Full Length Research

Effect of Using Mobile Phone Messaging Reminders in Improving Adherence to Treatment of Pulmonary Tuberculosis Patients in Jeddah, During 2016-2017: A Randomized Control Study.

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This study aiming at evaluating the effect of using SMS reminders in improving smear conversion rate and adherence to treatment of TB patients. Through a randomized controlled design, 216 newly diagnosed pulmonary TB cases in Jeddah TB Center assigned randomly to either intervention group, who received daily SMS reminders for treatment along two months, or the control group who did not receive it. The main outcomes were the extent of adherence to treatment and the smear-conversion rates. Chi-square test used to compare the outcomes between intervention and control group. Data analysis was according to an intention-to-treat method. Reveal that the SMS reminders provide a significant difference between the study groups in smear conversion results (72.6% in the intervention group vs. 52.4% in the control group). A positive impact on the treatment adherence in the intervention group has been found (with a P-value <0.001), 95.6% of the participants in the study did not feel disturbed with the SMS reminder system, and they recommend its use in the future. Text-messaging reminders provide a potential intervention for progressing treatment adherence, particularly for TB patients.

Key Words: Pulmonary Tuberculosis, Mobile phone, Randomized control study.

INTRODUCTION

Tuberculosis (TB) is one of the age-old health problems globally. Saudi Arabia is one of the regions where the disease is widespread. It can bring about problems and mortalities for billions of people each year if they are not treated. The threat of TB is more menacing in metropolises hosting visitors from outside. Jeddah City considered as the main gateway of access to Saudi Arabia. The strong financial condition of Saudi Arabia attracted more numbers of emigrants for occupation, with a considerable number of them originated from TB endemic regions including India, Bangladesh, Africa and Pakistan. All these elements resulted in a multiplied risk of tuberculosis in Saudi Arabia that entailed additional public health endeavors to deal with these difficulties and problems (Saud, N. 2014).

The total TB incidence rate in Saudi Arabia is around 16/100,000, and comparatively, the mortality rate in the country is around 1000 every year. Jeddah which is located in the western region has an incidence rate of 24/100,000 that is well beyond the national average and is increasing promptly. Treatment for TB is provided free of charge (Alotaibi, S.M, et al. 2016).

In South Africa a study conducted using mobile phone inventiveness project-2006 in health care, it was ascertained that the SMS reminder service is efficient and as well, it conserves the patients' time and money (Elangovan, R and Arulchelvan, S. 2013). Compliance rate has enormously improved from 40% to 90% with text messaging and SMS reminders. SMS service can help weaken these obstacles for example stigma and secrecy loss (Alotaibi, S.M, et al. 2016). Employing SMS services helped enhanced compliance to medication of affected people with TB by reminding them to consume their medicine in a right time. This service also helps patients to know about the treatment and medicines better (Kunawararak, P, et al. 2011). Everyone access mobile
phones easily nowadays. Thus, the reminder system helps them to keep engaged with the medication schedule. Thus, the people find this option valuable and encouraging. It turns negative only to people with low literacy rate and less access to mobile phones (Mohammed S, et al. 2012).

In recent times, SMS reminder system has been recommended as a mode of encouraging TB medication adherence. The results might be appropriate to adherence to medication programs for other disorders for example HIV/AIDS (Horvath T, et al. 2012), diabetes, asthma and also the cardiac disease (Karanja S, et al. 2011). Text messages might similarly be used to inform and alert health care centers that the tuberculosis patients are taking their medicine regularly (Nglazi MD, et al. 2013).

The medication for tuberculosis is a blend of powerful antibiotics, which should be taken on a daily basis for as a minimum of six months of period. As a role of the strategy DOTS, a health care provider or a TB treatment follower monitors the patient whether he or she takes their antibiotics regularly. Patients as well have counseling and assistance to confirm they do not lose their way from treatment process (Barclay E, 2009).

Tuberculosis is one of the major infectious diseases worldwide, around nine million people infected and approximately a million deaths in the year 2013 (World Health Organization, 2014). Most of the developing countries utilize mobile phone services to meet health demands and requirements. The fast acceptance of cell phones in developing nations has offered public-health agendas unparalleled access to infected people. Mobile phone-oriented interferences to improve treatment adherence has been embraced for several infections, with diverse results (Free C, 2013, Anglada-Martinez H, et al. 2015, Vervloet M, et al. 2012). Though there is substantial attention in the perspective of mobile phone-oriented interferences to develop medication adherence for TB, concrete evidence on their influence is inadequate (Mohammed S, et al. 2016).

There is an uninterrupted growth of mobile technology services all over the world, and the developing nations is not an exception. An enormous access to mobile technology, for example, the SMS service, has contributed a lot in healthcare systems and is named as mobile health (m-Health) (Kay M, et al. 2011). For tuberculosis, researchers have exposed the service and use of mobile phones. For instance, they could be utilized to transfer test center images and ensures to progress report and as well to cut down deferrals in the treatment of tuberculosis. They could be exerted in the treatment and well-being of patients, along within the instruction of healthcare employee. DOTS strategy is one of the services that deal with TB, though it has been established that this strategy creates a significant development in the struggle against tuberculosis, its application still considered as challenging in developing countries. For them, SMS service is absolutely a boon (Person AK, et al. 2011).

Mobile technology service has already been extensively accepted all over the world; its advantages are developing at a fast pace, not only for personal communication but also act as an essential feature of communication in health care institutions too. (m-Health) strategies have been established in treatment adherence and also deal with a range of problems, for example, increasing the accessibility, velocity, and accurateness of diagnostic tests; observing long-lasting disorders, adherence, and delivery of medicinal test result; and increasing patient and healthcare provider communication, diagnosis, infection and tracking, and well-access to medical records (Cole-Lewis H and Kershaw T, 2010).

Mobile health, which is commonly referred as m-Health maximizes the accomplishments of the mobile phone services to offer health in a practical, valuable and tailored method. Employing mobile phones to recover, diagnose, care for, recall and track TB patients can establish to be very efficient in resource-restrained backgrounds, especially when problems for example shortages of health care providers or environmental terrain obstruct efficient TB treatment and control (Ahmed J, et al. 2012).

Reminders from SMS or text messaging are undoubtedly the least invasive to the affected people confidentiality and could be delivered using simpler mobile phones, allowing possible access to a more number of users. Henceforth, SMS services offer an assuring way of encouraging treatment adherence amongst people, particularly those who struggle with chronic disorders and are needed to intake medicines for such a long interval of time (Sarkar S, et al. 2015).

Problem Statement.

