

Usability of Chronic Kidney Diseases Electronic-Health Information: A Systematic Review

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ABSTRACT

Background: Information on chronic kidney disease is easily accessible in a variety of digital formats and is posted in health information resources, electronic-health, or eHealth. In that it can enable people with chronic kidney disease to manage their condition, the field of eHealth is promising. **Aims:** The purpose of this study is to evaluate the usability of eHealth in the treatment of chronic kidney disease by critically analyzing the published papers in this area. **Methods:** The following databases were searched systematically: The following databases were thoroughly searched: EBSCO, CINAHL, ProQuest, MEDLINE, PubMed, Cochrane, and Google Scholar. Eight studies looked into the specific impact of eHealth on chronic kidney disease. These studies addressed a variety of subjects, including the user, healthcare professionals, and system bonding, mobile eHealth, content, and eHealth evaluation on chronic kidney disease. **Results:** There is a knowledge gap in the field of eHealth for chronic kidney disease. The findings reveal a significant disparity in the terminology and conceptualizations used in eHealth information on chronic kidney disease. The availability of eHealth information on chronic kidney disease that prioritizes patient education, behavior modification, and prevention has led to inconsistent usage. Lack of sufficient data may hinder the development of eHealth interventions for people with chronic kidney disease. **Conclusion:** This study emphasizes the urgent need for content acceptance and access as well as evaluation that is evidence-based for the conceptualization of eHealth for chronic kidney disease.

Keywords: Chronic kidney disease, Electronic-health, Digital health, Health service, Health risk.

INTRODUCTION

The advancement of health information technology (HIT) is recognized as having a major impact on how users, providers, and health systems use and alter information (Bonner et al., 2018). HIT directly provides users with access to health information. This easy access to information is intended to promote consumer interest in any health-related product. Around 62% of Americans with chronic diseases are connected to the health information system (HIS), and half of them used the Internet to look up medical information (Fox & Purcell, 2010).

A generic phrase used to describe paperless information, communication, education, diagnostic, and treatment services provided by electronic means is "eHealth" (Ossebaard & Van Gemert-Pijnen, 2016). Past eHealth studies categorized this term into a number of electronic information delivery methods, such as telemedicine, telecare, or

telehealth (Ossebaard & Van Gemert-Pijnen, 2016). Significant health effects were found in previous research exploring the impact of information technology (IT) tools on the empowerment of people with chronic renal disorders (Diamantidis et al., 2018).

Individuals with CKD are expected to feel empowered by eHealth knowledge on the condition (Diamantidis et al., 2018). Since there has been a significant rise in CKD globally, patient empowerment is essential. According to the Renal Data System, there were about 15% of Americans who had CKD (Saran et al., 2017). In Indonesia, the Ministry of Health of Republic Indonesia recorded a rise of 7% in new cases of end-stage renal disease (ESRD) from 2007 to 2017, with 52% of those being between the ages of 25- and 54-year-old (IRR, 2017).

However, Stevenson et al (2019) the impacts of of eHealth on CKD yielded conflicting findings. They suggested that was brought on by the included studies'

poor quality (Stevenson et al., 2019). There may be a number of factors that contribute to the listed studies' poor quality. Health information technology (IT) on CKD should investigate present and potential uses of health IT platforms to promote care and provide knowledge, engagement, and communication through creative ways (Diamantidis et al., 2018; Diamantidis et al., 2015). Ross et al. (2015) suggested a further element that could present a barrier to the adoption of electronic health; however, until the current study is completed, the findings of the review on this problem (Ross et al., 2015) have not yet been released. In light of this, the objective of this study is to identify the comprehensive eHealth on CKD platform and content by conducting a critical analysis of previously published papers.

METHODS

In this literature research, a procedure for conducting a literature review was developed and employed. The systematic review guidelines (Creswell & Creswell, 2017) were detained as the resources to construct the procedure. The steps of as the followings:

Identification of Keywords and Database Search

The primary search terms and Medical Subject Headings terms used in combination or singly. Within the context of the study, keywords for database research were selected to reach studies in relevant fields of eHealth intervention. The keyword search was elaborated by the first results for increasing accuracy in the search. In total, combinations of following keywords were used: "e-health", "m-health", "eHealth intervention", "mHealth intervention", "effectiveness", "information system acceptance", "adoption", "technology acceptance", "technology adoption", "chronic disease", "chronic kidney disease", "renal insufficiency", "kidney insufficiency", "patient engagement", "patient activation", "Patient empowerment", "Patient-center-care", "eHealth CKD content".

