



Is Mobile-Health the answer to Anti-retroviral therapy non-adherence in sub-Saharan Africa: A Systematic Review

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Abstract

Background: Literatures have shown that mobile phone technology can improve treatment adherence of most chronic diseases, but its impact on ART adherence is not clear. Although the uptake of cell phone in sub-Saharan Africa is high, there are few studies of high evidential value (randomized control trials) on the use of mobile technology to improve ART adherence. This review will examine good evidence from old literatures to determine how mobile technology impact ART adherence in sub-Saharan Africa.

Methods: I extracted information from randomized controlled trails and cohort studies from countries in sub-Saharan Africa on the use of mobile phone technologies on ART adherence. The three main parameters used in this review are methodologies, design and country of study. Among databases looked at are Cochrane, MEDLINE, EMBASE, EbscoHOST and PLoS one. Randomized controlled trail from South Africa, Kenya, Cameroun, and Nigeria and cohort studies from Uganda, Ghana and Mozambique were included in this review.

Results: The literatures reviewed showed that the use of mobile-health improved ART adherence. However, we need to consider what and how support is provided to the patient. The use of contextualized messages, confidentiality, infrastructural problems in sub-Saharan Africa and the doctor-patient relationship need be considered in the use of m-health.

Conclusion: This review recommends and highlights that mobile health is effective in improving ART adherence but is under-utilized. Persons known to the patients and messages that are contextualized are likely to make the best impact. Messages can be motivational, reminders, blood red flags, preventive and educational for both patients and supporter. Through mobile devises adherence can be improved; leading to reduced resistance, morbidity and mortality associated with HIV/AIDS, and improved ART uptake.

Methodology

Introduction

Tele-health entails the exchange of healthcare data and information; it may involve exchange of health information between remote health facilities, persons, health care professional and patients (Handley, 2009). It may involve exchange of images, disease updates, ongoing support and medical information. In addition clinical demonstrations, consultation for diagnostic purposes and educational materials can be exchanged (Handley, 2009). Tele-health surveillance involves the monitoring, management of patient's illnesses and symptoms from a distance using technology like mobile phones. Mobile health is the commonest form of tele-health and it is expanding rapidly in Sub-Saharan Africa.

HIV is a big problem in sub-Saharan Africa. It is estimated that 22million of the 33million people living with HIV in the world are in Africa (South African Nat. HIV survey, 2008). ART initially scarce in Sub-Saharan Africa are readily available now, despite this, adherence levels remain unacceptable with combined adherence rate in sub-Saharan Africa as low as 70 % (Mills et al, 2006). Reasons cited for not taking medications include; side effects, economic reasons, poor state of health, socioeconomic reasons (poverty & unemployment), unsatisfactory health care team or simply forgetting (Iliyasu, Kabir, Abubakar, Babashani & Zubair, 2005).

There is no doubt that ART reduces mortality, morbidity and improves quality of life and outlook to HIV. ARTs are effective and for good success adherence is important: At least 95% adherence is needed to achieve optimal results (Wakibi, Ng'ang'a & Mbugua, 2011). The use of mobile and wireless technologies to transform ART adherence and HIV management has enormous potential in sub-Saharan Africa. The WHO (2011) estimates that the coverage of mobile technology is about 85% world over, covering about 5billion people while The World in 2013 Facts and Figures (2013) contends that Mobile phone use has a penetration of about 96% worldwide and

about 89% in developing countries. The rapid uptake of Mobile phone is because it is cheap, has voice, digital and imaging technology. It is also widely distributed, convenient to use and carry any where we go. In a US study, 95% of the participants found SMS interventions helpful to avoid missing doses and improved self-reported adherence (Dowshen, Kuhns, Johnson, Holoyda, Garofalo, 2012).

This review will examine the impact mobile health has in sub-Saharan Africa and evaluate the extent this has gone to solving the problem of non-adherence. It will examine what else is needed to impact ART in sub-Saharan Africa. It will examine the role of mobile phone reminders in ART management, updates, education and ongoing support. How mobile phone can act as a medium of new health information, appointment reminders and results red flags? Are there better ways of using these technologies to ensure and improve adherence and patient management? Where, who and how has these technologies been used for positive impact and how new policies can be developed to further ensure and improve ART adherence.

Background:

Although, the uptake of cell phone in sub-Saharan Africa is high, it is underutilized in assisting adherence. Previous studies have shown that the use of Mobile phones to improve ART adherence is not widespread in sub-Saharan Africa despite the World Health Organization (WHO) affirming that mobile technologies have the potential of changing the delivery of health services across the world (m-health, 2011). There are also few studies of high evidential value (randomized control trials) on the use of mobile technology in ART adherence in sub-Saharan Africa.

