WEST AFRICAN JOURNAL OF MEDICINE

*ORIGINAL ARTICLE*

# Enhancing Routine Immunization Performance using Innovative Technology in an Urban Area of Nigeria

## *Améliorer Les Performances De La Vaccination Systématique À L'aide De Technologies Innovantes Dans Une Zone Urbaine Du Nigéria*

**G. U. Eze*, A. O. Adeleye†**

**ABSTRACT**

BACKGROUND: **Routine Immunization (RI)is known to beone of the most cost-effective public health strategies ever, and a cornerstone among all primary healthcare efforts but has been bedevilledin Low and Middle Income Countries (LMICs) in the last two decadesby poor coverage and lack of timeliness -both due, among other factors, to clients forgetting appointments. These setback RI effectiveness from ensuring herd immunity and preventing disease. Across the world, different cost-effective mobile telephone-based reminder systems are currently in use as strategies for improving coverage and compliance in various health interventions.Their application to RI is thereforehighly recommended.**

OBJECTIVE: **This study sought to provide evidence validating the need for development and deployment of automated client Reminder-Recall systems for the Nigerian National Routine Immunisation Program and to compare its projected cost withthe cost of a health personnel-based defaulter tracking system.**

METHODOLOGY: **A multi-centre, parallel-group, Randomized Controlled Trial was carried outusing multi-stage sampling.Nine hundred and five child-caregivers were followed-upat 8 health facilities in an urban/sub-urban area in South-South Nigeria.Text messagereminders were sent to the Intervention group only, with concurrent weekly data collection, including that for controls, at each of the enrolled health facilities. Recall messages were sent to defaulters and their responses (presence at immunization session) assessed the next RI session. Receipt of DPT3 vaccine on or before the 18th week was categorized early, while receiptafter was categorized delayed.**

RESULTS: **Clients in the Interventiongroup were1.5times earlier than Controls intheir receipt of DPT3. Immunization coverage was also 8.7%better in the Interventiongroup. A first year estimate of cost of deploying this strategy was less than a quarter ofthe estimated cost of using home-visits which is the defaulter tracking method currently recommended by regulatory authorities.**

CONCLUSION: **Routine immunization performance was significantly better in the Interventiongroup who received SMS reminders compared to the controls who did not. Since this occurred at a cheaper rate than projected costs of home visits, in a habitual stock-out situation, this is ample evidence for health policy-makers in LMICs to leverage the ever expanding mobile telecom platforms for future sustainable improvements in routine immunisation performance and even other disease control efforts in Nigeria. WAJM 2015; 34(1): 3–10.**

Keywords: **SMS text Reminders, Immunization coverage, timeliness, Defaulter tracking, cost-effectiveness, Nigeria.**

**RÉSUMÉ**

**CONTEXTE:** La Vaccination de Routine (VR) est connue pour être l'une des stratégies de santé publique les plus rentables, et une pierre angulaire parmi tous les efforts de soins de santé primaires, mais a été perturbée dans les pays à revenu bas et intermédiaire (PFR-PRI) au cours des deux dernières décennies par une mauvaise couverture et une manque de rapidité ; les deux en raison - et parmi d'autres facteurs-, des clients qui oublient les rendez-vous. Ceux-ci ont fait reculer l'efficacité de la VR pour assurer l'immunité des foules et la prévention des maladies. Partout dans le monde, différents systèmes de rappel à base de téléphone mobiles efficace sont actuellement utilisés comme stratégies pour améliorer la couverture et la conformité de diverses interventions de santé. Leur application à la VR est donc fortement recommandée.

**OBJECTIF**: Cette étude visait à fournir des preuves validant la nécessité pour le développement et le déploiement de systèmes automatisé Rappel-Appel de retour du client pour le Programme National Nigérian de la vaccination de routine et de comparer son coût prévisionnel avec le coût d'un système de suivi défaillant basé sur le personnel de santé.

**MÉTHODOLOGIE**: Un essai randomisé contrôlé à groupes parallèle dans de centre multiple a été réalisé en utilisant un échantillonnage en plusieurs étapes. Neuf cent cinq enfants-soignés ont été suivis dans 8 établissements de santé dans une zone urbaine / sous-urbain dans le Sud-Sud Nigeria Des Message de rappels ont été envoyés au groupe d'intervention seulement , avec une collecte de données hebdomadaires concomitante , y compris pour les contrôles, à chacun des établissements de santé enrôlé . Des messages de rappel ont été envoyés aux défaillants et leurs réponses (présence à la séance de vaccination) évalué durant la session de VR suivante. La réception du vaccin DTC3 avant ou à la 18e semaine a été classé tôt, alors que la réception après a été classé retardé.