The search was conducted on web-based academic: EBSCO, CINAHL, ProQuest, MEDLINE, PubMed, Cochrane, and Google Scholar. Seven databased was explore to retrieve sufficient and relevant studies.

Study Selection

In this phase, the keywords and the titles of articles were reviewed. The relevance to the context was explored. Accordingly, a set of inclusion criteria was applied to receive and ensure articles meet with the context of the research objective, as followings: Language for publication is restricted to English language articles, published articles, full-text articles, published within two decades (Starting from January 1999 to December 2021), synthesis of quantitative articles, articles providing instrument measurement, articles providing interpretation guideline, article providing categories and their interpretation. The search and selection processes are illustrated followed Prisma (Moher et al., 2015) as it is shown in figure 1 (Prisma flow diagram).

Data extraction

Data were extracted, measured and condensed as the addressed outcomes. The four outcomes of interest were (1) the conceptual framework of individual acceptance and use technology in daily life, (2) bonding entities among individuals with CKD, health care professionals, and health system, (3) eHealth intervention's an eHealth platform, and (4) the content of eHealth intervention for individuals with CKD. Each study may address one or more outcomes. Several excluded studies were used in the results and discussion section to sharpen the findings.

RESULTS AND DISCUSSION

The results of the literature review were dominated by articles published after 2010. In sequence, it was a study taken by Kuo, Su, & Lin (2018) measuring on the effectiveness of eHealth intervention who focused on patients with metabolic diseases where was dominated by type 2 diabetes mellitus (T2DM) patient but none with CKD (Kuo et al., 2018) and Stevenson et al., (2019) who concerned on eHealth intervention for people with CKD (Stevenson et al., 2019). Kuo, Su, & Lin (2018) found eHealth intervention effectively improves the health status of adults with metabolic diseases. However, Stevenson et al., (2019) reported the different findings. This finding leads to critically analyze of implementing eHealth for individuals with CKD.

The recent literature reported the successfulness of eHealth intervention for

people with CKD implementation were patients, health care professionals, and health systems (Granja et al., 2018). Technological learning theory and usage, belief, attitudes, and attention are important factors in the adoption of health information systems (Bagozzi et al., 1992). To reach the actual usage of accessing eHealth intervention and resulted in an engagement, these three entities; individuals with CKD, health care professionals and healthcare systems (Granja et al., 2018) responsible for the successfulness of eHealth intervention. The results of the literature review (table 1 included studies) as seen below.

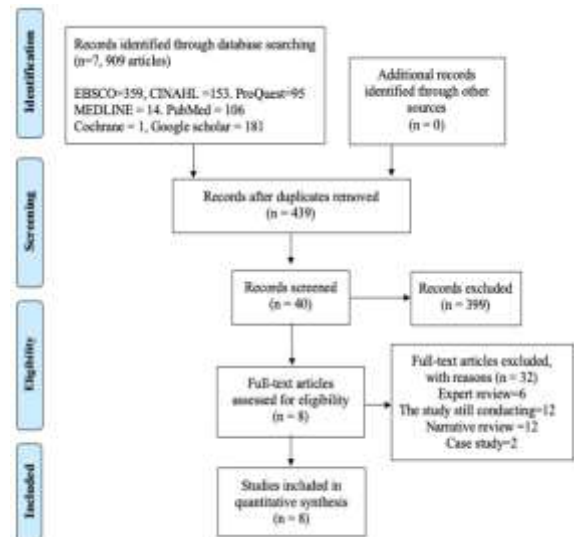


Figure 1. Search and selection process.

Table 1. Characteristics of studies and findings.

Studies	Number of studies/participants	Findings
Evidence-based evaluation of eHealth interventions: a systematic literature review. Journal of medical Internet research, 20(11), e10971 (Enam et al., 2018)	46 papers were selected for the qualitative analysis	<ul style="list-style-type: none"> Evaluation of eHealth program is seldomly performed in the design and pretesting phases. evaluation as an ongoing process throughout the program. The following factors impact on efficiency and effectiveness eHealth; organizational, technological, human and social, clinical, cost and economic, ethical and legal, and transferability.
eHealth interventions for people with chronic kidney disease. Cochrane Database of Systematic Reviews(8). (Stevenson et al., 2019)	43 studies involved individuals with dialysis, transplant candidates, and transplant recipients	<ul style="list-style-type: none"> eHealth modalities include; telehealth, mobile or tablet application, text or email messages, electronic monitors, internet/websites, video or DVD.
A Systematic Evaluation of Websites Offering Information on Chronic Kidney Disease. Nephrology Nursing Journal, 41(4), 355-363. (Lutz et al., 2014)	40 websites were included in the analysis involved patients with CKD in a pre-dialysis CKD program	<p>Characteristics of the Sample of Websites</p> <ul style="list-style-type: none"> The characteristics of websites provided CKD eHealth information were as follow: The webs were operated by either a not-for-profit organization or a for-profit commercial company. One-third of the websites targeted individuals living with CKD and their family Roughly half of the sample provided an overview of CKD, including causes, risk factors, common symptoms, and diagnostic tests. Of those, two websites offered information about coping with CKD or prevention, and one website addressed common