SMS reminders have used in healthcare sectors for providing improved outcomes. SMS has been providing a positive impact on the patients’ satisfaction (Kannisto KA, et al. 2014). SMS reminders can provide various advantages to patients which in turn increases patient satisfaction towards the healthcare sector. At the same time, there were only a few studies discussed the SMS that has been used in the health sector and so there is a need for well-conducted research about the effect of mobile SMS in healthcare sectors. Thus, it is clear that existing studies fail to investigate the effect of using mobile phone messaging reminders for improving adherence to treatment of pulmonary tuberculosis patients in Jeddah and so the gaps identified by previous researchers were addressed in this study and explained clearly.
Rationale

The achieving of expected outcomes by the national TB program through implementation of DOTS requires several challenges. Although it has demonstrated that the DOTS strategy is effective in the fight against tuberculosis, its application remains difficult in developing countries. This leading to the need for exploring the potential of m-Health to support DOTS strategy and to gather new evidence on the effect of m-Health, based interventions such as SMS reminders in the improvement of treatment adherence and the smear conversion rate of tuberculosis patients.

Aim

To improve the adherence to tuberculosis treatment during the intensive phase of management and to increase the smear conversion rate.

Objectives

i- To evaluate the effect of daily SMS reminders on the smear conversion rate among newly diagnosed pulmonary tuberculosis patients in TB center in Jeddah city 2017.
ii- To investigate the effectiveness of daily SMS reminders on patient adherence to tuberculosis treatment during the intensive phase of management in TB center in Jeddah city 2017.
iii- To assess the appropriateness of the SMS reminders that used to encourage medication adherence among patients taking anti-tuberculosis medication in TB center in Jeddah city 2017.

Significance of the Study

Tuberculosis is one of the life-threatening diseases in recent days. However, it is curable. But treatment adherence is essential for dealing with any disease and tuberculosis is not an exception. People are fully loaded with pressures and strains these days. They used to work forgetting their diseases and treatments. SMS reminder service is indeed considered as a boon to those people to get cured and to avoid from a dangerous transmission. Thus, the study has set out to explore the importance of using mobile phone messaging reminders for improving adherence to TB treatment. Text messaging is certainly appropriate for behavior change interferences as it considers tailored health reinforcement.

Hypothesis

Null Hypothesis is that reminding tuberculosis patients to take their anti-TB medication by sending daily SMS messages, will not increase the smear conversion rate at the end of the 2nd month of treatment from 60% to 80% (the desired effect size to reach the standard) in Jeddah.

Alternative Hypothesis is that reminding tuberculosis patients to take their anti-TB medication by sending daily SMS messages, will increase the smear conversion rate at the end of the 2nd month of treatment from 60% to 80% (the desired effect size to reach the standard) in Jeddah.

Introduction

Saudi Arabia considered as the third-largest Arab country having a moderate burden of tuberculosis annually. As several infectious diseases under control, TB is one among the diseases which are wide-spread one despite considerable efforts undertaken by the government. By World Health Organization with the success degree of TB treatment, the country considerably falls behind the globally defined target. The patient-centric approach and easily accessible clinical strategies are required. An adherence monitoring system is needed to keep track of patients to complete medication cycle. The technology has taken its place in availing m-Health at every hand on providing services of easy reminders and pre-appointments, and emerging trend of treatment adherence is globally practiced (Al-Hajoj S and Varghese B, 2015).

Role of mobile technology in enhancing healthcare services in the Middle East

The extensive use of mobile technology in the Arab world especially Saudi Arabia will have a positive impact in the healthcare and occupied the 2nd biggest market of mobile phone technologies in the Middle East. It recorded a significant mobile penetration rate of 186 % with advanced fourth generation (4G) technology yielding high bandwidth and transfer rate, and this rapid expansion of mobile usage affects m-Health to be accessible and to help healthcare sector in solving many issues. World Bank reports the m-Health took a big step in halting the spread of chronic diseases like tuberculosis by the expansion of healthcare services and improving the quality.

They also emphasized the Qtel group which is a working group aiming to help patients in managing their health efficiently in the middle east by delivering m-Health innovative solutions. The Qtel group declared partnership with Saudi Arabia’s mobile Health Company in the intention of giving healthcare guidelines and instructions over mobile phones. The health tips from Qtel group through SMS/MMS provide more high quality of services for residents. With 11 million 4G subscribers in 2016 in
Saudi Arabia, the enhanced data mobility and the information delivered up-to-date (Albabtain AF, et al. 2014).

Millions of dollars have been spent by Saudi Ministry of Health (MOH) to implement Health Information System (HIS) technology. The National Guard Health Affairs (NGHA) is one of the existed healthcare organizations that work under different governmental jurisdictions and have several achievements in fields such as Electronic Medical Record (EMR) implementations and integration with SMS services. These services implemented with appointment remainder which has a significant positive sign on the efficiency of services, for example, the rate of missed appointments of outpatients. Furthermore, these healthcare practices that supported by electronic processing which referred to as (e-health) technologies with telemedicine are benefited to the communication of healthcare (Hasanain R, et al. 2014).

Non-attendance of out-patient appointments and evaluation of the efficacy of sending SMS reminders to reduce non-attendance and make their appointments scheduled are serious issues. Form 251 patients who have received SMS reminder, 100 patients contacted. With these 100 patients, 76 were reached and communicated over the phone, and 99% of patients had indeed read the messages, and 97% of patients found that the message was clear and expressed that these messages are useful to remind them the appropriate appointments. The SMS reminders sent in Arabic languages for the patient’s ease of use and clear, detailed messages (Youssef A, 2014).

A randomized trial to understand the impact of daily two-way SMS reminders for the people with drug-sensitive TB. The Zindagi SMS system designed to ensure the adherence to TB treatment.

A protocol of blinded and randomized controlled multicenter study which evaluates the daily SMS messages sent to the patients as a reminder to take their prescribed tuberculosis medication. The SMS strategy will combine with DOTS aiming to increase the cure rate from 65 % to 85% in a group of adult patients (Bediang G, et al. 2014).

The two commonly used mobile interventions of reminders are SMS and voice call or telephone call, the last two interventions which based on the real-time communication for medication reminder is quite costly and network issues concerned with it, therefore, SMS services found to be cheap and SMS text messaging based on store and forward communication are preferable for the regions with the unstable network connections (Haji A, et al. 2013).

A randomized control trial used automated SMS health promotions and reminders were carried out in Mozambique and found that this system improved the adherence regarding medication and not only reminds the patients to collect the medication on time but also complies with dosage instructions. The 88 % of TB patients reported being not having their appointments missed (Nhavoto JA, et al. 2017).