The use of mobile technology have the potential to affect many aspects of disease management; including HIV prevention like VCT uptake, condom use, ART adherence and patient follow-up. The advent of ART and the rapidity with which resistance can occur coupled with the need for frequent doctor-patients contact have led to experimentation with novel ways of adherence management. All these also acted as a driving force for a new field of medicine called tele-health, tele-medicine or mobile-health; a place where technology and modern medicine meets to change health care for the benefit of patients, providers and health systems.

Incomplete adherence to ART is a public health

problem considering the exponential increase in the number of people put on ART in the past 5 years in sub-Saharan Africa. This is made worse by the improved affordability, availability and survival of HIV patients on ART. The upward review of the guideline for commencing ART in recent year has also led to increase in the pool of positive persons on ART, making the need for adherence compliance more important. Further, the explosion of research and medium for the diffusion of knowledge has continually improved the contact between patients, community and health provider on HIV management. Following the advent of mobile phone technology and the rapid coverage of the world, the use of SMS (short message services) and accompanying technologies has impacted ART adherence in more ways than one.

Literatures all over the world have highlighted the place and success of tele-health and mobile-health in improving ART adherence (Wasti, Simkhada, Randall, Freeman, van Teijlingen, 2012; Day & Kerr, 2012). A research examined the use of video-conferencing in the management of patients; it found that apart from video-conferencing providing a visual and audio component to a consultation, primary care givers (usually a nurse) of the patient could take vital signs and examine patients with the specialist seeing the consultation in a clear screen. A six-month pilot study conducted to determine the value of this system in patient care in New Zealand determined that video-conferencing equipment and digital biometric equipment installed in the outpatient departments were successfully used to examine 109 patients across 25 clinics in six specialties. Patients and care givers completed questionnaires while the specialist was interviewed (Day & Kerr, 2012). This study demonstrated that the use of tele-health is quickly advancing and its application in HIV medicine need further enquiry especially in resource limited setting.

Problem Statement:

The use of SMS messages to improve ART adherence has been researched in various parts of the world (Wasti, Simkhada, Randall, Freeman, van Teijlingen, 2012; Day & Kerr, 2012) outside sub-Saharan Africa. However, researchers have not established if m-health are consistently useful in accomplishing ART adherence in Sub-Saharan Africa. Further, there have not been comprehensive reviews to provide policy statements on the best way, form and source of m-health that will work in sub-Saharan Africa.

The use of m-health in other parts of the world for

multiple health care improvement have been demonstrated in various studies; a cross-sectional and mixed-method studies involving 330 ART-prescribed patients in Nepal aimed at understanding factors influencing adherence interviewed three stakeholders: patients, care providers, and key people at policy level. This study found that Healthcare workers need consider practical, cultural and social support as interacting factors with SMS support (Wasti, Simkhada, Randall, Freeman, van Teijlingen, 2012). In another study, a sensor or imaging device installed in a mobile phone or in a household facilitated information transmission to health providers and in turn reduced frequent face-to-face check-up visits to the doctor. This system is most used in European countries and now the United States; can this work in Sub-Saharan Africa? What and how should the state of the patient be transmitted to their health providers to ensure proper context and innovation of diffusion?

Vervloet (2012) and Free (2013) has demonstrated in previous systematic reviews that electronic means are effective in chronic disease management. However, these reviews were not specifically focused on ART, neither were they focused on Sub-Saharan Africa. This review will examine how best to use mobile-health and mobile devices to assist adherence to ART in Sub-Saharan Africa. Will mobile phones act as a good medium for health information, appointment reminders and blood check red flags?

The other aspect of this review is to assess the usability of mobile technology by treatment supporters of patients and monitor their adherence to ART. In providing support structures to the patient on ART can mobile health achieve a dual goal of educating the supporter and provide medium for patient support (Woke, 2015).

In summary the gaps and Problem Statement identified include:

1. What role mobile-health technology can play to improve ART adherence in Sub-Saharan Africa; the use of motivational messages or direct individualized or group reminder messages?
2. Which model is preferred for adherence: inter-patient, patient-provider or patient-supporter?
3. What is the role of m-health in educating the supporter and supporting the patient on ART?

Purpose:

This review will examine the old literatures on how

mobile technology can be used in sub-Saharan Africa to impact ART adherence. It will elucidate the various ways that mobile health has been used in the past with a view to access how these methods could be used in the future. We will also evaluate their strength and limitations, and possible and best ways mobile health can further be put to use to improve ART adherence.

This enquiry will explore quantitative studies done in Sub-Saharan Africa among HIV positive patients on ART and the various mobile-health methods used to enhance adherence. It will explore the best way to use mobile-health devices to improve adherence, knowledge and support (inter-patient, patient-provider, and patient-supporter). Further, this review aims to understand if Mobile Phone Messages delivered through support structures of patients could produce better adherence to ART than if delivered directly to the patient.

