

Does Message-Based Communication Through Mobile Phones for Medication and Treatment Adherence Improve Health Outcomes? A Systematic Review

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Received date: Jun 23, 2017; Accepted date: Jul 11, 2017; Published date: Jul 25, 2017

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Abstract

Medical non-adherence has been a pervasive issue in healthcare for far too long and consequences of medical non-adherence are far reaching. With the proliferation of mobile technology globally, there have been concerted efforts to improve adherence using mHealth both in developed and developing countries. The objective of this study was to evaluate through previous studies whether mobile phone innovations improve health outcomes through adherence messages to patients and how many of the studies mention and actually consider the content going out to patients as contributing to positive or negative health outcome. A systematic review was conducted using four search engines: PubMed, Mendley, Advanced Google, and Google Scholar. The publications were randomized clinical trials, cross-sectional studies, and pre and post interventional studies. The publications reviewed were considered to be eligible if they were based on use of mobile technology or smart phone applications in improving health outcomes through sending adherence messages. Forty one potential articles were retrieved based on the first search criteria and review of abstracts. Full text was not obtainable for 11 articles due to fees to access the document and/or a registration requirement for the websites making the full text inaccessible. Nine articles were published before the year 2009, 7 were systematic reviews, 1 was an SMS based study but was used by community health workers and did not necessarily address adherence, 3 were protocols for a study to be done, 10 articles met all the inclusion criteria. Mobile health technology has been proven to contribute towards improving adherence to treatment, medication and appointments. However it is crucial to consider the content and its development processes just as much as the technology in use as this might elevate the health outcomes even higher.

Keywords: mHealth; Adherence; Impact; Content development; mAdherence

Introduction

Adherence is an important aspect and measure when it comes to treatment success or failure. In 2003, WHO noted that poor adherence to treatment of chronic diseases was a worldwide problem of striking magnitude. Adherence to long-term therapy for chronic illnesses in developed countries was averaging 50%. In developing countries, the rates were even lower. It was undeniable that many patients experienced difficulty in following treatment recommendations [1]. The impact of poor adherence was growing and the burden of chronic disease continued to grow worldwide. Non-communicable diseases and mental disorders, human immunodeficiency virus/acquired immunodeficiency syndrome and tuberculosis, together represented 54% of the burden of all diseases worldwide in 2001 and it is expected that this will exceed 65% worldwide in 2020. The poor are disproportionately affected. Leane and McCarthy broadly categorize factors contributing to non-adherence as intentional and unintentional. Factors affecting therapeutic non-compliance could be categorized into patient-centred factors, therapy-related factors, social and economic factors, healthcare system factors, and disease factors [2]. The consequences of poor adherence to long-term therapies are poor health outcomes and increased health care costs. Poor adherence to long-term therapies severely compromises the effectiveness of treatment making this a critical issue in population health both from the perspective of quality of life and of health economics [1].

Conversely, evidence shows that good adherence to drug therapy is associated with positive health outcomes [3]. Patients suffering from chronic conditions face several potentially life-threatening risks if not appropriately supported by the health system because most of the care needed for chronic conditions is based on patient self-management (usually requiring complex multi-therapies), use of medical technology for monitoring, and changes in the patient's lifestyle [1]. With the increasing global mobile telephony penetration [4], the need to develop innovative ways to improve adherence, which would help enhance patients' safety and subsequently patients' lifestyles and prevent adverse health outcomes was and still is apparent [4-6].

Despite the fact that there have been efforts to use mobile technology to increase adherence to treatment or medication for communicable and non-communicable diseases, there is still lack of rigorous research on the effectiveness of the interventions particularly in developing countries. There are many factors that could contribute to the success of the innovations, some being experience of the health care workers providing care to the patients, increased adherence due to other factors like fear of death due to unusual or change of circumstances, media campaigns and the messages being relayed through those mobile devices. Based on their popularity, availability, portability, and technological capacity, mobile phones have enormous potential to impact chronic disease management around the globe [7]. Mobile technologies such as phones and wireless monitoring devices are increasingly being used in health care and public health practice for communication, data collection, patient monitoring, and education, and to facilitate adherence to chronic disease management.

