., 2022). Self-management in patients undergoing hemodialysis is a positive effort by patients to participate in their healthcare to optimize their health, prevent complications, control signs and symptoms, follow treatment programs, and minimize the effects of the disease in their lives (Astuti & Herawati, 2019). The main components of self-management are information management,

medication, emotional management, lifestyle, and social support (Hafezieh et al., 2020). Self-management in hemodialysis patients is still low compared to the ideal level of self-management, which is taken into consideration when formulating appropriate interventions or actions for patients (Siregar et al., 2020).

Self-management interventions for hemodialysis patients are focused on concepts such as fluid restriction management, dietary restrictions, and vascular access care. Currently, the ability for self-care management in patients has become a global concern, in line with the increasing incidence of chronic diseases (Rahmanti & Sunarto, 2022). Nursing interventions generally address the ineffectiveness of self- health management, as recommended by the Nursing Interventions Classification (NIC), including health education, increasing self- efficacy, self-modification assistance, emotional support, family support, and group support (Husain et al., 2022).

The development of technology in the era of Industry 4.0 has had a significant impact on various sectors, including healthcare. One of these advancements is the emergence of mobile applications that can be downloaded for free through Android and iOS platforms. These applications play a crucial role in supporting patient self- management, especially for those undergoing hemodialysis treatment. Applications like Di Care, developed for hemodialysis patients in Iran, offer educational videos on diet management, fluid restriction, and managing hemodialysis complications, helping patients better understand and adhere to their treatment guidelines (BMC Nephrology, 2021; Weichbroth, 2020). In addition, the SMART-D application, designed to monitor factors such as interdialytic weight gain and serum potassium and phosphorus levels, has been shown to help patients monitor their condition in an easy and intuitive way (JMIR Research Protocols, 2017). These applications not only provide educational information but also offer tools to remind patients about their medication, as well as enable the monitoring of key parameters in managing their condition independently. Based on previous research on self- management applications for patients undergoing hemodialysis, it is explained that eHealth can improve patients' psychological function and self-management abilities, with strengths in participatory design and high acceptance rates. However, some weaknesses, including short-term follow-up, small sample sizes, and methodological limitations, highlight the need for further research to strengthen the findings and ensure the sustainability of the intervention benefits (Cardol et al., 2023). The HD-SEMA App (Hemodialysis Self Education Management) is an innovative application designed to support patients in managing their condition independently. HD-SEMA is unique compared to other applications designed for hemodialysis patients. This app not only provides standard features such as improving psychological function, but it is also equipped with health education tailored to the individual needs of the patient. HD-SEMA stands out in its integration of self- management and self-education within a single, adaptive platform. Unlike other applications that focus solely on enhancing psychological function, HD-SEMA provides health education to improve patients' understanding of their condition and encourages better behavioral changes. With this approach, HD-SEMA creates a solution that not only helps patients manage their hemodialysis therapy more effectively but also empowers them to take an active role in managing their own health.

Usability testing on applications is crucial to ensure an optimal user experience and meet their needs. This process helps identify issues such as confusing navigation, difficult-to-use interface elements, or non- intuitive features before the application is launched to the market. For example, research shows that usability testing involving direct users can improve application efficiency, user retention, and overall satisfaction (Weichbroth, 2020; Kumar & Chand, 2023). In addition, systematic approaches in testing, such as using survey methods and model validation, have been

proven to provide reliable results in enhancing the user experience on mobile applications (Kumar & Chand, 2023). In the context of digital health applications (mHealth), usability testing helps ensure that the application meets the specific needs of user groups, such as the elderly, by prioritizing user-friendly design and good accessibility (BMC Medical Informatics and Decision Making, 2020). Another study shows that usability testing involving the measurement of performance metrics, such as task completion time and user success rates, can provide valuable insights for improving the application (Zhang et al., 2019). Therefore, usability testing is a key element in ensuring the success of an application in a competitive market. Hence, the objective of this study is to conduct usability testing on the HD-SEMA application.

METHODS

Study Design

This study is quantitative, with a nonequivalent control group design. This type of research uses a cross-sectional study conducted to determine the usability of a mobile application. The study was carried out at the Hemodialysis unit of RSUP Dr. Hasan Sadikin Bandung. The research was conducted in January 2024. The independent variable in this study is the HD-SEMA app, while the dependent variable is hemodialysis patients.