Significance:

This review will determine the common benefits derived by the support structures and the patients through mobile messages. It will also determine if diffusion of innovations can provide the buttress patients need to be adherent to ART. It will educate and motivate the support persons to encourage their adherence and prevent HIV infection through diffusion of innovation; it is hoped that by motivating the patients, they also get motivated themselves. It will also determine the benefits derived by communicating health message in a contextualized way to the patients.

At the end of the review, the areas for future studies will be clearly identified, addressed and the methodological advances needed to improve adherence by the use of mobile technology highlighted. This review will integrate studies done on mobile health in the field to HIV management and adherence compliance. The importance of this review for other practitioners, primary care providers and HIV Clinicians will be elucidated to bring about social change. The result will be used to suggest new ways of transmitting health messages in order to be more effective and have wider effects than what we already know.

It would also suggest ways for the supporter to make a more informed decision by educational and motivational messages and improve community health by reduced transmission and infectivity. Social justice, equality and equity can only be achieved through research dissemination, which in turn, can be used for

better evidence based practice and improved ART adherence.

Research Question and Hypothesis

The research questions are:

1. Is m-health beneficial to ART adherence in sub-Saharan Africa?
2. What is the best way of using m-health to improve ART adherence; one for all reminder, motivational or loved one reminder?

Theoretical framework:

The key concept underpinning this review is the use of the theory of diffusion of innovation to achieve change and empowerment. Can the gradual, persistent and continual transmission of information to the patient through mobile technology by his supports improve ART management and adherence? Diffusion of innovation and health believe models of change are at the centre of information and research dissemination through the use of mobile technology. People are empowered by diffusion of innovation and this empowerment brings about social change.

Diffusion of innovation is probably the most important theory in ART adherence. This theory was developed by Rogers (1995) and reviewed by Rogers & Scott (1997). This phenomenon suggests that information obtained through research and evaluation processes are applied to a target population so as to influence their knowledge, attitude and practice. Diffusion of information also includes the transfer of information that has passed through research and medical scrutiny to other medical practitioners or fellows in the same field to influence and promote good practice. The variables of the diffusion of innovation include the diffusion of an innovation through communication channels over time among the members of a social system. Diffusion is a special type of communication concerned with the spread of messages (Adherence to ART with mobile phone) perceived as a new ideas. The four main elements in this theory are the innovation, communication channels, time and the social system.

Since this review deals with the use of mobile technology like short messages to improve ART adherence in the patient and those providing support, the theory of diffusion of innovation is the basis through which empowerment occur. Diffusion of innovation deals with the transfer of information from a source to the recipient through a medium and it

emphasizes factors that determine this change. Information is exchanged if the message is beneficial and the channel accessible. The recipients then eventually transmit it to others through same or other medium, in this case the mobile technology. Through this medium support structures can act as buffers at times of stress; the support system can also receive information and considering the psychosocial state of the patient transmit this information in a less stressful way, time and mode.

Methodology

Inclusion and exclusion criteria

This study is a systematic review of studies done on the use of mobile-health among ART patients. The inclusive criteria include studies used in Sub-Saharan Africa to improve ART adherence for the patients and their support structures. The studies will include quantitative studies of clinical trials and cohort designs.

Theoretical framework and year of study were not limiting factors. The studies included those done in sub-Saharan Africa on the use of m-health or mobile phones in improving ART adherence. Patients' needing these devices for additional psychological or social needs were not included. Studies done in countries in sub-Saharan Africa were also abstracted and compared.

Abstraction:

I extracted information like Authors, title, date of publication, population, methodology, design, intervention and sampling methods from studies used in this review. The two main parameters used in this review were methodologies and study design, and country of study. Databases looked at are Cochrane, MEDLINE, EMBASE, EbscoHOST and PLoS one. Among studies reviewed are mainly randomized controlled trail from South Africa, Kenya, Cameroun, Nigeria and prospective cohort studies from Uganda, Ghana and Mozambique.

Key search terms:

Searches were carried out using the following key words: Tele-health, tele-medicine, m-health, cell phone and SMS in Human immunodeficiency syndrome (HIV) treatment, antiretroviral therapy (ART) adherence, ART adherence and Sub-Saharan Africa. In this case Mobile devices included all form of electronic mobile messages including but not restricted to e-mails, twitter and SMS.

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Theoretical framework and year of study were not limiting factors. The studies included those done in sub-Saharan Africa on the use of m-health or mobile phones in improving HIV management. Patients' needing these devices for additional psychological or social needs was not included. Studies done in specific countries were also abstracted and compared.

Abstraction:

I extracted information like Authors, title, and date of publication, population, methodology, design, intervention and sampling methods from studies used in this review. The two main parameters used in this review were based on methodologies and study design, and country of study. Among databases looked at are Cochrane, MEDLINE, EMBASE, EbscoHOST and PLoS one. Among studies reviewed are mainly randomised controlled trial from South Africa, Kenya, Cameroun, Nigeria and prospective studies from Uganda, Ghana and Mozambique.