A systematic review by Sharma and Agarwal et al. on one study comprising of 273 participants initiating ART reported the effect of mobile phone text messaging on the adherence to treatment [8]. According to Sharma and Agarwal, the patients receiving text messages were found to be at a lower risk of reporting non-adherence to ART at 12 months compared with those receiving standard treatment Relative Risks (RR) of 0.77, at 95% confidence interval. Patients receiving text messages were also reported to be at a lower risk of experiencing failure of viral load management compared with patients on standard care RR of 0.83. These kinds of findings prompt certain fundamental questions such as what type of messages were sent to the patients? Could the success and/or failure of the intervention have had anything to do with the message sent via text messages? Could we truly say that the text messages increased adherence without assessing the content of the message? Could the excitement of being part of the research have contributed towards motivating the health care provider in giving better instructions or boost them into doing a better job? Could the excitement of being part of the research have contributed towards motivating patients to adhere as opposed to the intervention content itself?

Objective of the Paper

The objective of this paper is to evaluate through previous studies whether mobile phone innovations have helped in improving health outcomes through adherence messages to patients and how many of these studies mention and consider the content going out to patients as contributing to positive or negative health outcome?

Methodology

This paper is a systematic literature review and the selection process followed three steps. The first step was to review the titles that are relevant to the topic. Once this was done, the second step was to review the abstracts of the papers identified as potentially relevant. Once these were identified, it was then that they were downloaded to full text for the complete article. The search for publications was done in electronic databases including Google Scholar, Advance Google, Mendeley, and PubMed. To ensure reliability, two researchers were involved in literature search and concurrence on the inclusion criteria based on the laid out framework. The key words used in the search for publications were terms like “mHealth,” “mAdherence,” and “adherence,” “text messages,” “SMS,” “smartphone,” and “SMS reminders” [9-11].

The inclusion criteria was that the articles had to be written in English and they all had to be focussing on the use of mobile technology to improve adherence to treatment and/or medication. They needed to have been published between the year 2009 and 2016. The articles covered randomised clinical trials, pre and post intervention studies and quasi randomised clinical trials. The exclusion criteria was papers older than 2009, mHealth papers that are not targeted to improving adherence and other systematic reviews on the same topic.

The search did not discriminate on the type of condition because the assumption used was that if mobile technology is successful in improving adherence of non-communicable or chronic diseases, it would most likely have the same results in communicable disease. mAdherence was used in search because it refers to any use of mHealth tools by patients and health care providers to improve adherence to chronic disease management [12].

Theoretical Framework

This paper addresses two important factors; mobile technology as a means of communication and the use of health content sent to patients to improve adherence to treatment. There are two theories relevant to this paper.

Diffusion of innovations theory

The first theory is the diffusion of innovations theory. Diffusion research centers on the conditions, which increase or decrease the likelihood that a new idea, product, or practice will be adopted by members of a given culture. Diffusion of innovation theory predicts that media as well as interpersonal contacts provide information and influence opinion and judgment. Studying how innovation occurs, E.M. Rogers argued that it consists of four stages: Invention, diffusion (or communication) through the social system, time and consequences [13]. The information flows through networks. The nature of networks and the roles opinion leaders play in them determine the likelihood that the innovation will be adopted. Innovation diffusion research has attempted to explain the variables that influence how and why users adopt a new information medium, such as the Internet. Diffusion research has focused on five elements:

1. The characteristics of an innovation which may influence its adoption;
2. The decision-making process that occurs when individuals consider adopting a new idea, product or practice;
3. The characteristics of individuals that make them likely to adopt an innovation;
4. The consequences for individuals and society of adopting an innovation;
5. Communication channels used in the adoption process [14].

This theory relates to this paper in the fact that mobile technology innovations have been used to communicate to the recipients to influence behaviour. Diffusion is the “process by which an innovation is communicated through certain channels over a period of time among the members of a social system” [13]. The journals reviewed in this paper have used mobile technology to communicate adherence messages to patients suffering communicable or non-communicable diseases. The patients targeted in these innovations are those that may not have been adhering to treatment or medication.

Diffusion scholars have shared qualities that determine the success of innovations, which have also been very relevant to the mHealth innovations that have been implemented in the papers reviewed.