HD-SEMA Application

The HD-SEMA (Hemodialysis Self Education Management) application was developed by a research team under a health technology development program to support self-management for hemodialysis patients. This application is designed using the Kodular platform, a visual programming- based website that allows for app development without the need for complex coding. HD-SEMA can be downloaded and installed on Android-based smartphones with a minimum version of 5.0 (Lollipop) or newer, making it compatible with various modern devices. The data inputted by users through this app is automatically saved and managed in Google Spreadsheet, which serves as a database to monitor user activities and allows for further analysis.

Table 1. HD-SEMA Application content

Con ents Application	
Self-management	1. Self-management definition 2. Self-management skills 3. Self-management tips
Fluid restriction management	1. Definition of fluid management 2. Purpose of fluid management 3. Impact of excess fluid 4. Daily fluidd restriction 5. Inter-dialysis body weight (IDWG) 6. IDWG classification 7. Fluid management tips
Diet/Nutrition management	1. Dietary goals 2. Familiarity with laboratory results 3. Food organization 4. Things to consider 5. How to make the diet effective
Medicine management	

Hemodialysis adequacy	1. Hemodialysis adequacy 2. Definition of adequacy 3. Effects of inadequate hemodialysis 4. Factors that influence 5. Tips
Emotion management	1. Impacts of stress and anger 2. Stress coping strategies 3. Tips 4. Practice relaxation techniques 5. Relaxation technique training video

Figure 1 Fitur Application HD-SEMA

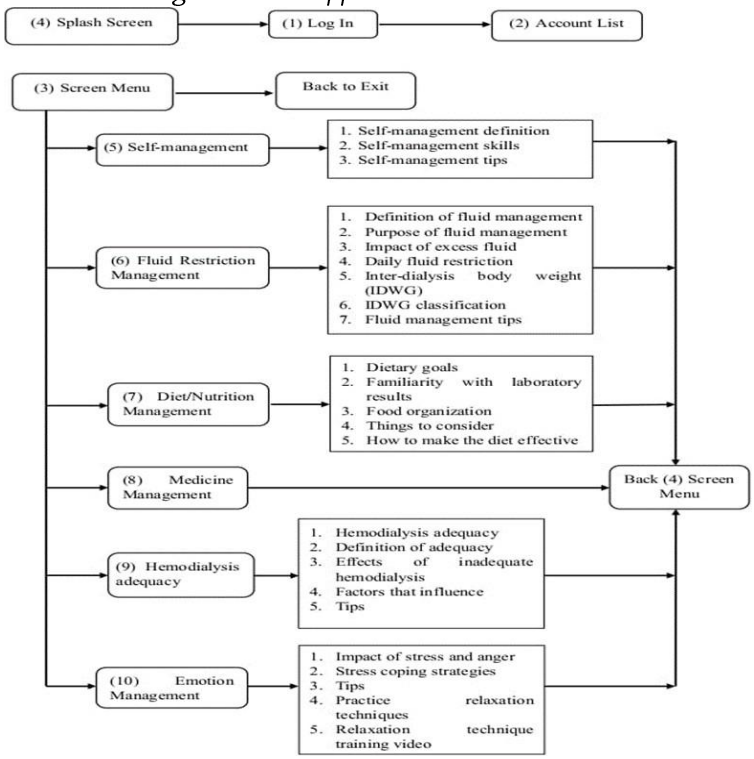

Figure 2 User Flow Diagram Of HD-SEMA

Sample

The sample population in this study consists of hemodialysis patients at RSUP Dr. Hasan Sadikin Bandung. Inclusion criteria include patients undergoing routine HD, patients who are conscious or hemodynamically stable, patients aged ≥20 years, who own an Android smartphone, and patients who are able to read, write, and have good communication skills. The exclusion criterion is patients with cognitive impairments. The study sample of 30 trial respondents (hemodialysis patients aged 20 years and above) was obtained through convenience sampling. Aside from confidentiality issues, the mobile application is newly developed for future trials, and it should be noted that practical sampling was used for usability testing. Sample recruitment was conducted at the Hemodialysis unit of RSUP Dr. Hasan Sadikin Bandung. Respondents were approached face-to-face and provided with informed consent. A sample size of 30 respondents is considered sufficient to determine the usability of the mobile application. The choice of the number of respondents is based on research findings indicating that 30 respondents in a usability test will identify 95% of all usability issues (Muhamat et al., 2021).

Instrument

The instrument used in this study is the System Usability Scale (SUS). The SUS method is one of the methods that can be used to measure the usability level of an application or website. This method was first proposed by J. Brooke in 1986. The SUS method is considered quick and dirty. It uses a 10-item questionnaire with Likert scale answers, ranging from "Strongly Disagree," "Disagree," "Neutral," "Agree," to "Strongly Agree" for each question. To date, the SUS method has been widely used to measure the usability of a system and has several advantages, including its ease of use since the results are presented as a score between 0-100. SUS is easy to administer, does not require complicated calculations, is available for free, and does not incur additional costs. SUS has proven to be valid and reliable, even with small sample size.