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Result

Result**Synthesis of Findings:****Literature Review:**

This review will investigate the use and impact of mobile health in communicating messages to patient on ART. It will also explore alternative ways, methods,

means or types of health messages delivered through mobile means. Will the provider be a good source of ART messages or will a family member known to the patient do better. Will motivational messages or just reminders be better channel for communicating messages? Should ART messages and follow-up reminders be sent by those close to patients since they are more aware of the patients stressful life events and can ensure that adherence messages are delivered in the right mindset and time; they are also more suited to directly supervise treatment and conduct visual pill counts when patients are facing stressful life events (directly observe treatment-DOT).

Cohort Studies:

The Broad-Reach Project in South Africa highlighted the place of m-health in commencement and retention in ART programs. Broad-Reach (2014) used tele-health to reduce the lead "in" time for commencing ART. The purpose of this study was to use centralized telemedicine pharmacy services to reduce lead "in" time to commencing ART. Since the ART roll-out in South Africa there has been a problem of long queues when commencing or procuring monthly ART supplies. In the local clinics the lead "in" time of HIV stage 4 patients or those who immunologically or virologically qualify for treatment has been quite high; 87% at 6weeks and 99% at 3months after qualifying. This often led to loss of lives and patients to follow-up due to incapacity or simple frustration with the system.

The implementation of the Broad- Reach project involved pairing patients up with local private GP where their medications are collected within a median 20-days period using telemedicine pharmacies that communicated with patients phones via short messages when medications are delivered. During the 20-day period all counseling and administrative processes were done. This study showed how telemedicine pharmacies considerably reduced lead "in" time and coordinated community based support for patient through the GP. This study is an example of how telemedicine can save lives and fast track treatment. However, this study did not address adherence issues, making a follow-up telemedicine system to address adherence and patient knowledge necessary.

Mbuyi Reach out in Uganda used data monitoring systems to impact ART adherence. At the Makerere University researchers looked at the development of a monitoring system for HIV adherence using the data obtained from HIV patients in a health center reach out. Mbuya reach is a computer program developed similar to the electronic health system used in Europe and United States to improve HIV adherence

monitoring in the said clinics (Otin, 2004). While the study can be lauded as a starting point in identifying the problems of ART non-adherence due to inadequate monitoring, it failed to give specific adherence monitoring information on specific patients. It will be beneficial to look at the use of systems directed at updating patients on time for medications, results, new innovations, providing inter-patient support and the need for on-going adherence.

The SIM-pill program in South Africa improved ART adherence. Following a glimpse of an application provided by a 2007 Thai study that showed that TB patients who received daily SMS to improve adherence to anti-TB medication showed a remarkable increase in adherence up to 90%; a similar study was conducted in South Africa with the same technique among HIV positive patients-SIMpill. The SIMpill showed an increase to 90% compliance of HIV positive patients attending ART clinics. This was significant considering that previously only 22-60% compliance was recorded without the SMS intervention. Interestingly a similar research showed similar response for other diseases in Spain, Australia, Finland, and Korea; emphasizing the benefits of using mobile technology in areas such as vaccination follow-up, asthma and diabetes self-care. These studies clearly demonstrated that mobile technology can improve adherence to ART treatment (Vital Wave Consulting, 2009). While this clearly demonstrated the impact of mobile technology in improving adherence; it does not give insight into why such remarkable improvements in clinical measure were recorded in sub-Saharan Africa.

The Smart-track system in Ghana improved stock control and hence impacted ART non-adherence positively. An innovative study in Ghana showed a more contextual use for telemedicine in Sub-Saharan Africa in the implementation of Smart track system to improve the uptake of ART. This study identified that in Ghana, despite the free ART there was still obstacles to the delivery and adherence to ART due to lack of accountability in its distribution and theft of medication. This study interviewed 516 HIV-positive patients in rural locations across the country; smart-track was used to track the flow and consumption of ART through a cell-phone based device. The study found that the implementation of smart-track did not only improve adherence but also accountability for the medications (Levine, Hopkins, Rapchack & Subramanian, 2009). This study has a contextual application in most sub-Saharan Africa countries where non-adherence is exacerbated by poor stock control and pilfering of medications. The

backdrop of the smart-track system is that it only informs the patients retrospectively of non-adherence. This system will need to be improved to remind patient of non-adherence on time, so that missed doses can be taken immediately. The current review will consider more proactive reminders and continuous diffusion of innovation to the patient through mobile devices.