Relative advantage: This is the degree to which an innovation is perceived as better than the idea it supersedes by a particular group of users, measured in terms that matter to those users, like economic advantage, social prestige, convenience, or satisfaction. The use of mobile technology has been used to help increase or improve adherence to treatment or medication. The idea of sending short text messages to patients is perceived to be better than having patient rely on their memory to take up their medication or remember to go for their appointments. By increasing adherence, the quality of life for the patients is also improved [15,16]. Effective chronic disease management can result in improved health outcomes and increased quality of life [17]. mHealth has been used by health care workers to improve disease management in facilities and promote patients managing their own health in the privacy of their own homes. Text messaging via mobile phone has become the most frequent form of

adolescent interaction with friends overtaking phone calls and face-to-face communication [18]. The quality of relevant advantage applies as the use of text messaging has been proven to improve adherence.

Compatibility with existing values and practices: This is the degree to which an innovation is perceived as being consistent with the values, past experiences, and needs of potential adopters. mHealth innovations have been implemented in many countries as is evidenced in the publications reviewed. However, it is very difficult to copy and paste the exact same innovation and implement it in multiple countries without factoring in the values and practices for the country of implementation. In some cases, the language used in certain countries is different. Additionally, some countries could have the systems communicating in different languages especially in countries diverse in tribes. If the language is not understandable to the user then the innovation has little chance of success.

Simplicity and ease of use: This is the degree to which an innovation is perceived as difficult to understand and use. New ideas that are simpler to understand are adopted more rapidly than innovations that require the adopter to develop new skills and understandings [15]. This is quality that cannot be taken lightly. Any application developed will only be successful if it is easy to use. The MPESA platform is a great example when it comes to ease of use. No one was ever trained on how to use the platform, but the instructions on the use are very clear and precise and any one can use it. Most of the applications that are developed for use by patients should be just easy to use for them to be successful.

Trialability: This is the degree to which an innovation can be experimented with on a limited basis. An innovation that is trialable represents less risk to the individual who is considering it [15]. Most of the studies reviewed were based on pilots done. The pilots are great as they inform the scalability of the project and people get to learn from any mistakes that may have been experienced in the pilot. Any innovation has to go through a trial so that it can be improved before it goes to scale. This is also an opportunity to get feedback from the participants on the content that is being communicated and how impactful it may have been. It is at this point that content can be improved based on feedback from the participants of the pilot.

Observable results: The easier it is for individuals to see the results of an innovation, the more likely they are to adopt it. Visible results lower uncertainty and also stimulate peer discussion of a new idea, as friends and neighbours of an adopter often request information about it [15]. The mHealth innovations in this review are meant to help increase adherence. The results of the innovation are very useful to the care providers in confirming that the patients' care is improving or not. In most cases, mHealth innovations have indicators that are fed into a dashboard or reports that the health care providers use to monitor the patients.

According to Everett Rogers, these five qualities determine between 49% and 87% of the variation in the adoption of new products. These five qualities make a valuable checklist to frame focus group discussions or project evaluations. They can help identify weaknesses to be addressed when improving products or behaviours [13].

The diffusion of innovations principles were used in a program in South Africa that was launched in 2009 known as Brothers for Life (BLF). It is a program that promotes HIV testing and Voluntary Medical Male Circumcision (VMMC) among other things. For VMMC, BFL used the Diffusion of Innovations principles of Observability and Trialability by interviewing men who underwent the

VMMC procedure and publicizing the interviews through a national campaign using TV and radio. Through storytelling, BFL connected other men to the experiences of their peers and encouraged them to make a decision to go forward with the procedure. In support of these activities, BFL also created an SMS number that men and women could text to get answers to their questions about VMMC and directions to the nearest clinic. BFL successfully increased knowledge of VMMC from 8% in 2009 to 47% in 2012. Statistical data also shows BFL activities led to an increase in VMMC uptake.

Self-efficacy theory

Self-efficacy is the belief of one's own ability to successfully accomplish something. Self-efficacy theory tells us that people generally will only attempt things they believe they can accomplish and won't attempt things they believe they will fail in. They avoid them based on their own personal weaknesses, give up in the face of difficulty and failure, and it does not take much for them to lose faith in their capabilities.

The theory introduces the idea that the perception of efficacy is influenced by four factors:

1. Mastery experience;
2. Vicarious experience;
3. Verbal persuasion;
4. Somatic and emotional state.

Mastery experience: Mastery experiences are the most effective way to boost self-efficacy because people are more likely to believe they can do something new if it is similar to something they have already done well. Mastery experience is the reason why workshops, training programs, internships, and clinical experiences are offered. To develop a strong sense of efficacy, difficult tasks need to be attempted and obstacles worked through.

