Mobile-Phone Based Patient Compliance System for Chronic Illness care in Nigeria

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ABSTRACT

To improve chronic illness care, patients must be empowered and engaged in health self-management. However, only half of all patients with chronic illness comply with treatment programme. The self-regulation model needs practical tools to help patients adopt this self-centered approach for long-term care. This research work considered a Mobile-phone based Patient Compliance System (MPCS) that can reduce the time-consuming and error-prone processes of existing self-regulation practice to facilitate self-reporting, non-compliance detection, and compliance reminder among patients in Nigeria. The uniqueness of this work is to apply social behavior theories to engineer the MPCS to positively influence patients' compliance behaviors, including mobile-delivered contextual reminders based on association theory; mobile-triggered questionnaires based on self-perception theory; mobile enabled social interactions based on social-construction theory, also explained how mobile phone can help patient to comply to their medication treatment; the existence of mobile phones and its uses in health sectors in Nigeria.

Keywords: Chronic Illness, Association theory, Patient Compliance System, Mobile Phone, Self-regulation.

1. INTRODUCTION

There are several Nigerians who are currently with at least one chronic health condition. Unlike acute illnesses that may be open to short-term intervention, chronic diseases require long-term monitoring and management, lifestyle changes, and adherence to medication regularly.

[1] are of the view that poor adherence to long-term therapies severely compromises the effectiveness of treatment, making this a critical issue in health both from the perspective of quality of life and of health economics.

ICT came into existence in most of the African countries through research institutions, educational institutions, or international organizations like the World Bank, UNDP, USAID, WHO, etc. In 1993 most provinces, Aimaks in Mongolia were provided with personal computers funded by the WHO with the goal to support the health services in the country [2].

In Nigeria, the history of the Internet in universities can be traced to the joint project handled by the International Center for Theoretical Physics (ICTP), Trieste, Italy and Obafemi Awolowo University, in 1999. Also the introduction of ICT into Nigerian teaching hospitals came into being as a result of the INDEHELA project by the Computing Centre of the University of Kuopio, Finland, Obafemi Awolowo University and Obafemi Awolowo University Teaching hospital in the late 80s. In Africa, South Africa is ranked among the top 20 countries in the world with regard to the number of Internet nodes and it is 30 times larger than any other country in Africa. [3]

According to [4], many types of chronic illness, such as diabetes, hypertension, malaria among others, are essentially self-managed diseases and therefore require a collaborative care in which patients are motivated to perform optimal self-management. In view of this, [5] says this is a fundamental challenge, and however to lower the barriers and increase the motivation for patients to adopt the self-regulation approach for long-term care.

Recently, there is increasing interest in using mobile phones and wearable sensors for remote health monitoring. On the other hand, using mobile technology to improve patient compliance is still an emerging research area. For example, Kim and Jeong have used a self-reporting system for patients to input their blood glucose level, diet and exercise diary using mobile phones; based on this information, clinicians sent optimal intervention recommendations to patients using the Short Message Service (SMS) [6]. [7], proposed a mobile phone-based remote patient monitoring system for management of hypertension in diabetic patients, who are requested to report hypertension measurements twice a day and will receive compliance reminders on their phones if measurements are not received on schedule. These studies have primarily focused on self-reporting, fixed-schedule reminders, and minimal non-compliance detection.

In this research work, a Mobile-phone based Patient Compliance System (MPCS) for better chronic illness care will be describe for the self-regulation approach used and how MPCS can work and to address some of its limitations to facilitate its adoption in practice. The uniqueness of this work lies in the use of three social-behavioral theories to provide the foundational principles for the MPCS designed to positively influence patient's compliance behaviors.

2. MOBILE TELEPHONE IN NIGERIA

The telephone system in Nigeria has been having for years. A breakthrough in telephone infrastructure emerged in January 2001 when the sector was totally liberalized with the licensing of MTN and ECONET (mobile phone Company). They injected over a million lines into Nigeria within a year. Also Globacom, Etisalat and others also came into existence there after. The Global System of Mobile Communication (GSM) is spreading in a highly competitive manner from state to state and city to- city. The advent of GSM has greatly enhanced the exchange of information especially in Nigerian teaching hospitals.

Mobile Phones

The use of mobile phones in all the Nigerian teaching hospitals can be traced back to 2001. At that time the Global System of Mobile Communication (GSM) was made available in Nigeria and quickly medical experts in teaching hospitals started using GSM phones. The hospitals surveyed in this study were located within the coverage area of one or more of GSM providers.