The MDNet program implemented in Ghana has been novel in improving ART non-adherence as well as patient-provider-supporter network in HIV management. Another country in Africa that have made significant stride in the use of tele-health in improving HIV related care is Liberia. In Ghana, MDNet mobile phone companies registered physician and provided them with over 1600 free subscriber identity module (SIM) cards linked to telephone numbers within the mobile network. The SIM cards worked with any brand of mobile phone and allowed doctors to make voice calls free of charge, as long as they are contacting other colleagues or patients within the MDNet program (WHO, 2011). According to a 2009 switchboard survey, this initiative improved patient management throughout Ghana health system and improved knowledge of physicians as they were able to get support from colleagues. The MDNet, patients and providers are still discussing the best way to operationalize the free text messaging service originally agreed to by the three partners. According to the 2009 switchboard survey, based on Ghana's success the program was extended to Liberia in 2009 and is currently discussing the possible implementation of same program in Kenya (WHO, 2011). This study was hugely successful because of the patient-physician relationship which was enormously supportive.

Project Masiluleke or the like in South Africa could work for ART non-adherence. Health promotion studies used in addressing public health challenges such as smoking cessation, HIV/AIDS and other sexually transmitted infections are well documented but there are no studies to prove how effective these methods are; a study in South Africa called Project Masiluleke have in the past sent out 1 million SMS messages a day to encourage HIV testing. However, there is no evidence of the effectiveness of these messages in behavior change. These messages were sent to encourage couple testing and counseling (Vital Wave Consulting, 2009). While they may be effective in disseminating information, there has been no study to investigate how effective these systems succeeded to change behaviors, including increase the adherence of persons on ART.

Other projects in this study include a prospective

observational single arm study of 531 Mozambique patients of mainly low-literacy and low-income patients over a 12 month period in 2005 were provided care by a multi-disciplinary team which educated patients about HIV transmission, prevention and adherence by mobile means resulted in 69.5% of the patients with over 95% adherence level to HAART. In addition, over 90% of patients said they had a good relationship with their physician (Magnano San Lio et al., 2009). Text Alert in South Africa has been used to support HIV patients and health providers on Antiretroviral Therapy (ART) adherence. The success recorded has been resounding reducing missed appointment rates from 27% to 4%.

Randomized Control Trials:

Women living with HIV (WLH) are not necessarily provided with post-natal care. Project Masihambisane was a cluster randomized controlled trial in KwaZulu-Natal (KZN) province where peer mentors provided group sessions to improve the outcomes of pregnant mothers living with HIV. In this study there were four antenatal and four post-natal groups. In the study 1200 participants were randomly assigned to each of these groups making a total of eight groups-four for standard antenatal making up 600 persons and four for the intervention group making up 600 persons called Masihambisane (Rotheram-Borus et al., 2011). This study collected data using cellular phones. The results revealed that cellular phones are an innovative and effective way in resource limited settings, and women living with HIV are not equipped to handle challenges of post-natal period (Rotheram-Borus et al., 2011). It also showed that peer mentors can assist in the alleviation of their stress and problems during this period (Rotheram-Borus et al., 2011). This study also illustrates that cellular phones, apart from the usual impact as reminders for medication and adherence, can also be a medium through which support can be accessed in adherence improvement.

Antiretroviral therapy has changed the face of HIV treatment from a "deadly disease" to a chronic manageable disease. A prospective randomized control trial with two arms-the first arm managed in a virtual hospital environment and the second arm a standard care. A virtual hospital was developed as an internet-based home care model covering the management and care of chronic HIV-infected patients. This was called Virtual Hospital. Eighty three patients with similar baseline characteristics were randomized in two arms over 2 year; the virtual-hospital offered four services including virtual consultation, tele-pharmacy, virtual community and library, and

each year patients in each arm were switched. The result showed that 85% of the virtual arm had more satisfaction for access to clinical information and felt comfortable with the tele-videoconferencing. Although, clinical parameters like CD4 cells, viral load >90% adherence, evaluation of quality of life or psychological questionnaires did not change or differ significantly between the two groups; satisfaction level was better with the virtual group. The study concluded that the virtual care is effective in multi-disciplinary aspects of chronic Home-based HIV management since it improved access to clinical data and information, and hence was more acceptable and satisfactory of HIV patients (León et al., 2011).

A Solomon four group randomized study was performed in Nigeria among women attending antenatal to assist in prevention of MTCT. This study involved 144 randomly selected HIV-positive women in the intervention arm; involving women with cellular phones provided with one session of acceptance and commitment therapy and a weekly value-based health messages in 3 months of the pregnancy. The control arm received standard care consisting of post-test counseling only. Each site had 32 pregnant women (a total of 132 women study participants in four sites). The pretest evaluation showed no significant difference between the two arms while the post-test evaluation of the 2 arms demonstrated that the intervention arm had a higher acceptance and action questionnaire (AAQ-II) score. This study demonstrates that the use of mobile phones in the commitment program improved psychological acceptance of women in the PMTCT program.