Vicarious experience: Vicarious experience is the observation of the successes and failures of others who are similar or one's self. Watching someone like yourself successfully accomplish something you would like to attempt increases self-efficacy. We have seen vicarious experience used in trying to persuade smokers to stop smoking by showing images of people suffering from lung cancer or images of a healthy lung compared to one that belongs to a smoker.

Verbal persuasion: The other factor that influences self-efficacy is verbal or social persuasion. When people are persuaded verbally that they can achieve or master a task, they are more likely to do the task. The messages are meant to send reminders to the patients to take medication, appointments and provide encouraging messages to the patients. Through consistent encouragement, they end up mastering the management of their condition without much follow up.

Somatic and emotional states: The physical and emotional states that occur when someone contemplates doing something provide clues as to the likelihood of success or failure. Stress, anxiety, worry, and fear all negatively affect self-efficacy and can lead to a self-fulfilling prophecy of failure or inability to perform the feared tasks. Stressful situation create emotional arousal, which in turn affects a person's perceived self-efficacy in coping with the situation. For example, fear of discrimination or stigma prevents asthma patients from using or carrying inhalers, which are detrimental in their continued asthma care. It is for this reason that mHealth applications are used to encourage patients, provide educative material that informs and empowers them and subsequently reduces the anxiety.

mHealth application and SMS messaging has been used to transmit content to patients suffering from all kinds of conditions. While the diffusion of innovation if followed will ascertain that the system is developed and is successful in its implementation, the content that is being sent to the patient ultimately determines the health outcomes. The adherence messages are meant to help in changing the behaviour of the patient into adhering to medical treatment and any requirements need to impact positive outcomes. Self-efficacy theory would be a good guide in the development of content and what it is supposed to achieve every step of the way [19-25].

Results

In this paper I define adherence to treatment as compliance with or the degree to which study participants correctly followed prescribed medical advice including medication or drugs, medical device use, self-care, self-directed exercises or therapy sessions.

A total of 41 potential articles were retrieved based on the search criteria and abstracts. Full text was not obtainable for 11 articles due to fees to access the document and/or a registration requirement for the websites making the full text inaccessible. Nine articles were published before the year 2009, 7 were systematic reviews, 1 was an Short Message Service (SMS) based study, but was used by community health workers and did not necessarily address adherence, 3 were protocols for a study to be done, 10 articles met all the inclusion criteria as shown in Figure 1 below.

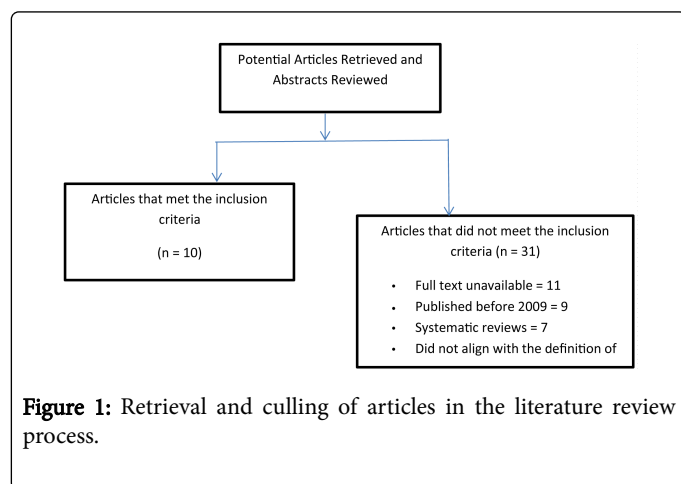


Figure 1: Retrieval and culling of articles in the literature review process.

The review considered studies in both developed and developing countries. Studies are drawn from countries including Canada, Denmark, United States, United Kingdom, Nigeria, China, and South Africa is some of the countries from which the studies are drawn. This shows that the mobile technology is being used for adherence in both developed and developing countries among diverse individuals and that they just need to be designed to the needs of the people within the diverse geographical regions.

SMS messaging was used in all the studies as the method used to communicate and measure adherence. The only difference was in the content, frequency and timing of the message. The duration of the study also varied. One study took two and half years of intervention plus one year of follow-up, there were two studies that took 2 years while others ranged from 4 weeks to 6 months. One of the studies was an outlier taking four days only where a message was sent on the 4th day of receiving the medication and the respondent needed to send

some feedback for the study to measure the adherence level. Four out of ten studies (40%) did not share the process they took to develop the content that was being communicated to the patients. The other 6 studies had a process of developing content.