To promote TB treatment adherence by a text messaging intervention, a pilot study conducted to understand the feasibility to access to mobile phones and familiarity in texting and evaluated the low rate of participant refusal with respect to basic features. They found that their intervention by text messaging was well accepted and feasible with greater adherence than the diary (Iribaren S, et al. 2013).

WelTel program enables an interactive text messaging service offering weekly check-ins, and follow-up is done over voice communication when required. This kind of intervention is robust and user-friendly patient engagement m-Health platform in which the initial feedback revealed that most of the health providers, decision-makers, and patients highly value this intervention policy especially in keeping the vulnerable patient’s to be connected to the health care system and also lets the remote patients in regular follow-ups and triage without fail (Mwai L, 2015).

Another study took place in Indonesia tried to find differences between behaviors of the TB patients with respect to drug consumption, either motivation through SMS or directly by health providers. The study conducted on 45 patients with tuberculosis who received SMS messages about drug use and on patients who are monitored by healthcare providers. The SMS used as an applied technology which merely increases the compliance of TB patients and respondents who received SMS reached a high level of compliance with regular drug therapy. Thus, the SMS could use as a substitute for the method to control non-adherence of patients. The advantages of this alternative system remind the patients regarding drug therapy, and more efficient, effective, cheaper and a wider range of services could deliver in a short span of time (Kumboyono, 2017).

The communication through some channels, ranging from face-to-face contact either by email or smartphone apps have their advantage and disadvantage over the cost of its own. The text messaging or Short messaging service has proven in most of the studies representing cost-benefit and especially messages that customized to every individual patient. With different cultural settings and chronic illness, the text messaging interventions have a feasible solution to the challenges in treatment adherence (Dolgin K, 2015).

Prompt isolation of TB patients and an automatic real-time laboratory notification sent via short messages. The mobile phones permit immediate communication, and automatic real-time alerts are also intimated when laboratory reporting system and SMS services are linked together. The outcome of this demonstration reveals that mobile phone SMS significantly reduces the delay occurred in the diagnosis of TB hence isolation of infected patient is taken proper care (Chen TC, et al. 2011).
Mobile technology and Tuberculosis cure- Relevant studies

A cross-sectional study on TB health care workers and TB patients found that the mobile graphics-based communication is effective to support treatment. This mobile graphics-based application is intended to push notification services despite language or illiteracy barriers (Haji HA, et al. 2014).

A pragmatic cluster-randomized trial performed in China, having one control (receiving standard recommendation care) and three intervention arms (receiving reminders about medications and monthly follow-up through text message, medication monitor or both). They conclude that using of DOTS in a country such as China is not feasible and innovative approaches supporting treatment adherence in TB patients are needed (Liu X, et al. 2015).

The complete treatment cycle is considerably lengthy hence timely reminders to the TB patients in the regular form of messages, and telephone calls will help them recover due to the forgetfulness and carelessness. It confirmed that the technology proved to be successful by having variable settings such as Smart pillboxes or uBox timely reminders for medication and also a biometric system with a fingerprint option ensures the regular attendance of patients to the near DOTS centers (Talukdar N, et al. 2015).

The mobile developed software which allowed the health workers to send their medical information for the patients who reside in rural areas and it reduced the hours reaching clinics and able to get quite and short diagnosis. In South Africa, a text-messaging service commonly known as “On-Cue Compliance” enrolls the patients and sends them daily SMS with the languages preferred. A pre-determined time was selected to send a message every day to remind them to take the prescribed Rifafol (West D, 2012).

The recent developments of TB care intersections along with m-Health research. A comprehensive search was performed on PubMed to analyze the articles and promoting adherence with two interventions mainly SMS messaging for reminding patients about their medications and surveillance of drug stock for reducing stock-outs and also informing the patients about the drug availability via SMS. The patients with high-risk targeted with important educational SMS containing the details of local TB clinics own by private sector providers who are well-trained for TB services (Denkinger CM, et al. 2013).

The functionalities of the mobile app on TB treatment and prevention. The main three functionalities assessed are to instruct, inform and record. Most of the apps found to be with minimal functionalities and targeted the healthcare workers and data collection including paper-based notification and tracking. Very few apps were developed to monitor TB patient’s involvement and their care services such as follow-up alerts or reminders and monitoring side effects or interaction with their respective healthcare providers. It suggested that the redefined work with the case of mobile apps to provide services to patients and patient-centered apps are to be developed and promoted. Smartphone apps are the ideal platforms in monitoring treatment adherence. The m-Health tools paired with smartphone healthcare apps increased exponentially (Iribarren SJ, et al. 2016).

RTMM (Real Time Medication Monitoring) combined with SMS reminders aiming to the improvement of adherence. It was studied that the patients receive SMS reminders likely to get medication on predefined time than the patient receiving no SMS or not subscribed the services. The majority of patients expressed that the reminder system indeed helps them and reported their positive experiences (Vervloet M, et al. 2012).

One of the Cochrane reviews analyzed the SMS reminder and proper adherence to TB treatment and evaluated the risk of bias existed. The pre-appointment with telephone reminders considerably increased the clinic attendance to 66%. Concluding that SMS reminders would be useful especially in low-resource settings (Liu Q, et al. 2014).

A qualitative analysis of TB patients carried out in Peru to get their views regarding treatment adherence and their willingness to the use of text messages to mobile phones. The participants expressed their barriers and some facilitators in treatment adherence and also discussed the use of SMS messages which overcomes the obstacle. The insightful information from the participants and their responses yielded more valuable information and expressed what kind of content need to be included. Although the proper efforts have been taken seriously to combat the diseases globally, the TB incidence and hindrance to treatment persisted in low and middle-income countries (Albino S, et al. 2014).

Simulations of text messaging (SMS) to the improvement of medication adherence through interventions by Reinforcement learning (RL). The RL system makes m-Health services more efficient and effective since RL could recognize barriers and produces 5-14% of absolute improvement in treatment adherence (Piette JD, et al. 2015).

Text message use and their preliminary perceptions on m-Health intervention with WelTel LTBI (Latent Tuberculosis Infection) trial, in Canada. The perceived value of WelTel intervention is health providers can improve the contact with their patients. The mobile health technology with text messaging services is considered as an innovative idea in the engagement of patient care, and it will make health care accessible available to all (Romanowski K, et al. 2016).

A novel approach is comprising private sector assisting them with mobile phone software and communication campaigns substantially held. The family doctors and their patients are reported about their sputum test results via text messages. Brief interviews are conducted to
analyze work experience, oral communicational style and the comfort using a mobile phone in treatment among community health workers and the candidates were given training on counseling patients and screening through mobile phones. The mobile phone software was used to submit, collect and retrieve data by screeners who are termed as healthcare workers. The mobile-phone-based mass screening is done by community lay people, and this mass campaign encourages self-reporting and mass elimination of TB (Khan A.J, et al. 2012).