A Kenyan trial involving 438 patients between 2007 and 2008 showed that SMS intervention can improve ART adherence. The intervention groups were provided with phones where they could receive messages that reminded them of their treatment while the control groups were provided with cell phones alone (Pop Eleches et al, 2011). Weekly SMS messages to patients who initiated ART found that 53% of participants receiving weekly SMS reminders achieved adherence of at least 90% by the 48th weeks of the study. This was significant when compared to those in the control group who received standard care and where only 40% achieved the same (Pop Eleches et al, 2011). This study was a randomized controlled clinical trial and the evidence was overwhelmingly in support of the positive impact of SMS messages on ART adherence. It was also shown that the intervention arm had less likelihood to experience treatment interruption of more than 48 hours in the time period. In this study confidentiality was important and

the participant could use phone for other purposes. A sample message could read "This is your reminder. Be strong and courageous, we care about you" (Pop Eleches et al, 2011).

A similar randomized control study conducted in Kenya where SMS were sent to 538 ART patients as reminders further buttressed the impact of SMS in ART adherence especially in sub-Saharan Africa. In this study the study group patients responded to a message by clinic nurses while the control group was standard care. Typically the nurse asked "how are you" and the patient responded "doing well" or "have a problem" (Lester et al., 2010). The native language of the patient was used. 57% of those in the treatment arm had clinical viral suppression while 48% of those in the control arm reported suppression (Lester et al., 2010). In this study patient that received text messages were at a lower risk of reporting non-adherence after a 12 months period. This study also revealed that patient preferred to continue with this cellular phone programs and the program had additional advantage for those in remote or in war torn areas difficult to reach. This program did not have issues of confidentiality and there were possibilities of handling problems on time through voice calls from the nurses. The program was also inexpensive (Lester et al., 2010)

However, the SMS has not shown consistent results in all studies. Some studies have shown no significant improvement in adherence when SMS and motivational messages are used to enhance adherence to ART. The CAMPS research in Cameroon was a single site randomized trial of two arms and parallel design in Yaoundé, Cameroun. This study was conducted to test the impact of motivational SMS phone messages on ART adherence. In this study outcome was measured at 3 and 6 months via visual analogue scale, number of doses missed and pharmacy refill data while the health provider was blinded to the two arms (Mbuagbaw, Thabane, Ongolo-Zogo, Lester, Mills. et al., 2012). This study showed that motivational messages did not significantly improve adherence to ART; highlighting that motivational messages alone may not be enough to improve adherence in contrary to the Kenyan studies which showed that when health providers known to the patients provided SMS support there was a remarkable improvement in adherence (Scanlon & Vreeman, 2013; Pop Eleches et al, 2011). The findings in this study indicate that trust and proximity of the health messages and their provider may be more important than the intent of the messages.

One problem with the use of SMS and motivational

messages to enhance adherence has been the classification of all patients as a "group" without considering individual difference in mindset, believe systems, literacy and stressors at different times as demonstrated by Pop Eleches et al. (2011). For instance, patients who develop pill fatigue can be depressed or lack support and likely to respond to messages differently at these times. This may be because these messages contradict the basic principles of communicating health messages; the buffer theory of social support and the fundamental cause theory. This is because individuals differ in their experiences, beliefs, social perception and may respond better to contextualized messages that suit their present psychosocial mindset. This makes the same message to everyone, everyday unlikely to succeed in adherence compliance no matter how motivational. In the light of all of the above, it becomes clear that communicating health messages by sending group SMS and motivational messages alien to the patients maybe questionable.

Discussion

Discussion

In a previous review it was shown that all forms of support will positively impact uptake of ART (Woke, 2015). However, Mbuagbaw et al. (2012) demonstrated that motivational messages did not significantly impact ART adherence. In contrast, a Kenyan study demonstrated that when motivational support was provided by health providers known to the patients adherence improved remarkably (Scanlon & Vreeman, 2013; Pop Eleches et al, 2011). This indicates that although support structures were important to the patient adherence, issues of trust and closeness to the source of the messages were probably as important, if not more important (Pop Eleches et al., 2011).

The use of anonymous group SMS messages to improve ART adherence have been long talked about, practiced and researched. Researchers have demonstrated the effectiveness of SMS in improving adherence to ART, but have not explored the difference between group-based SMS or individualized SMS. Further, questions are raised by the gap created by the little work done in the use of mobile technology to improve adherence compared to the rapid acquisition of mobile phone technology in sub-Saharan Africa. One thing is clear from this review, private patients and provider relationship is beneficial in ART adherence and supporting the health provider is an important aspect of ART management as

demonstrated in the MDNet program in Ghana (WHO, 2011).

Another issue is the ownership and use of cell-phones. It is well known that not everybody uses, owns or understands how to use cell-phones; although the WHO has said that the use of cell phones in Sub-Saharan Africa has increased rapidly over the past years, the socio-demographics of the people likely to use them still differ. A cross-sectional study of 883 HIV infected patients receiving ART in Chris Hani Baragwanath Hospital in Soweto, South Africa showed that mobile phones was the commonest reminder used among patients and was also used as reminders of appointment (Madhvani et al., 2015). In a logistic regression, It was found that patients more than 45 years or older, women, and those with only a primary or no schooling level were unlikely to use cell phone (Madhvani et al., 2015). This makes it difficult to decide on the model for the use of cell-phones, as not all may own and those that need them, may not access them. Should cell-phones be dispensed with ART as has been done in some studies?