**RÉSULTATS**: Les clients du groupe d'intervention ont été 1,5 fois plus tôt que les contrôles dans la réception de DTC3. La couverture vaccinale est également préférable de 8,7% dans le groupe d'intervention. La première année d'estimation du coût de déploiement de cette stratégie était de moins d'un quart du coût estimé d'utilisation des visites à domicile qui est la méthode de suivi des défaillants actuellement recommandé par les autorités réglementaires.

**CONCLUSION**: La performance de la vaccination de routine était significativement meilleure dans le groupe d'intervention qui a reçu des rappels par SMS qu' aux témoins qui ne l'ont pas eus . Puisse que cela se produit à un coût moins cher que les coûts projetés de visites à domicile, dans une situation habituelle de rupture de stock, cela est une preuve évidente pour les décideurs de politiques de santé dans les PRFM pour exploiter les plates-formes de téléphonie mobile en pleine expansion pour les futures améliorations durables de la performance de la vaccination de routine et même dans d'autres efforts de lutte contre les maladies au Nigeria. **WAJM 2015; 34(1): 3–10.**

**Motsclés**: Rappels de texte SMS, la couverture vaccinale, la rapidité, le suivi des défaillant, coût-efficacité, le Nigeria.

**Departments of *Community Medicine, Delta State University Teaching Hospital, Oghara, Delta State. †Community Health, University of Benin Teaching Hospital, Benin City, Edo State.**

***Correspondence:* Dr Godson. U. Eze,** Department of Community Medicine, Delta State University Teaching Hospital, Oghara, Delta State.

**Abbreviations: EPI,** Expanded Programme on Immunization; **LMICs,** Low and Middle Income Countries; **NPHCDA,** National Primary Health Care Development Agency; **RI,** Routine Immunization.

## INTRODUCTION

Routine Immunizationis the cornerstone of all immunization efforts and other primary healthcare efforts as well[1] and is considered the single most effective way tocontrol many diseases and among the most cost-effective public health strategies ever.[2,3] With the exception of safe water, no other modality, not even antibiotics, has had such a major effect on mortality reduction as immunization.[4] It is beneficial not only to the persons receiving the vaccines but also to others in the community – as it provides a kind of shield known as herd immunity for the immunized as well as the unimmunized within that community.[1] Also, when the number of such persons with immunity to a disease is not sufficient in a group, there would be no herd immunity to that disease. In such instances, epidemics of that disease could occur especially when the critical mass of persons unimmunised to that disease becomes significantly large.[5]All these underscore the importance of high coverage rates for immunization against Vaccine Preventable Diseases (VPDs) and timely vaccination of persons within that group for such vaccination.

All over the world the impact of immunization on childhood morbidity and mortality has been great, but its full potential is yet to be realized.[1] In Low and Middle Income Countries (LMICs) in particular, not all children receive their recommended vaccinations, and some of those who get vaccinated even receive it late. Meanwhile it is known thatif vaccination against a disease is not given in a timely and prescribed manner, the required immunity to combat that disease may not develop.[6]

In Nigeria, the Expanded Programme on Immunization (EPI) was launched, re-launched and even re-christened National Programme on Immunization (NPI) all due to perennial problems of poor routine immunization coverage and high dropout rates. Yet, these challenges still persist. Currently, NPI is no longer aparastatalof its own as it has been subsumed under the National Primary Health Care Development Agency (NPHCDA) all in a bid to improve immunization performance through integration with other services, yet there is still great difficulty with sustaining milestones gained from any strategy deployed, as poor coverage and high dropouts have remaineddistressing challenges.[7,8]

High drop-out rates suggest to us that there is a great problem with sustaining utilization of immunization services after initial access has been made,thus signifying the need for a functional reminder and defaulter tracking system to reduce drop-outs and enable every child attain full immunization status. Home-visits have been prescribed for defaulter tracking over the years[9] as caregivers habitually forget appointments but it has consistently failed to deliver its mandate as there are so many confounders to it – loss of inter-relationships among community members, security challenges, changes in work schedules and patterns, are a few among the gamut.In the face of this obvious shortfall, Nigeria is yet to develop or adopt another effective method for reminding child caregivers of the vaccination days of their wards or to recall them when they have missed their appointment(s).