In a three month follow-up study done for a daily SMS reminder to increase adherence to asthma treatment, a short text message was sent daily at 10:00 am from week 4. The text that was sent out was, “Remember to take your asthma medication morning and evening from the Respiratory Unit.” This 12-week follow-up study showed that asthmatic patients, who receive a daily SMS reminder on their cell phone, remember to take, on average, about 18% more doses of their anti-asthmatic medication compared with asthmatic patient who did not receive such an SMS reminder [26].

Based on participant’s preference, one text was sent out every week in either English or French. The approach used was motivational and reminder messages for example ‘Please remember to take your medication. You can call us at this number: +237 xxxx xxxx.’ Content development was participatory using focus group discussions. Control group participants received usual care with no message intervention. The study concluded that phone text messages did not significantly improve adherence to ART in this study. Other types of messaging or longer term studies were recommended [27].

The study sample for this pilot was on 25 HIV-positive youth. The pilot study demonstrated that a daily, interactive, personalized text message reminder intervention is both feasible and acceptable and shows promise as a tool to help HIV-Positive youth adhere to ART. Larger controlled study would be needed to determine the impact of this intervention especially with focus on the process of developing the content with the participants [28-32].

In a qualitative evaluation done after an SMS intervention meant to improve treatment adherence for blood pressure lowering in South Africa, it was noted that specific elements of the SMS-text messaging relating to content, tone and timing, also contributed to positive appraisal of the intervention. The polite and respectful tone and use of personalised SMS-text messages (e.g. acknowledging birthdays, named health providers) were singled out for generating a sense of being respected and valued. Practical health advice was another valued component and the interactive function (changing appointments via SMS) [33].

The study offered tailored messages according to mother’s gestational week to expectant mothers in rural China using mobile phones. The aim was to improve maternal and child health. The study involved various message categories emphasizing adherence to positive behaviours including reminders for prenatal visits, facility delivery and healthy lifestyles (nutrition and physical activity). Study findings imply that a mHealth intervention using messages can be more effective if participants have a chance to interact with a medical practitioner to discuss the messages for reinforcement and confirmation [34].

The study aimed at assessing the acceptability of and adherence to Rapid Diagnostic Test (RDT) for malaria results for patients seeking care from private sector drug retailers in two cities in Oyo State in south-west Nigeria. A short message was sent one day after testing as a reminder. After four days the participants were called via phone to assess if they had adhered to the Rapid Examination of Malaria and Evaluation of Diagnostic Information (REMEDI) and treatment advice. There was higher adherence among the intervention group and more so on malaria treatment on which participants had been advised on [35].

Through a smart phone app, the study aimed at users' self-efficacy by encouraging the users to rehearse their weight loss goals and reinforce positive behavioural beliefs (about competence, confidence, and mastery). The primary goal was to reduce weight using three key strategies: goal setting, self-monitoring, and feedback. A library of text messages was created and each message was triggered according to progress toward the users' calorie targets. The app was found to be feasible and a highly acceptable intervention. There was improvement in adherence towards positive behaviour change [36].

Tailor made interventions including reminders and cues were designed for adolescents with diabetes type 1. Findings show that the interventions had positive impact in terms of adherence to intended outcomes including frequency of blood glucose measurement and other self-care measures. Nonetheless, the researchers noted that the findings could be attributed to the seasonal effect of the pilot beginning in the winter and ending in the early spring and not in entirety to the intervention [37].

This was an assessment of the effect of automated treatment adherence support delivered via mobile-phone Short Message System (SMSs) on blood pressure. In this pragmatic Single-Blind, Three-Arm Randomized trial (StAR), undertaken in South Africa, patients treated for high blood pressure were randomly allocated in a 1:1:1 ratio to information-only or interactive SMS text messaging, or usual care. Though there was no evidence that interactive intervention was much more effective, generally patients assigned to the two mHealth interventions showed better health outcomes in terms of reduction in systolic blood pressure compared to usual care [38].

Confirmed that Interactive Voice Response (IVR) as a mHealth intervention was more likely to improve adherence when combined with an SMS intervention involving feedback from the care giver (Table 1) [39].