In addition to the above, the use of cell phones when there is lack of infrastructure like electricity and cellular networks in rural sub-Saharan Africa is worth mentioning. A study in rural Uganda showed that the use of cellular phones and m-health had the potential to improve the management of HIV in these areas (Kunutsor et al., 2010). Lester et al. (2010) showed that being a man, owning a cell-phone, living in the urban areas and receiving reminders will improve adherence. While this is a positive development, the implication is that in areas with problems of lack of infrastructure and phone network, the over-dependence on phones may bring about more missed doses and non-adherence; therefore cognizance and discussion of this common problem must be done where cell-phones will be used and depended on for adherence in sub-Saharan Africa.

Another important consideration in the use of mobile phones is confidentiality, especially in sub-Saharan Africa where household phones and common phones are more likely. The WHO notes the importance of national regulations to protect the privacy of those receiving text messages (WHO, 2013: 180). Pop Eleches et al, 2011 used simple questions unrelated to ART adherence to remind patients of their medication like "how are you". They also used the local languages of the patient to distract suspicion from such messages. This study further suggests that messages must be tuned to the patient's current psycho-social situations to create variation in question and ensure confidentiality while ensuring adherence.

From the foregoing, the use of mobile technology to improve ART adherence is not in dispute, what is not clear is how best it can be used to enhance ART uptake and adherence in sub-Saharan Africa-with its unique terrains and features. From the literatures reviewed the use of m-health must take into consideration how close the support is to the supported and the use of a more contextualized message. It is also important that while support is encouraged, special consideration must be given to confidentiality and the doctor-patient relationship. It is also important earlier on, situations of infrastructural failure or when patients belong to groups (like old age) unlikely to use mobile technologies efficiently; so that alternative methods of promoting adherence can be used when cell-phones, technologies and messages fail.

The WHO contends that factors like patient characteristics, regimen and patient-doctor characteristic determines adherence; while mobile phone technologies are novel and modern in improving ART adherence, it can never take precedence over the doctor-patient relationship and social support from close family, friend and community. This review therefore emphasizes that SMS intervention must be seen as one of the armaments and aides available in the ART adherence tool box. The use of Mobile phone technologies must be seen as trying to better ART adherence and not as a replacement for the role of the patient, regimen and patient-doctor relationship in adherence. The use of mobile phone technologies merely make the use of motivational messages, reminders, follow-up messages, directly observe therapy (DOT) and the diffusion of innovation more efficient.

Strength and Limitation

The studies in this review were subject to within and between study limitations and biases. The demographics of respondents in these studies were variable; especially as they came from different countries. There was also heterogeneity between the studies as they were performed at different settings, time and tested using different theories, methodologies and sample size. Variability in the settings is a significant source of bias as the population type was different; some studies were done in rural, others in urban while some in urban-rural setting. Racial difference was also significant as some countries in this study had significant white and colored population (like in South Africa). While other countries were almost exclusively blacks (like Ghana). These types of variability make a meta-analysis unlikely in this review.

Second, the meaning of adherence was also a source of variability in this review; while self-reporting was used in some studies, visual analogue scale was used in others, better still, laboratory determinants like viral load and CD4 count were used in some other studies. Inter-laboratory and intra-laboratory variability was also a source of variability, just as the cut off point for viral load was in different studies. In addition, adherence could mean 95% viral suppression while in other studies 90% cut-off point was used. Others studies used missed-doses per month, pill counters or pills left behind at the end of the month. Complexity of the ART regimen also varied in the different studies.

The strengths include the restriction of study to sub-Saharan Africa; although a large area, the epidemic is said to have the highest prevalence in this area as a whole. Second, the different studies used in this study were quantitative and mostly clinical trials with few cohort studies. This makes the level of evidence high and strong. Bias was limited by the use of statistical models to arrive at the conclusion in the different studies.

Policy implication

The use of mobile and wireless technologies to transform ART adherence and HIV management has enormous potential in sub-Saharan Africa (Lester et al., 2010; Pop Eleches et al, 2011). Its advantages include: Mobile Health is cheap, has voice, digital and imaging technology. It is also widely distributed, convenient to use and carry any where we go.

On the otherhand, various programs have identified barriers to the use of mobile-health in improving adherence in sub-Saharan Africa including: SMS length restrictions (maximum of 160 characters), language barriers, illiteracy, and lack of support in rural areas. Confidentiality and privacy issues are problems in communities where cell phones are shared within a household, family and communities in low and lower-middle income countries. This is a serious challenge especially in HIV/AIDS, which remain highly stigmatized in Africa (Kaplan, 2006).