Data Collection Procedure

This study was conducted after receiving ethical clearance, with the approval letter number III/034/KEPK/STIKEP/PPNI/JABAR/I/2024 from the Ethics Committee of the PPNI School of Nursing, West Java. Research permission was obtained from Hasan Sadikin Hospital, Bandung. A list of patients was obtained from the nurse on duty in the Hemodialysis unit, followed by obtaining informed consent from the patients to allow them to become research respondents. After patients agreed to participate, they were asked to download the HD-SEMA application and use it for 2 weeks. During the first week, the HD-SEMA application was installed, and the respondents were guided on how to use it. In the second week, monitoring was carried out to ensure proper usage of the application. In the third week, respondents filled out the SUS questionnaire to determine the validity of the data to be collected. The data collected will be analyzed based on the calculations used in the testing process. The conclusions of the study will be drawn from the results of this data analysis.

Data Analysis

The data analysis used in this study involved determining the frequency distribution of demographic data. The analysis was conducted by calculating the mean and standard deviation of respondent characteristics based on age and duration of hemodialysis treatment. Additionally, variables such as gender, occupation, and education were analyzed using frequency distribution and converted into percentage values (%). The assessment of the SUS questionnaire responses was conducted using mean analysis, standard deviation, minimum value, and maximum value for each respondent's answer to the questions.

RESULTS

Table 2. Demographic Data of Hemodialysis Patients

Characteristics	Total Population (N=30)
Age (mean ± SD)	42.20 ± 11.49
Long time undergoing HD (Year) (mean ± SD)	5.77 ± 3.67
Gender	
Male	20 (66.7%)
Fem	10 (33.3%)
ale	
Education	4 (13.3%)
Elementary	3 (10.0%)
school Junior	16 (53.3%)
high school	7 (23.3%)
Senior High School/Vocation	
School College	5 (16.7%)
Work	3 (10.0%)
Civil	2 (6.7%)
servants	2 (6.7%)
Employee	7 (23.3%)
Trader	11 (36.7%)
Laborer	
Housewife	
Other	

Table 2 presents the descriptive characteristics of participants undergoing hemodialysis. The analysis of age distribution reveals that the mean age among respondents is 42.20 years, with a standard deviation of 11.49, indicating a moderate variation in age within the sample. Regarding the duration of hemodialysis therapy, participants have been receiving treatment for an average of 5.77 years, accompanied by a standard deviation of 3.67 years, suggesting a diverse range of treatment experiences. In terms of gender composition, the sample is predominantly male, comprising 20 individuals or 66.7% of the total respondents. This demonstrates a notable gender disparity within the study population. Educational background data show that the most commonly reported level of education is senior high school or vocational high school (SMA/SMK), with 16 participants (53.3%) having completed this level. This suggests that over half of the respondents possess a secondary education, which may influence their health literacy and understanding of treatment protocols. Employment status among participants varies, but the largest proportion falls under the category of "other," which includes occupations such as entrepreneurs, freelancers, or informal sector workers. A total of 11 respondents (36.7%) reported working in these types of jobs. This occupational distribution indicates a prevalence of non-formal employment among the sample, which may have implications for their access to consistent healthcare or insurance coverage. Overall, the demographic data highlight variations in age, education, and employment that may be relevant in analyzing treatment adherence or patient outcomes.

Table 3. Results Quesionare SUS

Question	Mean ± SD	Min – Max
1. I think that I would like to use this system frequently.	3.5 ± 0.7	2 – 5

2. I found the system unnecessarily complex.	1.7 ± 1.1	1 – 5
3. I thought the system was easy to use.	4.5 ± 0.5	3 – 5
4. I think that I would need the support of a technical person to be able to use this system.	1.6 ± 0.9	1 – 4
5. I found the various functiond in this system were well integrated.	4.6 ± 0.5	3 – 5
6. I thought there was too much inconsistency in this system.	1.5 ± 0.6	1 – 3
7. I would imagine that most people would learn to use this system very quickly.	3.7 ± 1.0	1 – 5
8. I found the system very awkward to use.	1.4 ± 0.6	1 – 3
9. I felt very confident using the system.	4.2 ± 0.6	1 – 3
10. I needed to learn a lot of things before i could get going with this system.	2 ± 0.7	1 – 4
TOTAL SCORE	82.17 ± 175.867	62.5 – 95.0