		<p>questions that might be raised by patients who have been newly diagnosed with CKD.</p> <ul style="list-style-type: none"> ▪ One website was focused on peritoneal dialysis. ▪ One-quarter of 40 websites were not clear about their aims. ▪ Most websites with identifiable aims presented information consistent with the aims. ▪ Websites rated as higher quality tend to be more difficult to read and understand.
Factors determining the success and failure of eHealth interventions: a systematic review of the literature. Journal of medical Internet research, 20(5), e10235 (Granja et al., 2018)	903 articles with a total of 221 studies complied with the inclusion criteria.	<ul style="list-style-type: none"> ▪ The most mentioned as contributing to the success of eHealth application was the category quality of healthcare and to failure was the category costs ▪ For the category with the highest unique article frequency was workflow and six barriers related to workflow were workload, role definition, undermining of face-to-face communication workflow disruption, alignment with clinical processes, and staff turnover.
Self-management interventions for adults with chronic kidney disease: a scoping review. BMJ Open, 8(3), e019814. (Donald, Kahlon, et al., 2018)	A scoping review of electronic databases and grey literature were searched in October 2016 to identify self-management interventions for adults with CKD stages 1-5 (not requiring kidney replacement therapy).	<ul style="list-style-type: none"> ▪ The content of CKD eHealth literacy as follow; diet/nutrition, general CKD knowledge, medication, modalities, physical activity, comorbidities, symptom management, lifestyle ▪ Mode of delivery; face to face person to person or group, multiple modes, printed material, distance (telephone, email), digital (DVD, PowerPoint, audio recording), electronic (website, mobile application) ▪ Type of providers; nurse/nurse practitioner, dietitian, multiple providers, social worker, physician/primary care physician, nephrologist/nephrology fellows, patient volunteer/mentor, pharmacist ▪ The most frequently reported outcome domain was; cognitions (changes in general CKD knowledge, perceived self-management and motivation).
Why do people use information technology? A critical review of the technology acceptance model. Information & Management (Legris et al., 2003)	22 articles published 22 articles from 1980 to the first part of 2001	<ul style="list-style-type: none"> ▪ The usability of information and technology need to be integrated into a broader one which would include variables related to both human and social change and the adoption of the innovation model.
The unified theory of acceptance and use of technology: A synthesis and the road ahead. Journal of the Association for Information	Synthesize 1,267 papers on UTAUT from September 2003 until December 2014	<ul style="list-style-type: none"> ▪ Integrating the results of theoretical analysis with eight dimensions of the context for technology acceptance.

Systems, 17(5),
328-376.
(Venkatesh et al.,
2016)

Re-examining the unified theory of acceptance and use of technology (UTAUT): Towards a revised theoretical model. Information Systems Frontiers, 21(3), 719-734 (Dwivedi, Rana, Jeyaraj, Clement, & Williams, 2019)

A meta-analysis of 1600 observations on 21 relationships coded from 162 prior studies information acceptance and use.

- The usability of information and technology was influenced by user attitude.
- Attitude had a direct effect on behavioral intention, which implies that attitude partially mediated the effects of performance expectancy, effort expectancy, facilitating conditions, and social influence, and attitude exerted a direct influence on user behavior.

Concerning the findings as written on the table 1, the conceptual framework of individual acceptance and using technology in daily life explains the crucial thought of individual engagement with the health information system and health information technology. Since early 2000, the theory and conceptual model of individual acceptance technology have been proposed (Legris et al., 2003). A study conducted by Legris et al., (2003) stated Technology Acceptance Mode (TAM) created by David 1989 (Davis, 1989) was the fittest theory explaining the engagement process of individuals and technology. Later, Venkatesh et al., (2016) continue working on the theory of acceptance and use of technology (Venkatesh et al., 2016) where TAM was reviewed. Currently, Dwivedi et al., (2019) re-examined the unified theory of acceptance and use of technology (UTAUT) (Dwivedi et al., 2019). In comparison to TAM, UTAUT seems like the fittest theory and model of individual engages with technology (Dwivedi et al., 2019). UTAUT explained the process by first individuals reacted to use information technology, individuals with CKD, then used intentionally the eHealth application and resulted in the actual use of information technology.