Medical adherence with DOTS (Directly Observed Treatment Short course) and m-Health

Voice-Med-Alert is a tool of m-Health providing a kind of medical alert system which makes calls and sends SMS to TB patients reminding and prompting them about their drug intake. The patients will receive alerts over drug intake and dosage description and ensure adherence to treatment regimen and the prescriptions are sent via text messages and voice calls (Okuboyejo, S and Eyesan O, 2014).

A comparative analysis of m-Health effective options such as voice calling and messaging service in adherence to TB treatment. A Wise-pill is a product designed to transmit data to the central server whenever the patients' pill container is opened. The MDOT (Mobile Directly Observed Treatment) model for TB outcomes is applied using the combination of text messaging and video chat to encourage TB medication and to reduce the burden of DOT in rural areas (Betjeman T.J, 2013).

A systematic review reported interventions through text messaging have increased patient adherence rate to 85%. Medication adherence measured by various factors which included self-reporting, medical records, pill counts, pharmacy refills, laboratory values and different monitoring system and among all the measures, it was found that self-reporting is a simple method which measures adherence more accurately with 41.2% of treatment adherence (Sarabi R.E, et al. 2016).

The assessment of feasibility and evaluation of acceptability with respect to adherence reminders revealed that text messaging and voice calling are equaled affected when changing the phone numbers. Non-adherence to treatment is still a challenging one to measure, with a patient of having no literary knowledge or people with no awareness of high risk. Health workers and medical providers are expected to be playing their main role in reaching patients' phone numbers to get notified about their medication regimen (Oren E, et al. 2017).

The insights into barriers to the utilization of m-Health were perceived from the interviews of providers and patients. The m-Health intervention for TB treatment was found to be a user-friendly, low-tech and was acceptable to both healthcare providers and patients (Hirsch-Moverman Y, et al. 1999 - 2017).

SMS Reminders and DOTS (Directly Observed Treatment Short course) Strategies

Mobile health (m-Health) and Electronic Health (eHealth), both of them referred to as digital health occupy a significant space in curative and prevention services in an affluent manner. Digital health products are aimed to take part in daily life of TB practitioners and TB patients. The potential and wide use of mobile phones influence the outcomes of the patients declared by most of the researchers (Falzon D, et al. 2016).

Five intervention categories for m-Health that aiming to improve TB adherence:

1. VOT (Video Observation of Therapy)- Using smartphones patients record their videos by themselves and letting health care workers see the videos by using facial recognition and motion-detecting software.
2. Indirect monitoring technology and Patient-facilitated (IP) - A free call or SMS is sent to the central server by patients after ingesting their medication.
3. Indirect monitoring technology and Device-facilitated (ID) - A message is transmitted to the central server wirelessly when the patient opens the cap of the medication bottle.
4. Direct monitoring technology with embedded sensors (DE)- A wearable hub connected to patient's body which wirelessly transmits data to the central server and when the patient intakes the medication an ingestible sensor equipped with it will transmit the data.
5. Direct monitoring technology with metabolite testing (DM) - a low-cost encrypted chromatography with urine test strips will detect the drug metabolites in patients’ urine, and code generated with it and this code are sent to the central server via SMS by patients (DiStefano, MJ and Schmidt H, 2016).

A recent innovation in daily TB treatment with VOT (Video Observed Therapy) and it is highly feasible for mobile applications. This strategy of communication avails health professionals to monitor patient's medication, address concerns of the patient and provide support and advice through video-enabled cellular devices. The reliability of smart phones with video applications become affordable and improves access to those technologies. The VOT is seen as a new patient-centered option supporting TB patients and offers freedom to have their medication where and when they decide to intake (Story A, et al. 2016).

Impact of DOTS (Directly Observed Treatment Short course) and SMS reminders in treatment adherence

The intervention with interactive SMS which is not too automated and not simply sending of reminder...
messages. The SMS-based interventions help for the future guidance and development. The mobile phone’s commonly used feature is SMS more economical than a voice call, hence the affordability and reliability is assured. The main intention for the intervention with SMS is to establish a more personal relationship and observe the problems that could be faced during the short course of treatment adherence. SMS or text messaging is applied to an array of m-Health intervention (Iribarren SJ, et al. 2014).

The primary outcome measures and concluded Electronic pillbox reminders delivers not only the text messages alone but significantly decreased the no adherent months by 17%. This effect was robust when these reminders as text messages added with pillbox reminders. Approximately, one-third of patients randomly selected experienced substantial and non-adherence to an intermittent regimen, and it was analyzed that reminders with pill box for the complete course of treatment help the patient to follow medication regimen (Metcalf JZ, et al. 2015).

Through proper reliable text reminders, mobile phones are utilized to ensure the quality of care, quality of life, medication adherence, behavioral change, disease surveillance and prevention of risk state (Devi BR, et al. 2015).

Healthcare delivery in a rural area where there is a persistent shortage of health workers. The geographic barriers and difficulties in bridging patient-physician gap solved by m-Health interventions which provide a cost-effective solution to these communication barriers in the case of rural hospitals. (Mahmud N, et al. 2010).

The missed dose rate and interrupted treatment rate in the SMS group were significantly lower than those in the control group. Thus, the management of pulmonary TB through SMS effectively reinforces the treatment completion, reduces their missed dose rate and enhances their reexamination awareness. Therefore, SMS considered as a promising therapeutic strategy to the treatment adherence of TB patients (Fang XH, et al. 2017).

Rapid communication through text message using SMS with DOTS. The day-to-day SMS intervention sends the details of the referred patients to STS (Senior Treatment Supervisor), and this strategy reduces communication gap as persisted in the previous postal system. From the study 4.5% of treatment adherence achieved by sending SMS over mobile phones. Hence SMS reminders are known to be an important tool and achieved the optimal feedback with a limited resource (Vivekanand K, et al. 2017).

Impact of mobile-based applications in enhancing quality of healthcare services

Smartphone medical applications play a major role in women’s health by taking personalized tests and improving the behavior of health. It is the platform for supporting and improving the quality of healthcare services for women in pregnancy. The mobile medical application helps in weight loss, heart disease, and some mental health issues. It also supports for other health concerns. This application used for quick processing of information which helps them by sending messages. Nowadays, people feel easy, trustworthy and motivational to use this application (Derbyshire E and Dancey D, et al. 2013).