Many clients who think their vaccinations are up to date, are either missing routine immunizations outright or confuse them for the periodic supplemental immunization given during NIDs[10] – not knowing that the latter is grossly incomplete.This brings to fore the need for effective reminders for due vaccinations, or recalls for those overdue to ensure that caregivers know the next appointments of their wards or are made aware when they miss appointments. This approach increases childhood immunization timeliness and rates.[10]

Experts recommend that healthcare professionals remind patients of needed immunizations as reminders have been shown to improve dramatically, rates of immunization coverage.[3,11] All over the world various methods have been employed through history to attempt to achieve effective defaulter tracking and reduce client dropout from various routine immunisation programmes. Also, different kinds of reminder systems are currently being used successfully in various health endeavours. Among these are: the use of home visits by paid health workers or volunteers, use of neighbours in closely knit communities, use of fear and traditional leaders and town announcers, and other kinds of community monitoring strategies. All these have been unable to yielded sustainable results and therefore new approaches are being sought and executed with better results.[12,13] While the latter is the case in many LMICs, phone calls and emails have been harnessed effectively in the developed world with proven effectiveness.[11] If all these ailing issues are taken care of, especially by buying into existing technologies, routine immunization as well as other health services uptake rates would surely show visible improvements in our locale and country at large.

The former president of the United Nations Foundation, Timothy E. Wirth emphasized: "Modern telecommunications, and the creative use of it, has the power to change lives and help solve some of the world's biggest challenges."[14] Nigeria is currently one of the fastest growing markets for mobile telephony in the world with penetration near 90%. An estimate of the number of mobile cellular phones in use in Nigeria was 240,000 in 2001,over 43 million in 2007 – about a third of Nigeria's population at that time,and over 164 million active GSM lines as of June 2013.[15,16] Nigeria's health sectormight as well benefit from the same, as it has become appropriate technology and a sound social marketing avenuefor healthcare in our day. Ignoring this would mean leaving out a great vista of opportunity from which the health sector could so easily benefit.

This study sought to provide evidence validating the need for development and deployment of automated client Reminder-Recall systems for the Nigerian National Routine Immunisation Programme and to compare its projected cost to that of a health personnel based defaulter tracking system.

## MATERIALS AND METHODS

A multi-centre, parallel-group, Randomized Controlled Trial was carried out between June 2010 and June 2011. A total of 1001 consenting caregivers who

brought their wards for routine immunization were selected using multistage sampling method from 8 health facilities in Egor local government area of Edo State. The facilities included 1 tertiary hospital, 2 primary health centres and 5 privately owned health facilities – all of which provided routine immunization services. They were selected proportionate to the relative distribution of these various types of health facilities in the study area. Selection criteria wasbringing child for routine immunisation forthe first or second schedules of RI,and consenting to participating in the study. The second schedule was added because some babies get their first shots at their bedside and as such, at their first visits to the RI centre they are given the second schedule of vaccines.They allfilled aquestionnaire at the point of recruitment into study and cell phone numbers werecollected from all participants to allow for sending SMS reminder messages.

Participants recruited per facility were randomized into 2 equal groups:Intervention and Controlgroups using the RANDOM. EXE function of the Programme for Epidemiologists (PEPI) version 4.0,irrespective of their owning a mobile phone, to allow for proper randomization.The Interventionand Controlgroups were 500 and 501 respectively at the onset of the study. Some respondents,who did not have mobile phones but were randomized into the Interventional group initially, were eventually matched for age and sex and swapped with persons who ownmobile phones and were randomized into the Control group.

Ninety-six caregivers(9.6%) were lost to follow-up. As a result, only data from the 905 (90.4%) who lasted the whole duration of the study were collated and analysed. Figures for intervention and control groups at the end of the study were 452 and 453 respectively.

**Baseline Survey**

At the inception of the study, the immunization records of the previous year were reviewed for the 8 selected health facilities to establish baseline coverage and dropout rates for each facility individually, and collectively for all the facilities.