Regarding the concept developed by Venkantesh, Thong and Xu (2012) and Dwivedi et al., (2019) and it relations to the acceptance and usage of eHealth by individuals with CKD, Sarker& Wells (2003) reported eHealth as the most effective way of building the know-do

bridge (Sarker & Wells, 2003). In between the concept and the role of eHealth in education, Sezgin, and Yildirim (2014) explained the use of mobile technology in health service was depending on the degree of relation between the user and the system (Sezgin & Yıldırım, 2014). This degree relationship between the user and information system was explained based on the theoretical model such as attitude and behavioral intention (Fishbein & Ajzen, 1977). Venkatesh Thong, & Su (2012) described the actual use of information technology directly influenced by an individual's reaction to using technology and indirectly vice versa (Venkatesh et al., 2016).

Accordingly, the theory and model on the degree of relation between the user and the system have been proposed and used to examine information or information technology acceptance and usage (Dwivedi et al., 2019; Nadal et al., 2020; Williams et al., 2015). Thus, the figure shows that user behavior was directly influenced by facilitating conditions where was organization and technical infrastructure support the use of the system. Related to this review, these theories, concepts, and frameworks capture the basic blue plan of eHealth intervention for people with CKD. The first step should address the characteristic of individuals and establish supporting conditions where health professionals' teamwork in collaboration with the technical system. Secondly, bonding entities of individuals with CKD-health care professionals and systems.

The study on the successfulness of eHealth intervention (Granja et al., 2018) reported three entities need to be concerned; patients, health care professionals, and health systems. This successfulness included the failures as barriers and success as facilitators of implementing eHealth. Costs have mentioned the category most mentioned as contributing to the failure of eHealth interventions while patients were considered of most importance that the eHealth interventions support (Granja et al., 2018). Third, eHealth as a platform of eHealth interventions evidence reported a variety of modalities has been implemented. For example telenephrology (ALAzab & Khader, 2016; Ishani et al., 2016), a web-based clinical dashboard accessed by smartphone (Ong et al., 2016), e-learning (Barahimi et al., 2017) and iPad application (Diamantidis et al., 2015). While an observational study used the initiation of a Web-based consultation process for patients with CKD (Nynke D Scherpbier-de Haan et al., 2013). Fourth, related to the content, an evaluation of 40 websites offering CKD information (Lutz et al., 2014) reported the website quality was poor. A majority of websites presented a brief overview of CKD, with little information about lifestyle changes to delay CKD progression or how to cope with the illness (Lutz et al., 2014).

Another study on eHealth CKD content has been conducted by Donald et al., since the year 2018 to 2019 (M. Donald et al., 2019). These eight topics of eHealth CKD content was a condensed of four different studies on the CKD self-management; (1) a scoping review; (2) a national survey; (3) a quantitative study on analysis of behaviors of patients with CKD and caregivers utilizing the theoretical domains framework, and; (4) a qualitative study on CKD self-management program (Baay et al., 2019; Maoliosa Donald et al., 2019; M. Donald et al., 2019; Donald, Gil, et al., 2018; Donald, Kahlon, et al., 2018). The summary of eHealth CKD content are; understanding chronic kidney disease, diet, medications, symptoms, finances, mental and physical health, travel and work/school, as well as features including mixed-content formats (e.g., visuals, text, user-generated content)(M. Donald et al., 2019).

The preferences for topic areas and features for a self-management e-health

tool for patients with CKD resulted from a consensus workshop and personas. The content of eight predetermined topic areas was presented following the Guidance for Reporting Involvement of Patients and Public (GRIPP2) (M. Donald et al., 2019). Besides content, an evaluation based on the target outcome achievement is needed. An evaluation is acquired because eHealth program for individuals with CKD is an education program where was the learning outcome need to be measured (Enam et al., 2018). Accordingly, the evaluation of CKD program is essential to estimate effectiveness (KDIGO, 2012). Campbell et al., (2016) developed an evaluation of eHealth program for people with CKD (Stevenson et al., 2016; Stevenson et al., 2019) where patients' side focused on the clinical parameters and patients' change, while cost was a parameter of evaluation for evaluating the health system.

The relevancy of content of eHealth application for individuals with CKD might increase the acceptance and the usage of eHealth among individuals with CKD. Thus, the positive environment where the health professional and health system work in collaboration to support the learning process, evaluate CKD outcome among those users, evaluate HIT and HIS regularly might positively contribute to patient empowerment and establish patient-center-care.