IPT (Isoniazid preventive therapy) hinders the active TB patient’s adherence with latent TB infection. The ministry of health, the regional health bureau and the hospital and health workers, should create a design and deliver the health education messages towards risk factors and health service providers should engage in promotion of better adherence with mobile technologies. An increased usage of memory aiding system helps in IPT adherence in which the memory aiding tools stick to the exact time of dosage and health providers are engaged with patient’s treatment adherence (Abdulalim E, et al.2016).

The vision of m-Health and their advancement in providing health services and the power of communication via mobile devices to combat against chronic diseases like tuberculosis. It was suggested that the government and non-governmental organization should work together to get powerful mobile technologies to promote treatment adherence (Sweileh WM, et al. 2006–2017).

TB Manager system which works with a dialogue box and the user can login into the system to access their medication details. The reminders sent to regional supervisors and follow-up phone calls are also enabled. All those responses are logged in a Survey Gizmo application to maintain confidentiality and anonymity of the responses. The e-TB manager (TB management information system) got high ratings regarding improved patient’s care, more reliable and satisfied with e-learning (an online education service) methodologies (Konduri N, et al. 2017).

METHODOLOGY

Study Area

The study was carried out in Jeddah city, which is one of the largest cities in Saudi Arabia after the capital city, representing its importance as the western gateway and known as “The Bride of The Red Sea.” The population of Jeddah city are about (4,108,156), (2,062,236) of them are Saudis. The study was conducted in the main governmental clinics diagnosing pulmonary tuberculosis working under the umbrella of Ministry of Health, which is in Jeddah TB Centre, where the office of the National TB program located in from ten years ago. Jeddah TB Centre is a government building, includes five outpatient
clinics, receives daily from 80-100 cases, and usually any patient diagnosed as new pulmonary TB case starting on CAT-regimen is following in these clinics under the guidance of the National TB Program. It serves all classes of society Saudis or non-Saudis regardless their eligibility. TB center is carrying the tasks of the chest outpatient clinic in hospitals where individuals with any chest complaint could attend, with no facilities for hospitalization. TB center has functions such as: identifying TB suspects among all attendees, investigating TB suspects identified to confirm or exclude active disease, performing smear microscopy for diagnosis and follow-up, prescribing treatment protocol for confirmed TB patients, ensuring patient adherence to treatment.

**Study Design**

Randomized controlled trial, divided the recruited patients into two groups:

Group I (intervention group): Patients who provided with daily SMS based reminder for doses of DOTS treatment.

Group II (control group): Patients who evaluated without providing any SMS based reminders for DOTS treatment or dosing.

**Study Period**

This research conducted from 11th June 2016 to 30th August 2017.

**Study Population**

All the newly diagnosed pulmonary tuberculosis patients (Saudi or non-Saudi) in Jeddah TB center during the study recruitment period from 17th July 2016 to 16 March 2017.

**Population Criteria**

The following criteria set:

**Inclusion**

- All patients with newly diagnosed pulmonary tuberculosis.
- Age group of 13 and above.
- Patients with least one positive test out of two smear tests will be included in the study.
- The patient must know to use mobile phones properly like reading text messages and open messages.

**Exclusion**

- Pregnant females and children below 13 years.
- Patients who require to follow up at the private sector.

**Sampling**

**Sample Size**

A representative sample size was calculated based on detecting the desired effect size in improving smear conversion rate (which is one of the main indicators used for evaluating TB control activities that reflect the outcome and achievements of the NTP) by 20%. That was targeted because the average of the smear conversion rate in Jeddah through the past five years was 60.3% and there is a need to improve it at least to reach 80%.

Accordingly, by using Raosoft program, the estimated sample size was: 191. To compensate for the expected lost to follow-up, the re-estimated sample size was: 200. At = 0.05 and power = 0.8.

The total sample size collected by the researcher in this study was 216 patients had been evaluated (113 as intervention group and 103 as a control group).

**Sample Technique (Randomization)**

Participants who founded to be eligible for including in the study by each physician had consented to participate in the study, then had registered by the nurse in charge of each clinic by filling the first compartment of the data collection sheet, which was collected from the clinics by the head-nurse on a daily basis. Then gathered by the researcher twice times/week for their random allocation by shuffling the box that contains 200 sealed envelopes (100 for the intervention group and 100 for the control group). So, this guaranteed equal chance for each participant to be in each group. Service providers were blinded to allocation.

**Data Collection Tool**

Data has been gathered through a structured data collection sheet was designed by the researcher after reviewing the literature (Bediang G, et al. 2014, Kannisto KA, et al. 2015).

The data collection sheet constituted of two separate compartments of variables:

Compartment (A): that consisted of sociodemographic data {gender, age, and nationality}, and data related to the case {medical record number, mobile number and the preferred language of the SMS reminder} (appendix4).

Compartment (B): that consisted of four parts in addition to the patient’s name and file number at the beginning of the sheet (appendix5).
Smear conversion result.


iii. Furthermore, we have been assessing how well members keep their arrangements toward the finish of the second month. We were utilizing a clear-cut variable: ‘3 and more visits’ or ‘1-2 visits’ or ‘no visits after the determination.’ We depended on the fact that the protocol of follow-up visits during the intensive phase of management in Jeddah TB center scheduled as: One visit after a week from starting treatment then the visits become after each two weeks, then the last visit at the end of the 2nd month of treatment. To consider the number of attended visits as a measure of adherence, this adapted from the Cameroon study (Bediang G, et al. 2014). But, the frequency of the attended visits categorization was based on Jeddah TB center schedule for follow-up.

iv. We have been assessed the appropriateness of SMS reminders by adopting five items organized questionnaire (which are: satisfaction, usefulness, easiness, harm and future recommendation) in view of Technology Acceptance Model hypothesis (Kannisto KA, et al. 2015).

Operational Definition of the ( Appropriateness of SMS Reminders)

Intended by appropriateness (satisfaction of the patient, usefulness of the reminders, easiness to use, causing any harm and future use recommendation by the patient).

Data Collection Technique

All patients who newly diagnosed as pulmonary tuberculosis and who advised for DOTS treatment (CAT-) regimen in Jeddah TB center within eight months from (17th July 2016 to 16th March 2017) included in this randomized control study. The usual diagnostic procedure of the National TB program will be followed, which is that all patients with clinical signs of pulmonary tuberculosis will undergo two smear tests. At least one of these tests must be positive. The used data collection sheet constituted of two separate compartments of variables:

Compartment (A): that was filled immediately after diagnosis of the condition. After filling it, the head-nurse was collecting them on a daily basis, and a mark was set on each record to diminish the danger of them being overlooked by facility staff. Amid the enrolment stage, the researcher was in charge of gathering these forms from the head-nurse twice times/week for their random allocation by the sealed envelopes method into one of the two study groups. Then a phone call was held with each member enter the intervention group after randomization to make sure the mobile number is accurate, and for the continuous updating of the mailing of SMS respectively. The language of the remainder based on the participant’s preferences, the Arabic and English reminders formulated by the researcher then when we had to deal with other languages (Amharic and Ordo) we have translated it in their embassies.