**Training of Research Assistants**

Six research assistants were trained on the rudiments of routine immunisation and reminder systems before the start of survey. Four of them were involved with data collection while the other two coordinated the sending of reminders/ recall SMS messages to clients. Those involved in data collection were told to intimate all respondents with the details of the study and that they would get SMS messagesif they got into the intervention group. They also informed the clients that the message would be tagged with the name of their health facility for easy recognition; that they should follow its instructions. Those involved with sending reminder messages were taught how to modify a prepared prototype and to properly tag the message with the facility name. Below is a prototype SMS message.

*Dear client, your child is due for his/her next dose of vaccines tomorrow Tuesday 20/7/10. Kindly bring your child to Hospital X for vaccination at 8am. Please come with immunization card. Thank you.*

**Questionnaire Survey**

Each respondent filled out a questionnaire as part of the recruitment process. Questionnaires were researcher administered and comprised questions on socio-demographic data of both child and its caregiver, questions to ascertain existence of a defaulter tracking system, and others to establish clients' felt-need for a reminder system. All these were to allow for testing ofassociation of these factors on coverage and timeliness of receipt of scheduled vaccinations.

The number of clients interviewed per facility was computed using the baseline from the previous year as reference. Respondents were recruited using systematic sampling method proportionate to the number of clients registered at the other facilities used in this study.

A total of 1001 questionnaires were administered in the 8 facilities while 905 were followed up till the end of the study giving a total response rate of 90.4%.

**Database and Reminder/Recall Messages**

Data for clients in intervention and control groups were separated on the database to prevent side by side comparison of performance to ensure blinding and prevent bias. A list of phone numbers was kept for clients in the intervention group on the bulk SMS website and used to coordinate the sending of text message (SMS)to them.

Reminder messages were sent a day before clients' appointments while recall message were sent one day to the next immunization session each time babies in the intervention group defaulted from appointments. All text messages were by internet-based web-to-SMS (Bulk SMS) service and were tagged the name of client's health facility for easy recognition.

**Data Collection, Concealment and Follow-up**

Weekly, updates of immunization data were collected by research assistants from immunization registers at all 8 health facilities included in the study. Data for both intervention and control groups were collected together in the same collection forms to prevent bias on the minds of the data collectors. Data collectors could not tell if a client was in the intervention or control group.

When study duration elapsed, SMS messages were sent from a phone with an identifiable number to all study participants who had not shown up for vaccination for greater than 2 cycles of each facility's schedule. Some clients responded and phone calls were made to those who did not respond to the SMS messages. All those who could not be reached, or followed were excluded from the analysis.

Ninety-six clients (9.6%) were lost to follow up through infant deaths, family relocation, change of preferred health facility for immunisation uptake, and other unknown reasons.

**Decision Rule**

Each child recruited into the study at its first immunisation session (BCG) was followed-up for 18 weeks while those who were recruited at their second session (DPT1) were followed up for 12

weeks. They were followed-up this long to allow for 4 extra weeks after the recommended dates of receipt of DPT3 - 14th week after commencement of RI vaccination.

Timeliness of receipt of DPT3 vaccine was used to categorize children into *Early or Delayed.* Since DPT3 is scheduled for the 14th week, Early meant a baby recruited at its first session received DPT3 on or before 18 weeks from the date of first visit. For those recruited on the second visit, 12 weeks was used as cut-off, since according to the national schedule, there are 6 weeks between the first and the second visits. Anyone who did not make the aforementioned timeline was categorised as Delayed.

**Cost-effectiveness Analysis**

A cost effectiveness analysis was done to compare the cost of using SMS reminders compared to the cost of currently recommended home visits using the formula below.

$$\text{Cost Effectiveness (CE) Ratio} = \frac{\text{Cost of New Strategy - Cost of Current Practice}}{\text{Effect of New Strategy - Effect of Current Practice}}$$

$$\text{That is, CE Ratio} = \frac{\text{Cost of Reminder System - Cost of Home Visits}}{\text{Effect of Reminder System - Effect of Home Visits}}$$

The cost of equipment, human resources and recurrent expenditure was calculated for both strategies and the results used to compute the Cost Effectiveness ratio.

**Ethical Issues and Advocacy**

The Ethics committee of University of Benin Teaching Hospital gave ethical clearance for this study before data collection commenced whilea letter of introduction to the various health facilities was obtained from the Director of Public Health and State Immunization Officer (SIO), Edo state. A letter of permission was also obtained from the Local Immunization Officer, Egor LGA before visiting health facilities. The Officer In-charge at each health facility received this letter, was enlightened on the study, and consented to the study before it commenced.