One of the chronic diseases deemed to be a major global public health issue and in need of a comprehensive treatment is CKD. The current study discovered that rather than being supported by evidence, the use of health information technology (HIT) and health information systems (HIS) in healthcare was mostly motivated by expectations of the benefits to be gained. The users' behavior supports the prediction of eHealth information (Jacobs et al., 2016). Yet, it is apparent that the amount of eHealth evidence for people with CKD may not be comparable to the quantity of published studies. Also, authors incorporated a variety of literary notions and eHealth terminology. Stevenson et al., (2019) applied the word modalities to covered all the term related eHealth applications such as; Telehealth; mobile tablet application; text or email messages; electronic monitors; internet/websites; and video or DVD (Stevenson et al., 2019). The term "modalities" was used by

Stevenson et al. (2019) to refer to all eHealth-related apps, including Telehealth, mobile tablet applications, text or email messages, electronic monitors, the internet/websites, and video or DVD (Stevenson et al., 2019). While some researchers defined "eHealth" as being accessible via a smartphone (Doyle et al., 2019; Ong et al., 2016). These contradictions may have made eHealth studies premature, making it difficult to draw conclusions about a new trend that were both comprehensive and explicative (Sezgin & Yldrm, 2014). Current health information systems are being evaluated using acceptance theories and constructs (Adesina & Abiodun, 2019; Dwivedi et al., 2019), and their implementation on the mobile platform (Grekin et al., 2019) has revealed the relevance and inconsistencies in theories of acceptance.

It is challenging to draw thorough conclusions regarding current eHealth trends for people with CKD since eHealth research may be on a premature level in compared to eHealth. Because of this, there is little research on eHealth programs for patients with CKD in this review. As a result, there were concerns about the accuracy of eHealth material related to CKD. For instance, a 2014 investigation on the evaluation of websites delivering information about CKD (Lutz et al., 2014) found that websites with higher ratings for quality tend to be more challenging for users to read and comprehend. As a result, neither the majority of websites nor their content is written at a level that most people could easily grasp, regardless of whether the material was based on research or an expert's opinion. Telehealth is another eHealth application platform for people with CKD.

From those terms of eHealth or eHealth, there was an inconsistent concept of telehealth application. For instance, previous researcher suggested telehealth can be a website application (Bryan et al., 2009). Later, Stevenson et al (2019) used the word modalities rather than a platform to define the used of eHealth in eHealth program for people with CKD (Stevenson et al., 2019). The word platform itself was applied in HIT and HIS studies by several scholars (Bonner et al., 2018; Diamantidis et al., 2013; Grove et al., 2019). Other variabilities of platforms have been

applied in the CKD field such as an interactive website (N. D. Scherpbier-de Haan et al., 2013), telehealth (Ishani et al., 2016), telenephrology (AlAzab & Khader, 2016) and e-learning (Barahimi et al., 2017). However, these platforms did not explicitly describe whether these were eHealth delivered through mobile devices or immobile or mixed.

In line with the result of the study on the websites offering CKD information (Lutz et al., 2014), there was also no evidence on the eHealth CKD intervention's content should be. The most current study on the content of CKD was aimed to gain self-management among patients with CKD (M. Donald et al., 2019). The development of patient education which aim to empower patient with chronic disease has been gradually shifting from face-to-face interaction to virtual, and from paper to paperless. As a result, after the baby-boomers generation, more people lay on the internet access to find any information on health (Paige et al., 2018; Sudbury-Riley et al., 2017).

This study determined preferences for CKD content and features of an e-health tool (M. Donald et al., 2019). The scarcity of evidence on the electronic-health CKD content possibly interrupts the progression of eHealth application for individuals with CKD. It is noticeable that the need for eHealth platform and effectiveness eHealth content evidence were not clearly stated in any of the papers. Likewise, the evaluation of the empirical studies typically focused on the CKD goal-outcomes, and the usage of health information technology and health information system, and the benefit received. This then resulted in an incomprehensive effect on the rising of eHealth in health care services.

This study has several limitations. First, it focused on academic database. Second, relied on the MeSH classification. Third, obtained limited relevant sample on English publication. To a large extent, more articles expanding the search to other languages. To a large extent, more articles could be obtained by expanding the search to other terms and languages.

CONCLUSION

The current findings underline information on CKD in eHealth had a wide range of topics. Those findings might relate to individual acceptance and usage

of eHealth information was discovered to have an impact on its acceptability and usability. It may not be clear at this point how eHealth information for people with CKD differs in terminology, concept, and application. As electronic health information is context-specific, it may be difficult to obtain, reach, and convey the content. This study emphasizes the urgency of conducting research on the technology acceptance and usage, platform, and content of eHealth information associated CKD.

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