Study Reference	Study Design; Country	Participants	Disease	Aim	Duration	Content Development Process Followed	Method Used to Measure Adherence	Improvement in Adherence
Leon et al.	Randomized control trial- Two focus groups; South Africa	n=22 in 2 focus groups of 11 in each group. 16 females, 6 males	High Blood Pressure	Test the effect of an adherence support intervention delivered via SMS-texts, on blood pressure control & adherence to medication for hypertensive patients	2 Years	Not given	SMS messages	Yes
Dowshen et al.	Pre-Post Design, United States	n=25 Mean age of 23 with ages 14-29 Male-23 Female-2	HIV	To evaluate the feasibility, acceptability, and preliminary efficacy of short message service (SMS) or text message reminders to improve adherence to ART for youth living with HIV/AIDS	2 Years	Patients worked with the study coordinator to design their own personalized SMS reminder messages and personalized follow-up message 1 hour later. Patients were encouraged to develop messages that would respect their privacy	SMS messages	Yes
Cafazzo et al.	User-centred design method, Canada	n=20 Age 12-16 Years	Type 1 Diabetes	To design, develop, and pilot an mHealth intervention for the management of type 1 diabetes in adolescents	12 Weeks	Though the users were used in the development of the system, they did not play a part in the development of content	Automated reminders	Yes
Carter et al.	3-armed parallel group randomized trial-United Kingdom	n=128 Age 18 to 65 Years	Overweight	To collect acceptability and feasibility outcomes of a self-monitoring weight management intervention delivered by a smartphone app, compared to a website and paper diary	6 Months	Not given	Weekly text messages	Yes
Bobrow et al.	Single-blind, 3-arm, randomized	2558 patients were assessed 1372 randomly	High Blood Pressure	Assessed the effect of automated treatment adherence	1 Year	Content was developed, translated and	SMS text messages	Yes

	trial, South Africa	allocated information only SMS text (n=457) interactive SMS text messages (n=458) usual care (n=457)		support delivered via mobile phone short message system (SMS) text messages on blood pressure		tested before it was used on the participants		
Su Y et al.	Quasi randomised controlled trial, China	Enrolment still ongoing	Maternal and New-born Health	Assess impact on SMS advice on maternal and new-born health	38 Weeks	Content was developed and then localized to the local languages. These were then pre-tested for feedback from mothers. These were then reviewed by professors in maternal child health, local leaders and government officials to finalize the version	SMS Text Messages	Yes
U. Strandbygaard et al.	Randomized trial, Denmark	n=29 Age 18 to 45	Asthma	Assess if daily SMS Reminders will help increase adherence to asthma treatment	8 Weeks	Not given	SMS text messages	Yes
Modrek et al.	Double-blinded, parallel group study, Nigeria	(n=457) Allocated an intervention (n=228) Allocated to control (n=229)	Malaria	Assess the acceptability of and adherence to Rapid Diagnostic Test (RDT) results for patients seeking care from private sector drug retailers	4 Days after receiving RDT	Not given	SMS text messages	Yes
Mbuagbaw et al.	a single-site randomized two-arm parallel design trial	HIV-positive adults on ART, aged 21 years and above.	HIV	Assess adherence to ART measured using a visual analogue scale (VAS), number of doses missed (in the week preceding the interview) and pharmacy refill data	Between November and December 2010	Messages were developed based on feedback from Focus Group discussions	SMS text	Did not improve adherence to ART. Other types of messages were recommended.
Piette et al.	Individually Randomized controlled trial	331 patients & 328 care partners	Heart failure	A randomized comparative effectiveness trial testing the impact of systematic feedback to patients' Care Partners, compared to patients receiving standard mHealth monitoring and self-management education	Between June 2009 and January 2012 and were followed for 12 months	IVR calls were developed by a panel including primary care physicians, cardiologists, nurses, and experts in health behavior change and mHealth Calls. Care givers were supposed to provide feedback in terms of a text	IVR and SMS text	Significantly in those that had care givers give feedback compared to those in standard mHealth

Table 1: Summary of the study characteristic.

The chronic diseases analysed were Asthma (n=1), High Blood Pressure (n=2), Diabetes (n=1), Heart Failure (=1), Overweight (n=1). There were two infectious diseases HIV (n=2) and Malaria (n=1). Malaria in this case is being considered infectious even though it is not contagious but can be transmitted to another human through blood transfusion. Maternal and New-born health (n=1) is listed here as well.