Informed verbal consent was obtained from each client caregiver before any survey instrument was administered. Potential participants were allowed to opt out of being studied when they refused to participate even after a careful explanation of the study process. They were also assured of confidentiality; in the light of this there were no names on the questionnaires and facility names have been coded in the result section.

**Limitations of Study**

- DPT vaccine supply was inconsistent in most facilities throughout the period of this study. This affected the response of clients to recall prompts especially when they had met with vaccine stock-outs after previous reminders and recalls.
- Caregivers were expected to be able to read for this initiative to succeed. Though the messages were customized to ensure easy recognition, and clients encouraged to seek help if illiterate, the success of this strategy with illiterate persons was beyond the scope of this study.
- The study did not include an SMS delivery log to register delivery reports; final computations were therefore made on all those to whom messages were sent with the assumption that they received the messages.
- There was no provision to accommodate phone number changes during the course of this study and no provision was made for alternative phone numbers.
- Phone calls and SMS messages to long defaulters revealed that some of them had continued vaccinating their children at centres outside sites of recruitment. These were grouped under lost-to-follow up as including them in follow-up was beyond the scope of this study.
- Caregivers provided answers to questions by recall; this could have led to recall bias in the information supplied.

**RESULTS**

A total of 905 child caregivers were studied from 8 health facilities. Caregivers were mostly mothers [98.9%] with a mean age of 29.35 ± 5.3yearswith the modal age group being 26 – 30 years. The greater proportion of caregivers 522 (57.7%) had attained secondary level education, 247 (27.3%) had tertiary education, while131 (14.6%) had primary level education. Only 4 (0.4%) had no formal education (Table 1).

Although most caregivers, 896 (95.0%) had mobile phones (Figure2) almost all caregivers,898 [99.2%] had

**Table 1: Socio-demographic Characteristics of Respondents**

| | Relationship to child Frequency (%) | | |
|---|---|---|---|
| **Variable** | **Mother** | **Others*** | **Total** |
| **Age Group (Yrs)** | **[$n_1$ = 895]** | **[$n_2$ = 10]** | **[N= 905]** |
| <20 | 12 (1.3) | 0 (0.0) | 12 (1.3) |
| 20 – 24 | 134 (14.8) | 0 (0.0) | 134 (14.8) |
| 25 – 29 | 345 (38.1) | 0 (0.0) | 345 (38.1) |
| 30 – 34 | 252 (28.2) | 2 (20.0) | 254 (28.1) |
| ≥35 | 152 (17.0) | 8 (80.0) | 160 (17.7) |
| **Marital Status** | | | |
| Married | 860 (96.1) | 7(70.0) | 867 (95.9) |
| Cohabiting | 23 (2.6) | 0(0.0) | 23 (2.5) |
| Single | 7 (0.8) | 1(10.0) | 8 (0.9) |
| Separ/Divorced | 4 (0.4) | 0(0.0) | 4 (0.4) |
| Widowed | 1 (0.1) | 2(20.0) | 3 (0.3) |
| **Education** | | | |
| None | 4 (0.4) | 0 (0.0) | 4 (0.4) |
| Primary | 131(14.6) | 1 (10.0) | 132 (14.6) |
| Secondary | 518 (57.9) | 4 (40.0) | 522 (57.7) |
| Tertiary | 242 (27.0) | 5 (50.0) | 247 (27.3) |

never received reminder calls, text messages or home-visits from the facility they patronised for routine immunization. The majority of respondents, [93.1%] accepted the option of been sent reminder messages (Figure 2).

Logistic regression showed that receiving SMS reminders resulted in an earlier receipt of DPT3 in the intervention group, OR 1.47 (95% CI: 1.1 – 2.0) (Table 2); and 8.7% increase in coverage (Figure 3). The cost-effectiveness analysis also showed that projected cost of using SMS reminders was about a quarter what it would cost to use Junior Community Health Extension Workers (CHEWs) for functional home visits in one year [₦27.47 vs ₦107.28] (Table 3).

Also, the effect of receiving a text message reminder was nearly equivalent to a mother having at least a secondary leveleducation, [OR: 1.468 vs 1.687]. (Table 2).

Among those who preferred not to be sent SMS reminders, self-confidence in not forgetting appointments(61%) and the fear of giving out phone numbers (28.8%) were the greatest barriers to mHealth uptake in this study. (Figure 4).