Compartment (B): which filled for each case at the end of the 2nd month of treatment by their physicians. They were gathered from the clinics by the researcher regularly.

The status of every patient was in view of the consequences of smears conversion tests done in the second month of the treatment. At the second month, two situations were conceivable. If the smear test was negative, treatment proceeds as a continuation stage amid the following four months patient was considered smear change case.

If the test at the second month was positive, a smear test was performed again after one month, and this means extending the intensive phase by one month (which is not compulsory for this study). At that situation, the patient was not considered a smear change case in the study. Members lost to follow-up, were considered missing. Initially, we have gauged the effect of SMS reminders on treatment adherence. Treatment adherence was assessed by quiet self-assessment in view of the visual analogue scale (VAS), amid follow-up visit at the end of the second month. Treatment adherence surveyed by requesting the patients evaluate their adherence to treatment on a 0 to 100% scale amid the most recent 30 days before the visit. That was giving an adherence score and recorded by the physician in charge of the follow-up of these patients. Furthermore, we have been assessing how well members keep their arrangements toward the finish of the second month. We were utilizing a clear-cut variable: ‘3 and more visits’ or ‘1-2 visits’ or ‘no visits after the determination.’ We depended on the fact that the protocol of follow-up visits during the intensive phase of management in Jeddah TB center scheduled as:

One visit after a week from starting treatment then the visits become after each two weeks, then the last visit at the end of the 2nd month of treatment. Thirdly, we have assessed the appropriateness of SMS reminders with a five items questionnaire. That part only applied to patients in the SMS group, since patients in the control group did not receive reminders.

Before the onset of recruitment, a meeting held with the staff individuals from the treatment facilities. This was to advise them about the point and targets of the study and
approve the systems for the execution of the study (consideration of members, accumulation of data, utilization of VAS by patients to assess adherence, utilizing the survey to assess the appropriateness of the SMS reminders, transmission of data and so on). No less than one session to oversee staff individuals has done in every clinic with the goal that data accumulation stays successful and reliable. Treatment clinics confronting issues were getting further advice and supervision at suitable interims.

**Pilot Study**

A pilot study led, 10% from the sample size of the intervention group was chosen to plot the possibility of data accumulation and to recognize the reasonable troubles and discover methods for limiting it. Because there was no change in any steps of collecting the data and dealing with it, this 10 % included in the study sample.

**Data Processing and Analysis**

The data has been analyzed using Microsoft Excel and SPSS (Statistical Package for Social Sciences) software version 21. Descriptive analysis was done by calculating mean ± SD for quantitative data, frequency, and proportion for qualitative data. Data analyzed to test the significance of statistical difference. The student’s t-test was used to compare between the groups of quantitative data, whereas the Chi-square test and Fisher’s exact test used for qualitative data. P-value considered significant if p<0.05 at a confidence interval of 95%.

**RESULTS**

Out of 216 pulmonary tuberculosis recruited patients, 113n and 103n were intervention group and control group respectively. The total response rate in the intervention group were almost 90n (80%) while 84n (81.5%) in control group that completed until the end of the proposed study period. There are three main compartments addressed in the result section: demographic characteristics, adherence measures (smear conversion, VAS, No. of visits for follow-up) and assessment of the appropriateness of the SMS reminders. Table 1 and 2 shows the demographic characteristics of the study participants, which has shown that there is no significant difference between the control group and the intervention group according to the gender, nationality and age factors, which means that the two groups are similar and matched for most factors except the intervention factor. Patients in both groups were predominantly male, non-Saudis and the average age was 34 years ranging from 14-80 years. Figure 1 and 2 shows the details of different nationalities of the TB cases, which included in the study according to their group, statistical analysis revealed that there is no statistically significant difference in nationality between the two groups.

Table 3 shows that there is a highly statistically significant difference between the control and the intervention groups in smear conversion results (t:2=18.459, P<0.001). Almost three-quarters (72.6%) of the intervention group converted to negative smear at the end of the 2nd month of treatment compared to only half of the control group (52.4%), with an effect size of 20%. Table 4 showed that the intervention was beneficial in making a difference in the smear conversion results regardless of the gender, the nationality, and the language of the reminder, however, with no statistically significant difference. Also, Figure 3 displays that, although the cases who showed negative smear conversion were younger than those who remained positive (mean±SD; 32.6±14.5 vs. 38.8±19.2 years), this difference is not statistically significant (p<0.05).

Results from Table 5 shows that there is a significant statistical difference between the control and the intervention group according to the Visual Analogue Scale (VAS) rating of the patient adherence to his anti-TB medications. Table 6 and 7 shows that 95.6% of the respondents agree that they are satisfied with the text message reminder system. And, 92.2% agree that the reminder system is easy to use, 95.6 % expose that they do not feel disturbed with the SMS reminder system.

**DISCUSSION**

TB control in the Kingdom of Saudi Arabia is an approach within the national health system for control of TB. It has specific objectives for the fight against tuberculosis: to detect more than 90% of the estimated TB cases, to cure more than 85% of identified patients with pulmonary smear-positive TB using standardized treatment, to ensure universal access to all TB patients to high-quality diagnosis and treatment, to prevent TB transmission in the community. The main objective is to set the stage for elimination of the disease by reducing the incidence rate of TB among nationals to < 1 new TB case per 100,000 population. There is sincere hope to achieve this target by the year 2040. Implementation of National TB program has started in the early seventies in successive phases to achieve the targeted objectives (Abouzeid MS, et al. 2014). These goals raise numerous challenges in the fight against tuberculosis, regarding infrastructure, organization, socio-political context and funding (Bediang G, et al. 2014, Sandhu GK, 2011). The challenges for public health are the capacity of the program to detect a significant number of pulmonary TB cases, to maintain...
Table 1. Outcomes of the study