According to the interview carried the medical experts on the impact of the mobile phone in the health care delivery in Nigerian teaching hospitals. The interviews showed that mobile phones are used for the following:

    a.   Communication between the wards such as for patient referrals from one ward to another.
        During one of the interviews, a baby was brought to the emergency room for admission.
        The physician was able to facilitate the admission in the neonatal ward via the mobile phone.
    b.   Reaching Physicians. Physicians not present in the hospital may be reached in their mobile phone if there is an emergency. Some doctors post their mobile phone number on wall in their ward.
    c.   Consultation. When physicians need a second opinion they contact their colleagues for consultation via the mobile phone.
    d.   Health care professionals use their mobile phone to get materials or equipment into a particular ward or room.

Long term diseases compromise the quick effectiveness of medications, thereby making patients a regular visitor to the clinician. Thus, there is a need for a self-managed therapy and a collaborative care model in which patients are motivated to perform optimal self-management. This brought about Mobile-phone based Patient Compliance System (MPCS) for monitoring patient compliance and quick illness by the clinician. This research work hereby considers the ways which mobile phones can help patients in complying with medications.

3. ADOPTION OF MOBILE PHONE BASED ON PATIENT COMPLIANCE SYSTEM USING SELF-REGULATION MODEL

According to [8], several frameworks for examining adaptation to chronic illness, such as biomedical or stress-coping models, the self-regulation model is considered to be most comprehensive and flexible. As shown in Figure 1 below, a self-regulation model of patient compliance typically uses a negative feedback loop, which monitors the patient's regimen-relevant behavior. The self-regulation model is compared with the recommended treatment regimen. When deviation is detected, an error signal is generated as a feedback to the patient. If the patient is motivated to comply, he will adjust his behaviors, which will be continuously monitored for the full self-regulation loop (fig. 1).

4. SOCIAL-BEHAVIOR THEORIES

There are several social behaviour theories that can positively influence compliance behaviors, these includes mobile-delivered contextual reminders based on association theory; mobile-triggered questionnaires based on self-perception theory; and a mobile-enabled social interaction

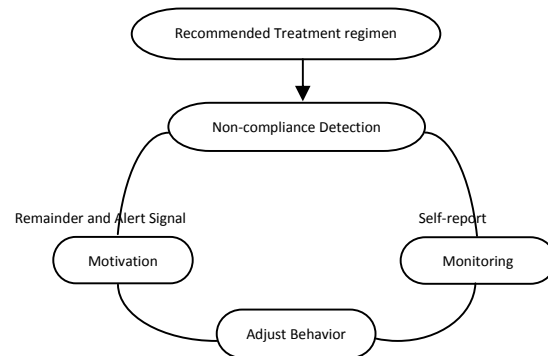based on social-construction theory. These theories are explained as follows:

Fig. 1:   Self-regulation model

Associative Theory

A treatment regimen could potentially be too complex to remember and follow, particularly for people with multiple chronic diseases or difficulties with memory. [7] explained that mobile-delivered reminder systems have shown promise in improving medication compliance; these reminders are mostly delivered using a static schedule, such as sending a pill reminder at 8am every morning. If a pill reminder, however, is delivered out of context, such as when the patient is outside of his home, the reminder is unlikely to be useful. The question is then under what situation a reminder should be sent so patients are more likely to take actions?

Associative theory takes care of this question. The Rescorla-Wagner model is one of the principal associative theories in the area of cognitive psychology, which have been used to infer human behavior for several decades [9]. According to Rescorla-Wagner model, associative mechanisms do not simply count event co-occurrences but rather evaluate those co-occurrences in a broader context of the stream of events. The context of event occurrence plays a major role of causality between events. For example, in patient compliance, the analysis of a patient's self-reports may reveal that he often takes medication after completing his evening work and returns to the kitchen. Delivering a reminder in a context that is similar will more likely result in the patient's compliance in taking medicine (because of the strong association between the context and the action). In respect to this approach, the work for compliance requirements with different timing constraints, and outperform the static-reminder method in improving patient compliance.

Self-Perception Theory

Knowing the cause(s) of poor compliance is important for the clinician to choose an intervention strategy, but it is difficult to obtain this information in traditional practice. When patients are being asked questions consistently for non-compliance, they may lie, which may confuse the clinician. To improve the response rate and accuracy, we

examine self-perception theory, which was developed to improve survey response rates [10].

The theory states that, a survey needs to be designed and conducted in such a way that by responding to the survey, the user reduces cognitive conflict and perceives himself as a generous and helping person. The questionnaire must not make patients feel that they are being blamed for non compliance, rather, questionnaire should ask patients to rate different aspects of the regimen, such as the instruction complexity, taste and smell, perceived effect, perceived side effect, difficulty to open container or to swallow a pill, cost of drugs, and so on. By using a rating system, patients may consider themselves to be helping the clinician improve the regimen and thus to indirectly help other patients using the similar regimen.