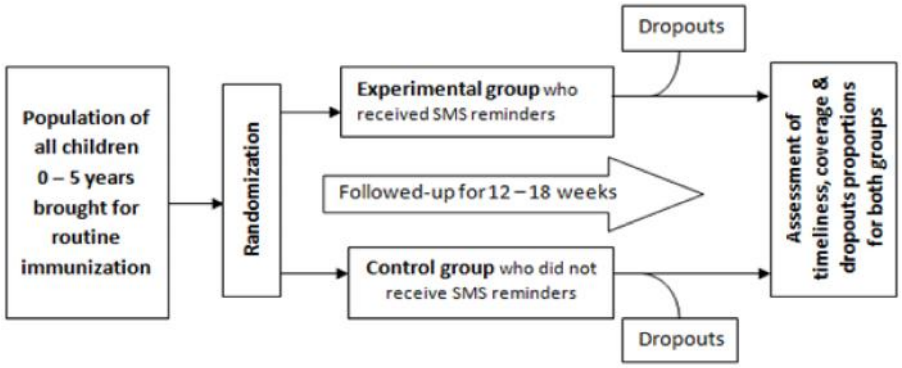


**Fig. 1: Flow Chart for Intervention Study using SMS Reminders to Enhance Routine Immunization.**

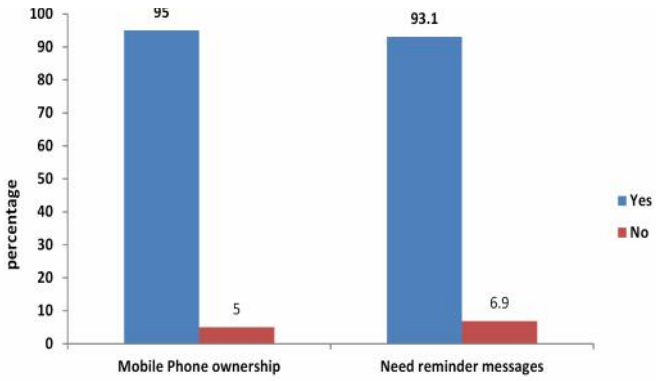


**Fig. 2: Phone Ownership and Desire for Reminder Messages**

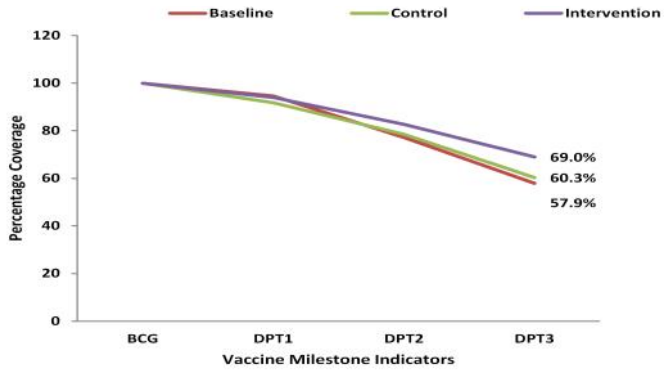


**Fig. 3: Comparison of DPT3 Coverage for Baseline, Experimental and Control Groups.**

## DISCUSSION

Client reminder and defaulter tracking is a recommendation for routine immunization services and other periodic medical services all over the world.[17] The results of this study on mobile phone-based reminders and defaulter tracking have buttressed the efficacy of this adaptive strategy in achieving complete and timely immunizations especially nowadays when the pace of life and business makes being unavailable or outright forgetting of an appointment a common occurrence.Studies have shown that both parents and healthcare providers tend to overestimate the immunization status of their children or patients and that most parentsof under-immunized children do not know that their child is notup-to-date on immunizations.[18] This brings to mind the major barrier to accepting mHealth in this study: 'I never forget appointments', and leaves programme implementers with the need to show evidence of need during public or stakeholder enlightenment.