<table>
<thead>
<tr>
<th>Study objectives</th>
<th>Outcomes of the study</th>
<th>Measure of outcomes</th>
<th>Type</th>
<th>Statistical analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Smear conversion rate</td>
<td>Bacillo-scropy at 2nd month</td>
<td>Percentage of patients with +ve or -ve results</td>
<td>Categorical</td>
<td>Chi-square</td>
</tr>
<tr>
<td>2-Adherence of patients to treatment (at 2nd month)</td>
<td>A) Patient’s adherence self-assessment by (VAS)</td>
<td>Percentage of adherence to treatment during the last 30 days</td>
<td>Continuous</td>
<td>t-test</td>
</tr>
<tr>
<td></td>
<td>B) Number of visits for follow up</td>
<td>———</td>
<td>Categorical</td>
<td>Chi-square</td>
</tr>
<tr>
<td>3- Participants’ feedback on the appropriateness of SMS reminders.</td>
<td>A) Satisfaction.</td>
<td>———</td>
<td>———</td>
<td>Frequencies tables</td>
</tr>
<tr>
<td></td>
<td>B) Usefulness.</td>
<td>———</td>
<td>———</td>
<td>———</td>
</tr>
<tr>
<td></td>
<td>C) Easiness.</td>
<td>———</td>
<td>———</td>
<td>———</td>
</tr>
<tr>
<td></td>
<td>D) Harm.</td>
<td>———</td>
<td>———</td>
<td>———</td>
</tr>
<tr>
<td></td>
<td>E) Recommendation for future use.</td>
<td>———</td>
<td>———</td>
<td>———</td>
</tr>
</tbody>
</table>

Table 2: Characteristics of the study groups

<table>
<thead>
<tr>
<th>Demographic characteristics</th>
<th>Intervention (n=113)</th>
<th>Controls (n=103)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>80 (70.8%)</td>
<td>68 (66%)</td>
<td>0.450</td>
</tr>
<tr>
<td>Female</td>
<td>33 (29.2%)</td>
<td>35 (34%)</td>
<td></td>
</tr>
<tr>
<td>Nationality:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saudi</td>
<td>29 (25.7%)</td>
<td>16 (15.5%)</td>
<td>0.067</td>
</tr>
<tr>
<td>Non-Saudi</td>
<td>84 (74.3%)</td>
<td>87 (84.5%)</td>
<td></td>
</tr>
<tr>
<td>Age:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>34.5±14.20</td>
<td>34.8±14.72</td>
<td>0.901</td>
</tr>
<tr>
<td>Range</td>
<td>14-78 years</td>
<td>16-80 years</td>
<td></td>
</tr>
</tbody>
</table>

people in the program and to cure most of them to prevent drug resistance (Sandhu GK, 2011).

The World Health Organization’s DOTS strategy was introduced to Saudi Arabia in 1998, which is highly cost-effective and it is the sole strategy that could save lives of millions and decrease the chance of emergence of drug-resistant tuberculosis strains (Abouzeid MS, et al. 2014). Although the DOTS strategy has demonstrated a significant improvement in the fight against tuberculosis, still in the developing countries its implementation is hard to reach Borgdorff MW, et al. 2002).

This study through its fundamental purpose has the potential to support the DOTS strategy in achieving the expected outcomes. This study was seeking to provide new evidence on the effectiveness of interventions based on m-Health by using of SMS reminders to improve treatment adherence and the smear conversion rate of tuberculosis patients.
That is a comparatively different type of intervention, which practiced in healthcare systems. Although the evidence for SMS application recommendations is still indecisive, Kannisto et al. (2014) found that 77% of the studies showing improved outcomes which may still indicate its use in healthcare settings. Widespread use of mobile phone text message reminders among different patient groups such as patients with diabetes, asthma, and schizophrenia may have the potential to improve adherence to medication and appointment attendance globally (Kannisto KA, et al. 2014).

There is a scarcity of high-quality information on the effectiveness of SMS interventions for moving forward patients’ adherence to tuberculosis treatment. The questionable quality of the current evidence suggests that encourage researches (in specific randomized trials) on the subject are required (Nglazi MD, et al. 2013).
This trial was unique in that it was the first to report the effect of an SMS intervention on Anti-TB medications adherence among patients in Saudi Arabia. This randomized control trial for SMS reminders and TB found that patients who received SMS reminders had significantly improved rates of smear conversion and self-reported medication adherence compared to the control individuals.

These results are concurring with those have been observed in areas, like HIV/AIDS, where it has been demonstrated that SMS reminders are effective in improving adherence to antiretroviral treatment and reducing viral load (Lester RT, et al. 2010, Pop-Eleches C, et al. 2011). While in Pakistan Mohammed et al. (2016) found no significant impact of the SMS medication reminders on TB treatment outcomes and self-reported medication adherence (Mohammed S, et al. 2016). Similarly, in China Liu et al. (2015) concluded that text messaging alone did not improve medication adherence among patients with tuberculosis, possibly because the messages were too frequent or too impersonal, although this intervention did reduce patient loss to follow-up (Liu X, et al. 2015). There are reasons that can explain the diversity of the results. For example, differences in included patient numbers, patient population, the method of adherence measurement and follow-up period, so all of that make it difficult to be compared with our findings.

Furthermore, we are in line with the results from previous studies evaluating the effect of daily SMS reminders on adherence. Similar to our results, Strandbygaard et al. (2010) showed that mean adherence rates to asthma medication of 82% in the group of patients receiving daily SMS reminders compared to 70% in the group receiving no reminders (Strandbygaard U, et al. 2010).

Miloh et al. (2009) revealed that text messages raised adherence level to immunosuppressive medicines in liver transplant beneficiaries measured by concentricity of the medications in the blood (Miloh T, et al. 2009). Hardy et al. (2011) found higher adherence in HIV-patients who
Table 5. Differences in rating of the adherence:

<table>
<thead>
<tr>
<th>VAS result</th>
<th>Intervention (n=90)</th>
<th>Controls (n=84)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>94.3±15.98</td>
<td>94.3±15.98</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Table 6. Differences in number of visits:

<table>
<thead>
<tr>
<th>Number of visits for follow up</th>
<th>Intervention (n=113)</th>
<th>Controls (n=103)</th>
<th>χ²</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>80 (70.8%)</td>
<td>70 (68%)</td>
<td>0.204</td>
<td>0.651</td>
</tr>
<tr>
<td>1 or 2</td>
<td>33 (29.2%)</td>
<td>33 (32%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

gotten day by day cell phone reminders compared with patients being alarmed by a beeper (Hardy H, et al. 2011). On the other hand, there are other studies demonstrated that weekly reminders significantly increased adherence in patients, while daily reminders did not (Vervloet M, et al. 2012, Pop-Eleches C, et al. 2011), and that may occur due to the habituation that resulted from automated daily reminders which lead to loss of effectiveness. The variation in results could be understood if we know that the last two mentioned studies were followed patients for a longer period of six months or more. While we were following up each patient for only two months, during them habituation to these automated alerts may not have yet occurred. That was
confirmed by Strandbygaard et al. (2010) who demonstrated that daily reminders significantly increased adherence in asthmatic patients even with a follow-up period of 12 weeks of automated alerts (Strandbygaard U, et al. 2010).