In addition, patients should also be allowed to add a free-style comment in case some factors concerning him are not covered by the questionnaire. To minimize typing on a small screen, the mobile interface should allow patients to record an audio clip that can be analyzed by the clinician or coded by researchers.

Social Construction Theory

Adopting a self-regulation approach for long-term chronic illness care imposes a great life-style challenge for patients, particularly when acute symptoms are not evident. The question is how to positively influence the patient and keep him motivated to comply in a continuous way. The importance of family member involvement and community support has been well recognized. [11], and there are existing efforts to build websites that share patients' health data with trusted family members, and that allow a patient community to ask and answer questions about their diseases. Studies have shown that such efforts increased patient knowledge, but were not necessarily successful in changing compliance behaviors. They influence from groups that a patient encounters, including the clinical team, family members, and patient community with similar diseases, can be quite different. It remains a research challenge to understand each group's influence so we can deliberately tailor the group interactions to increase the positive influence on patient compliance.

[12] said if that patient feels attraction to the group, the conformation will lead to strong self-motivation for group compliance. [13], also asserts that while social-construction theory has primarily been used for studying the influence of social factors in adoption of new technology, and useful to study group influence over patients to improve compliance. According to [14], existing efforts have mostly focused on connecting community members for question asking and answering (such as www.imedix.com).

A patient may browse aggregated statistics of his peer group members on the phone, such as overall daily activities (medication, diet, and exercise), average vital and health measurements and readings, and so on. The mobile enabled social interactions allow patients to form a group sharing the same health-improvement goal for a particular chronic illness. By combining this feature with other social application features, such as status updates, community interactions, and knowledge sharing, patients are likely to

be attracted to the group, as evidenced by the popularity of other social-networking sites.

According to the social-construction theory, the increased attraction to the group will influence individuals to conform to group compliance behaviors, which are visible to the patients through group-level shared regimen relevant activities and measurements. In addition, a patient may explicitly define some group members as his friends, such as those he knows in real life, or those introduced by the same clinician, or those he interacts with in the community but decides to establish a closer connection. A patient may feel more confident and can seek skills from his friends for better adherence.

5. SYSTEM ARCHITECTURE OF MPCS

Figure 2 below shows the overall architecture of a mobile phone compliance system. The clinician can submit a recommended treatment regimen, as a set of rules, to the MPCS server, which also receives compliance self-reports gathered from the patient's mobile phone, either using manual inputs or automatic sensing. The users' context information is also periodically inferred and sent to the server, which uses the user context and historical data to determine an optimal reminder delivery schedule. The server also detects non-compliance by comparing the treatment regiment with the self-reports, and triggers a rating questionnaire on the patient's mobile phone. The ratings are used to infer non-compliance reason(s) and the clinician is asked to choose an evidence-based intervention strategy. Family members can also log in to see the patient's health conditions and compliance activities. Patients themselves can interact with their social community through their mobile phones. In particular, they can browse group-level compliance activities of their peers and follow detailed compliance actions of their buddies, as permitted by the privacy settings.
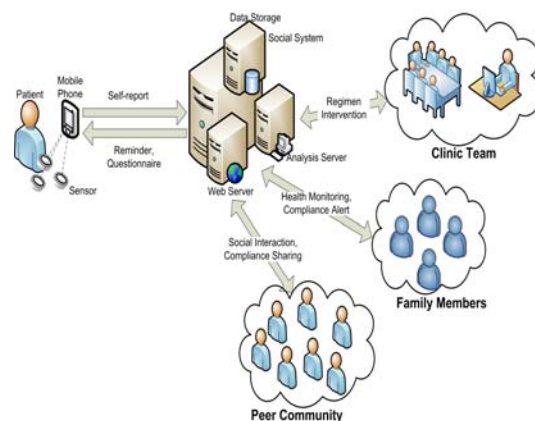

Fig. 2:   The System Architecture

6. HOW MOBILE PHONES CAN HELP PATIENT COMPLIANCE

[14] described how Nigerian doctors use mobiles to communicate with each other across different parts of a large hospital, and to respond to emergencies when offsite

and [15] also assessed the use of mobiles in facilitating information flows for HIV AIDS intervention programs. However, the rapid advancement of mobile communication technologies of numerous opportunities for remote monitoring of such chronic diseases has not been appreciated in Nigeria. The following describes how the mobile phone communication technologies can help improve patient compliance:

Self Reporting Tools
In practice, patients can use a logbook for self-recording and compliance deviation can be identified during periodic patient visits. Patients themselves may be aware of non-compliance if the treatment regimen is simple enough, but it is challenging even for the motivated patients to understand the importance of occasional non-compliance. However, [17] explain that patients need better tools to facilitate self-reporting than traditional logbooks and periodic interviews. Mobile phones, for example, are personal devices that are easily accessible to many patients. Recent phone technology includes bigger screens, faster processors, and open platforms, all of which make mobiles a good alternative for patients to record regimen-relevant activities such as medication, diet, and exercise. [16], further explained that emerging medical and health-related sensors (many of which are portable and wireless) can measure patients' glucose level, blood pressure, heart rate, or activities and automatically transfer the measurements to the mobile phone, from which the data is relayed to an Internet server for storage and analysis, The integrated wireless sensors and mobile phones can eliminate some of the manual-input effort to further reduce the barriers to self-reporting. The auto-sensed data is also likely to be more accurate and can better assist a clinician to detect non-compliance, to monitor symptom development and treatment progress, and to choose evidence based intervention strategies.

Reminder System
Mobile phones can be used to automatically deliver reminders on certain actions that patients should take, such as medication and exercise. [7] recommended for treatment regimen, it is important to know the cause(s) of patient noncompliance for a clinician to choose an appropriate intervention strategy. [11] report stated that there are many potential hard to- predict causes of non-compliance, which could be either general or personal, such as forgetfulness, perceived lack of effect, not understanding the purpose of or the instructions for the treatment, physical difficulties, or even unattractive formulation. While the clinical team can seek this information during patient visits, the patient's answers may not be accurate (e.g., due to forgetfulness or embarrassment) and better intervention strategies may not be adopted due to the delay.

Interactivity
Mobile phone will be useful to deliver questionnaires seeking non-compliance cause(s) when poor compliance is detected, by comparing the recommended treatment regimen and the self-reported compliance activities. We conjecture that this feedback system will collect fine-grained non-compliance behavioral data, which when analyzed will provide the clinicians more accurate and personalized understanding of noncompliance cause(s). [11] report also says that mobile phones can be used as the social interaction devices that enable tighter communications with (and heightened awareness of) the patient's community, and sustain and promote patients' motivations of compliance through social influence from their community.

7. CHALLENGES OF MPCS
According to the research by [17], there are two fundamental challenges in the design and implementation of the MPCS which is discussed below:

Power Consumption
The client application on the mobile phone must run continuously to send data from wireless medical sensors or manual inputs, and to receive reminders, questionnaires, and social updates. For instance the Studies have shown that the battery life can reduce to less than 7 hours if GPS is continuously used (Nokia N95). The device discovery process may consume 100–200mW energy and take about 10 seconds, depending on the particular Bluetooth devices. Once connected, the medical sensor may either automatically start pushing data to the phone or require some user actions to start data transfer, such as pressing a button on the blood pressure monitor or stepping off the weight scale through Bluetooth supports multiple low-power modes once connected, but a mobile phone acting in the slave mode needs to keep the radio on and perform an inquiry scan, resulting in non-trivial power consumption.
Data transmission over a cellular network also incurs significant energy cost on mobile phones. One possibility to prolong battery life (and reduce network charges) is to opportunistically transfer data using a Wi-Fi network, which is becoming pervasive and often supported by latest smart phones. In addition, it may also be sensible to compress the data to save bandwidth, since local computation often consumes less power than transmission. How to effectively manage several radio interfaces, trade off data compression and bandwidth, and trade off compression with transmission delay, remains as an interesting research problem.

Security and Patient Privacy
Medical data collected by the mobile device is extremely personal. It can reveal the patients' dietary habits, daily schedule, disease stage, treatments rendered, medications taken, psychological profiles, and even social relationships. If leaked to the wrong person, it could be devastating to the patients' safety and social life. Without assurance of privacy, patients may resort to lying or omitting details in their reports, the health-monitoring system should provide the following security services: data security, entity authentication, access control, auditing, privacy management, and secure data sharing.

8. CONCLUSION
In this research work there is description of a Mobile-based Patient Compliance System (MPCS) for better chronic illness care. This research work has been able to address the patient compliance through social behavioural theories and limitations of implementing the mobile compliance

system. More so, the new contribution is that its use well-grounded social-behavioral theories as the design principles for a system built with pervasive mobile technology (primarily mobile phones), to positively influence patient behaviors by reducing compliance obstacles and improving compliance motivations.

Patients themselves must take actions to adjust their behaviors to comply with the treatment regimen and Clinicians should motivate their patients always. If they are not motivated, the compliance is unlikely to improve even if non-compliance is detected and they receive pill reminders, deviation alerts, and new treatment interventions. Studies have shown that increasing self-awareness of their own health conditions and treatment progress has positive impact on patient compliance, and social support from patients' community is also important in influencing health outcomes and behaviors.

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