Various legislations guide the exchange of medical information and electronic health records in various countries. Legislations similar to the HIPAA and HITECH acts used in the United States are increasingly being used in sub-Saharan Africa to provide new set of challenges with electronic data us in sub-Saharan Africa. Roger's diffusion of innovation is the guiding principle in this study, and it suggests that in the transition of medical facilities and individual information to the m-health system there may be perception and affectation of information, work and

procedural flow. Factors like organizational structures, cultural setting and background of the patients and health facility may militate against this transition. It is therefore suggested that proper strategies be developed to assist this transition to m-health system (Walker & Whetton, 2002).

The projects seen in this study like in the Lesotho Senkatana HIV Clinic showed that mobile phone alarms, phone clocks and family and friends support can be used as facilitators of adherence (Axelsson, Hallager & Barfod, 2015). Others like SIMpill, Smart-tract and Project Masiluleke in South Africa are all programs where health promotion through the use of m-health addressed public health challenges in respective communities. It is imperative that new policies are developed to assist patients, involve communities and compel health providers to support ART adherence and various areas of HIV management that afflict specific communities in question.

Key Stakeholders:

The key stakeholders in this review are the National and provincial Departments of Health, nurses, all the mobile phone companies. HIV care and health care providers in private or public sectors, Social workers, NGOs, treatment supporters', psychologist, psychiatrists and various HIV treatment outlets and support organizations in Sub-Saharan Africa.

Recommendation for social change

Considering that the cost of m-health is low (Rodrigues et al., 2012), the use of m-health to improve ART adherence can go a long way to impact ART management. It can help in improving adherence and monitoring of patients. It can also help in prevention; primarily, by preventing new infection of treatment supporters known to patients and these treatment supporters educating communities. It can also serve for secondary prevention by improving adherence of infected persons hence preventing resistance, and new infections of their spouses (Harm reduction). This will reduce the prevalence of HIV and ensure that HIV levels remain low.

Recommendation for future research:

More researches on the use of cellular phones to improve support by treatment supporters and others charged with patient follow-up are needed. Can mobile devices serve a dual purpose? Educate the supporter and support the patient. Further, studies are needed on the most suited person to provide ART support for optimum results.

Key Recommendation

Literatures are mixed on the best sources and medium of instruction, however, the use of group messages from anonymous senders unknown to the patients do not always lead to the desired effect. Group messages also contradict the basic principles of communicating health messages, diffusion of innovation, buffer theory of social support and the fundamental cause theory. It is reasonable that because individuals differ in their experiences, beliefs, social perception and needs they may require unique messages that suit their present psychosocial mindset. This makes the use of the same message for everyone, everyday unlikely to succeed in adherence compliance no matter how motivational they are. In the light of all the above, communicating health message by sending group SMS and motivational messages by people alien to the patient is questionable.

Further, considering the strengths and set-backs that this study found in the use of mobile phone, identification of the group that mobile phone use will make the most impact is important. Direct messages must also remind patients of the appropriate time for medications and that individuals known to the patients be responsible for this. To this end, a good doctor-patient relationship needs be developed and the support structure of the patient identified and given this task.

It follows that messages associated with faces, persons that care and somebody the patient can revert to in the case of problems may be more useful. Pre-medication counseling may be a good time to identify and incorporate this person. It is also advantageous as these persons may have other means of communicating with the patient in times of network or electricity failure. This avenue may also be a good avenue to educate the supporter and support the patients.

In summary this review recommends and highlighted that:

1. Mobile-health is effective in improving ART adherence but is under-utilized.
2. The person closest, chosen by the patient and/or aware of his HIV and ART status is likely to make the best impact on ART adherence.
3. Messages that are contextualized and take into consideration the patient's current Bio-psycho-social status are likely to make the best impact.
4. Message for adherence can include motivational, reminders, blood red flags and preventive.
5. Messages can be used to educate the supporter and the patient through prevention, empowerment and

diffusion of innovation.

Conclusion

Conclusion

As the population of sub-Saharan Africa grows and the prevalence of HIV/AIDS increases due to better availability of ART; M-health is fast becoming a saving grace and driving force for optimum ART adherence in this region. According to *Pricewaterhousecooper(2013)*. M-health has the potential of saving more than a million lives in Sub-Saharan Africa in the next five years by impacting ART adherence positively and connecting more people, who will in turn support others.

List of Abbreviation:

ART- Anti-retroviral Therapy

ARV-Anti-retroviral

DOT- Directly Observe Treatment

HIPAA- Health Insurance Portability & Accountability Act

HITECH-Health Information Technology for Economic and Clinical Health

HIV- Human immunodeficiency virus

M-health-Mobile health

SA-South African

STI- Sexually transmitted infection

TB-Tuberculosis

UNAIDS Joint United Nations Program on HIV/AIDS

WLHIV or WLH- Women living with HIV

Competing Interest:

I declare no competing financial or non-financial interests.

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