Discussion

Almost all the studies 90% (n=9/10) reviewed in this paper show that mHealth interventions have potential to improve adherence to treatment or self-management and care among patients. Literature suggests that some of the factors that affect adherence include

forgetfulness, complexity of medical advice, self-medication where patients diagnosed and prescribed for medication usually do not think they need the medication, and lack of adequate engagement with service providers. Simple interventions such as SMS texts therefore become necessarily important in addressing the barriers thus improving adherence. As evidenced in this review, combining more than one mHealth such as IVR and text message is more interactive and most likely to be more effective in improving adherence. A study among ART patients in Malaysia concluded that Mobile phone reminders (SMS and telephone call reminders) and peer counselling are effective in improving adherence. In previous studies and in measurements of adherence, only 17.6% of the studies used more than one method. This percentage is extremely low, considering that more than one method is widely recommended owing to the inaccuracy of current singular approaches.

The finding that there was no significant improvement in adherence in the study was attributable to measurement of adherence based on interviews. Whereas this could be true as individualized reports are likely to be socially biased, the study also found relatively lower levels of satisfaction (65%) with the intervention messages compared to the other studies in this review. The lower levels of satisfaction could potentially have negatively impacted acceptability of the intervention thus poor outcomes.

The findings in this review suggest that mHealth enhances adherence to medication or treatment thus better health outcomes. Nonetheless, there is no sufficient evidence to show that the improvement on adherence was directly linked to the messages sent to the patients. There is no link between the success and the content sent to the patients. While assessing the success of the innovation, content is rarely looked at as the reason why the innovation passed or failed in the success of the innovation. According to theories and models in communicating health messages by Corcoran Nova, communication as a planned process succeeds when the audience has achieved, acted on or responded to the message.

Overall, it is clear that most mHealth innovations for adherence are developed by technicians or system developers and involve health care providers. On rare occasions communication experts are used to help in the design of the content. Whereas most of the studies reviewed in this paper suggest that the process of intervention development was participatory, description of how participants were involved is brief and does not show full participation including adequate usability testing. According to Kenya mHealth Standards and Guidelines (2017), user involvement in development of mHealth interventions is a key component of mHealth interventions and has great benefits in terms of ownership and sustainability.

The limitation of this study is that the review period was relatively short (2009-2016). However this was in an effort to present the most recent if not current evidence on the impact of mHealth on adherence. It is also inherently evident that most of the studies reviewed in this paper were undertaken over shorter periods of time (between 2 years and 4 days). Whereas this is a limitation beyond this paper, it is a calling for longitudinal studies and long term programmatic efforts that would provide more detailed evidence [40-52].

Conclusion and Recommendations

mHealth innovations will continue to have an impact in health outcomes as many people in developed and developing world are utilizing mobile solutions in their day-to-day lives including in

banking, agriculture, education and health. Previous evaluations have shown that there are benefits in utilizing mHealth in people managing their own health but more importantly mobile solution can make health care more accessible.

While mobile technologies are able to bring solutions to patients in real time, there is need to make sure that the information that gets to the patient is accurate, has been assessed by communication experts and that it is relayed in a manner that will impact health outcomes and not discourage patients. The world today has a very technology-oriented population that will google everything including a diagnosis before they visit their health care providers. It is important that innovations that are being implemented pay more attention to the content, timing, and everything else that could have a negative influence to the message going out to the patient. While having a health innovation may be great, the content being relayed could make or break the outcome of that innovation.

The recommendation of this review is that all the mobile interventions should look at the content of the messages going out to the patient while evaluating the success of the mHealth interventions. mHealth solutions in themselves may have a positive outcome as compared to manual solutions but there might be a possibility that the success and health outcome could be even higher if the implementers took time to develop the content in a much more participatory manner involving target populations, communication experts and health experts.

There is a need to come up with a new theory that would be more relevant to mHealth applications being used as h for communication with the intention of behaviour change. We may need a hybrid of the two theories, the diffusion of innovation and the self-efficacy theories. There is need for communication and health systems scholars to work together and come up with theories that will address communication and health systems that will be applicable h information systems commonly used to communicate with patients to improve health outcomes.

Acknowledgements

Dr. Hellen Mberia and Dr. Lucy Gichaga for your mentorship through the process.

Author Contributions

Cathy Mwangi conceptualized the study, did the literature search, literature review and overall drafting of the first version and review of the paper. Collins Mukanya did further literature review and overall drafting and review of the paper.

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