The researcher believes it is necessary to assess the appropriateness of this SMS reminders service to patients, because that may affect the acceptance of utilizing technology in routine care. In order to do that, this study assessed the appropriateness of the tailored SMS reminders to pulmonary tuberculosis patients following at Jeddah TB center. Up to researcher’s knowledge, this is the 1st study that assessed SMS reminders appropriateness for people taking anti-TB medications during the intensive phase of management in Saudi Arabia. Earlier studies have shown that SMS are easy to use (Palmier-Claus JE, et al. 2013, Ben-Zeev D, et al. 2014), do not cause any harm (Branson CE, et al. 2013), and resulting in high levels of satisfaction (Ben-Zeev D, et al. 2014, Bogart K, et al. 2014, Agyapong VI, et al. 2013).

Likewise, this study found that 95.6% of the respondents agree that they are satisfied with the text message reminder system, 92.2% agree that the reminder system is easy to use and 95.6% expose that they do not feel disturbed with the SMS reminder system, which is compatible with the previous studies results. Only a few studies reported that SMS was causing harm in the form of disturbance or irritation (Agyapong VI, et al. 2013, Vervloet M, et al. 2012).

We have to accept the fact that patients forget to take their medication on time and as consequences, the disease period extended and the risk of drug resistance increased and sometimes a death may occur. Careful medical attention required in dealing with HIV and TB patients. The challenge behind is that majority of patients live far away from the clinic, and most of them do not afford the transportation cost. Though, it found that the establishment of mobile healthcare technology has the opportunity to enable patients on receiving the reminder messages through their phones at any time and everywhere. Almost all participants that were receiving the SMS reminders, supported that the use of mobile phone as reminder technology could help in encouraging and motivating them to follow the treatments procedures effectively (Haji A, et al. 2013), and in line with that results, this study found a 94.4% of participants in the intervention group was recommending the use of this kind of reminder system in the future.

A limitation of this study was that we needed an objective medicine adherence measurement tool. Our measure of adherence was self-reported adherence, which is an overestimated measure. It is in this manner conceivable that there was a potential contrast in adherence between the intervention and control bunches that was not picked up through the self-reported adherence measure. Add to that the adherence reported for the last month may not adequately reflect adherence behaviors over longer periods because patients may become more adherent in the few days preceding their appointment. But while it was a random subsample, the misreporting was comparable in both groups. Also, there is no gold standard for measuring medication adherence (Bediang G, et al. 2014, Simoni JM, et al. 2006, Martin S, et al. 2009, Mbuagbaw L, et al. 2011).

VAS method that we used in this study, also had been widely used in several RCTs evaluating different interventions including mobile text messaging to enhance adherence to HAART (Bediang G, et al. 2014, Simoni JM, et al. 2006, Mbuagbaw L, et al. 2011, De Costa A, et al. 2010).

Another potential restriction of this trial is that our essential outcome variable depended on clinically recorded treatment results by treating clinics. These results could be inaccurately expressed by clinics to meet the anticipated success rates aimed by the NTP of Saudi

<table>
<thead>
<tr>
<th></th>
<th>Yes (%)</th>
<th>No (%)</th>
<th>Ambivalent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Satisfaction:</strong></td>
<td>86 (95.6)</td>
<td>--</td>
<td>4 (4.4)</td>
</tr>
<tr>
<td>“Have you been satisfied with the text messages?”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Usefulness:</strong></td>
<td>85 (94.4)</td>
<td>1 (1.1)</td>
<td>4 (4.4)</td>
</tr>
<tr>
<td>“were the text messages useful?”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Easiness:</strong></td>
<td>83 (92.2)</td>
<td>1 (1.1)</td>
<td>6 (6.7)</td>
</tr>
<tr>
<td>“were the text messages easy to use?”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Harm:</strong></td>
<td>--</td>
<td>86 (95.6)</td>
<td>4 (4.4)</td>
</tr>
<tr>
<td>“did the text messages cause any harm to you?”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Future use:</strong></td>
<td>85 (94.4)</td>
<td>--</td>
<td>5 (5.6)</td>
</tr>
<tr>
<td>“would you use this kind of text message system in the future?”</td>
<td></td>
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</tr>
</tbody>
</table>
Arabia. However, realizing that the clinics were blinded to allocation, giving no reason to accept that this was done between the intervention and control groups differently.

Eventually, our sample size was powered to detect a 20% difference in smear conversion between both arms. The difference we found was sufficient to achieve the desired improvement in smear conversion ($t = 18.459$, $P$-value <0.001) which is considered highly statistically significant. With a representation of participants seeking treatment from public clinics, this trial has the representation of a variety of patient populations in Jeddah city, contributing to its external validity.

There is a need for several topics of reminder messages to be generated such as, educational messages which educate the patient regarding the disease care, treatment regulations, messages which reminded the patients to take their medication at right time and other messages which notify the patient to attend the clinic for collecting his weekly or monthly tablets. Our results largely endorse that the use of simple, already existing technology, such as mobile phones and SMS, may be an acceptable method in tuberculosis outpatient service, and that was similar to the findings of Kannisto et al. on psychiatric out-patient clinics (Kannisto KA, et al. 2015).

The information gained from this study is expected to be utilized to improve quality of care that given to tuberculosis patients in our community, and to raise the level of health care services provided for this category of patients to minimize the TB morbidity and mortality rates in Jeddah. To conclude, as the first randomized control trial in Jeddah city for evaluating the effect of SMS reminders on smear conversion rate and medication adherence for patients with TB, the study found promising and positive impact.

CONCLUSION & RECOMMENDATIONS

Conclusion

In conclusion, text messaging reminders provide a potential intervention for progressing treatment adherence. That has an exceptional demand for developing nations since it has witnessed the fast growth of telecommunication services, and increasing access to mobile and smartphone services. The results of this study are promising and positive. This research exposes furtherance for the usage of SMS system to transfer reminders for appointments, treatments, motivational messages, and health education data, to reach further enhancement of patient and healthcare workers' communications.

Recommendations

i. Implementing of this SMS reminding intervention in the follow-up of pulmonary tuberculosis patients is recommended to the decision makers in MOH.

ii. The effect of the SMS reminders on the pulmonary tuberculosis patients cure rate should be assessed by future studies.

iii. Future research has to concentrate on essential socio-economic elements, which make patients to stop their treatment process.

It is essential for future researchers to assess text messaging reminders in relation to cost-effectiveness examination that might be piloted to measure the economic input involved for supporting those interferences on the long run.

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