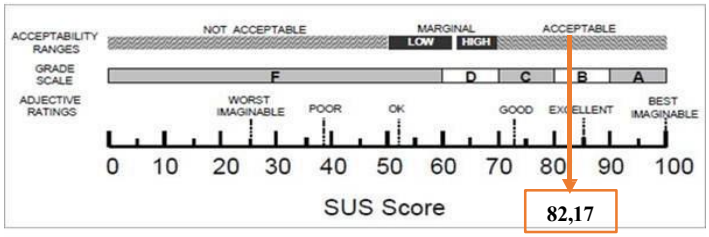

Figure 3 SUS Average Score Results

Table 2 provides a summary of the descriptive analysis results derived from questionnaire responses completed by 30 participants. Among all items assessed, question number 5 recorded the highest average rating, with a mean score of 4.6 and a standard deviation of 0.5. Respondents gave ratings ranging from a minimum of 3 to a maximum of 5, suggesting a generally strong agreement or satisfaction with the aspect addressed in that item. In contrast, question number 8 yielded the lowest average rating, with a mean score of 1.4 and a standard deviation of 0.6. Scores for this item varied from 1 to 3, indicating lower levels of agreement or satisfaction compared to other items in the questionnaire. When aggregated across all questionnaire items, the overall average score was 82.17, with a notably large standard deviation of 175.867. This overall score reflects participants' assessment of the HD-SEMA application's usability. Based on these findings, the HD-SEMA application falls within the "Acceptable" range of usability, suggesting that the majority of users responded positively and found the application functional and user-friendly. Moreover, the evaluation results classify the HD-SEMA application within Grade Scale B, which corresponds to an "Excellent" rating. This grade reflects a high level of performance and user satisfaction. The scoring range for this grade spans from a minimum of 62.5 to a maximum of 95.0, highlighting that users generally perceived the application's quality to be above average. These findings collectively demonstrate that the HD-SEMA application has been well-received by users and meets a high standard of usability, potentially supporting its implementation in hemodialysis patient care settings.

DISCUSSION

The results from Table 2 reflect the questionnaire evaluation of hemodialysis patients using the HD-SEMA application over two weeks. The responses from 30 participants to question no. 2 indicate that most users found the system not overly complex, which is a positive finding. However, there were also indications that some users felt the complexity could be improved. Additionally, responses to question no. 8 highlighted that users found the system fairly intuitive and not confusing. Nevertheless, refining the interface to ensure a seamless user experience across all user groups remains a priority. The questionnaire results suggest that the HD-SEMA application is well-received, with most users acknowledging that the system's functions are well-integrated, marking a significant strength. Moreover, the findings reveal that the majority of users found the system easy to use, reflecting an effective and user-friendly design. To address the system's complexity, the researchers plan to implement a more intuitive user interface with a simplified layout and more explicit usage guides to reduce confusion for some users. Addressing awkwardness in usage by incorporating a real-time feedback feature within the application could enhance comfort, resulting in a smoother interaction experience for users. These solutions could be evaluated through iterative usability testing involving a more diverse population to better accommodate the varying needs of users. This approach aligns with Nielsen's (1994) emphasis on the importance of iterative testing in user-centered system development.

The results of this study indicate that the HD-SEMA application achieved an average SUS (System Usability Scale) score of 82.17, placing it in the category of excellent usability. This aligns with previous research by Smith et al. (2021), which reported an average SUS score of 80.5 for the MyDialysis application. That study highlighted the importance of intuitive interface design in enhancing user experience. However, our findings differ from the study by Lee et al. (2019), where the DialysisHelper application achieved a SUS score of only 68, categorized as moderate usability. One possible reason for this difference lies in the additional features of HD-SEMA, such as self-management health education, specifically tailored to the needs of hemodialysis patients. Furthermore, differences in the user population may also influence the results; our study involved patients more familiar with technology compared to the population studied by Lee et al. (2019).

This study provides a novel contribution to the literature on usability testing for health applications by combining quantitative analysis through the SUS and qualitative interviews to gain a deeper understanding of user experiences. This methodology aligns with the findings of Jones et al. (2020), which demonstrated that a mixed-methods approach is more effective in evaluating the usability of health applications.

The advents of mobile health apps has revolutionized the management of chronic diseases, including hemodialysis. The app offers a health education platform for patients to monitor their health, adhere to dietary restrictions, and perform emotional management. This discussion explores the utility of hemodialysis self-management mobile apps, with a focus on their impact on patient outcomes, user engagement, and areas for improvement.

Several studies have demonstrated the positive effects of mobile applications on the self-management of hemodialysis patients. For instance, a mobile-app-based self- management program significantly increased sick-role behavior, basic psychological needs, and self-efficacy among elderly hemodialysis patients, while maintaining physiological parameters within normal ranges (Youngsoon Min et al., 2020). Similarly, a smartphone application-based dietary self-management program improved serum phosphorus and potassium levels, self- efficacy, and quality of life over time (S. Pack et al., 2020). Another study found that a self- management mobile application enhanced health behaviors and improved health-related quality of life (HRQoL) in patients receiving peritoneal dialysis (Yoon

Jung Chae et al., 2023).

User engagement is critical for the success of mobile health applications. A scoping review identified five main categories of smartphone apps used by hemodialysis patients: dietary monitoring, treatment adherence, lifestyle management, symptoms monitoring, and patient training (M. Jebraeily et al., 2021). The usability of these applications is often influenced by their design and functionality.

Despite the benefits, there are areas where these applications can be improved. A need analysis study revealed that both patients and dietitians perceive renal diet apps as important but noted the lack of local content and credibility as barriers to their use (Jun-Hao Lim et al., 2020). Additionally, a pilot study of the Self-Management and Recording System for Dialysis (SMART-D) found that while the system was well- regarded by patients, further studies with larger cohorts and longer follow-up periods are needed to evaluate its effects on clinical outcomes and quality of life (Aki Hayashi et al., 2017).

Mobile applications for hemodialysis self-management have shown promise in improving patient outcomes and engagement. However, there is a need for continuous refinement and evaluation to address usability issues and enhance their effectiveness. Future research should focus on developing tailored interventions that consider patient preferences and integrate comprehensive feedback mechanisms to support long-term self-management.

Limitations

This study has several limitations that should be acknowledged. First, the sample size was relatively small (n = 30), and participants were selected from a single healthcare facility, which may limit the generalizability of the findings. Second, the short duration of the evaluation period (two weeks) may not fully capture long-term usability challenges or sustainability of user engagement. Third, the participants in this study were relatively familiar with technology, which could lead to higher usability scores that may not reflect the experience of users with limited digital literacy. Additionally, the SUS provides a general measure of usability but does not capture context-specific barriers or preferences in depth. Although qualitative interviews were conducted, future research should expand the scope and diversity of the qualitative sample to explore cultural, cognitive, and age-related factors influencing usability. Lastly, the study did not include clinical outcome measures, making it difficult to determine the broader health impact of using the HD-SEMA application. Further longitudinal studies involving more heterogeneous populations are needed to validate these preliminary findings and assess long-term effectiveness.

CONCLUSION

The findings from this study, which involved 30 hemodialysis patients using the HD-SEMA application over a two-week period, demonstrate a strong level of usability. The average System Usability Scale (SUS) score obtained was 82.17, indicating that the application meets established usability benchmarks. According to standard interpretation, this score places HD-SEMA in the "Acceptable" category, signifying that it has been well-received by its users. Additionally, the application was rated with a grade scale of B, categorized as "Excellent," suggesting that it offers high quality in both design and functionality, and is considered suitable for routine use in clinical or self-care settings.

Despite the favorable usability outcomes, opportunities remain to further enhance user satisfaction, particularly in terms of the application's educational features designed to support self-management for hemodialysis patients. Users consistently emphasize the need for an application that is not only functional but also intuitive and easy to navigate. To address this, developers should consider simplifying the interface, using clear language, and including interactive guidance or help features tailored to the target population’s literacy and technological skills.

Looking ahead, future research and development efforts should adopt a more holistic usability evaluation framework. Beyond assessing usability through SUS scores, future studies

should explore user experience by evaluating the content quality, appropriateness of language, effectiveness of interactive features, and overall satisfaction with specific app components. By doing so, developers can ensure that the application meets both functional and emotional needs of users, leading to sustained engagement. These enhancements will be vital in maximizing the HD-SEMA application's potential to support behavioral change, promote treatment adherence, and improve health outcomes in the hemodialysis population.

Implications

These findings underscore the need for continuous user-centered development in mobile health applications. Specifically, developers and healthcare professionals should prioritize design elements that support comprehension, accessibility, and engagement. Future iterations of HD-SEMA should integrate usability testing with comprehensive content evaluations—including assessments of language clarity, feature relevance, and instructional design—to address a broader range of user needs and expectations. Moreover, these results imply that mobile health tools, when designed with patient usability in mind, can play a critical role in empowering patients to manage their own care effectively. By aligning technological development with patients' preferences and literacy levels, HD-SEMA and similar applications could significantly contribute to improved treatment adherence, health outcomes, and overall quality of life for individuals undergoing hemodialysis.

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