Leveraging the current widespread use of mobile hand-held devices is a sine qua non to future sustainable disease control efforts. The cell phone coverage

**Table 2: Logistic Regression of Factors Associated with Timely Immunization Completion**

| Variable | Timeliness of Completion of Immunization (Frequency %) | | | | | | 95.0% CI of OR | |
|---|---|---|---|---|---|---|---|---|
| | Early [$n_1$ = 585] | Delayed [$n_2$ = 320 | Total [N = 905] | ¡ ² | *p*-value | Odd's Ratio | Lower | Upper |
| **SMS Reminder** | | | | | | | | |
| **Yes** | 312 (69.0) | 140 (31.0) | 452 (100.0) | 7.589 | 0.009 | 1.468 | 1.103 | 1.955 |
| **No** | 273 (60.3) | 180 (39.7) | 453 (100.0) | | | | | |
| **Educational Status of Caregiver** | | | | | | | | |
| **≤ Primary** | 68 (50.0) | 68 (50.0) | 136 (100.0) | 15.010 | 0.008 | 1.687 | 1.148 | 2.477 |
| **≥ Secondary** | 517 (67.2) | 252 (32.8) | 769 (100.0) | | | | | |

**Table 3: Cost-effectiveness Analysis for Two Reminder Systems in First Year**

| Variables | SMS Reminders | Home Visits |
|---|---|---|
| | Effect of Strategy | |
| Increase in RI Coverage | 8.7% | *8.7% |
| | Cost of Method of Reminder in Naira (USD) | |
| Equipment Purchase | 1 520 000 | – |
| Bulk SMS units | 111 370 | – |
| Internet access | 792 000 | – |
| Imprest for Logistics | 52 000 | 1 404 000 |
| Training of workers | 110 000 | – |
| Salaries of workers | 759 291.84 | 11 650 364 |
| Cost-effectiveness ratio | 384 444 | 1 500 501 |
| Cost per additional child immunized | 27.47 | 107.28 |

**Although home visits programmes could not be said to improve routine healthcare coverage, an assumption of the same performance improvement from SMS messages was used to allow for computation.*

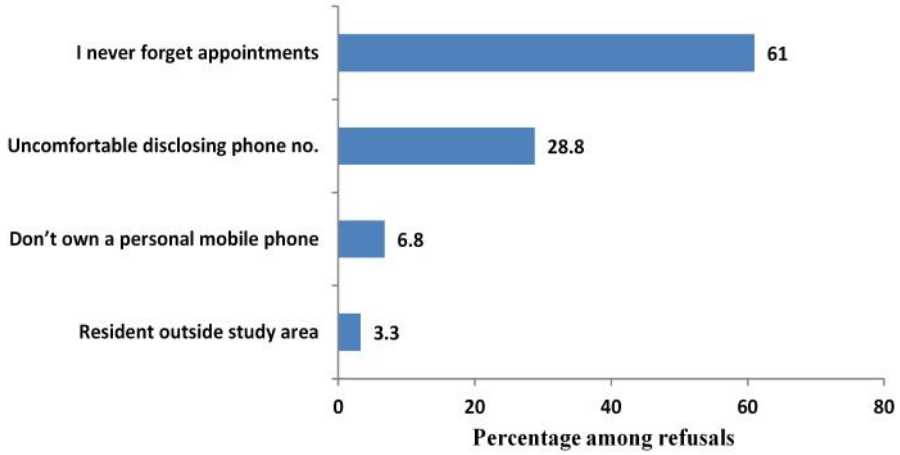


**Fig. 4: Barriers to Receiving Text Message Reminders for Routine Immunization**

in this study was 95%; it mirrors the 90% value for national penetration of mobile phonesquite well.[16] Although mothers in this study are better educated than the average Nigerian woman[19], it is common knowledge that mobile phones are relatively well distributed across educational levels. Obviously, particular strategies would have to be chosen bearing the target recipients in mind and once that is done, there is no doubt that adoption of mHealth initiativesfor the Nigerian health system would yield much better health systems performance as is already being witnessed in other LMICs around the world.

Kenya has recorded very major leaps in its health system by adopting health services based on mobile technology. Locally, ingenuous apps have been developed in that country for tracking infectious disease activity, supply chain management to reduce leaks and wastages, and even for tracking compliance to medication. There are at least 45 mHealth apps already in use or actively being developed in Kenya.[20]

The Ghana Health Service uses a mobile platform called Mobile Technology for Community Health (MoTECH). This initiative uses mobile technology to disseminate home-based health education to families and to encourage them to seek pre-pregnancy and child health services.This service uses either text or voice messages in local languages and has led to major strides in Maternal and Child Health in Ghana.[21]

India had a health system similar to Nigeria's; their Out-of-Pocket payment for healthcare was 75% which spelt a consumer driven market capable of rapid change. Their mobile phone penetration is high and smart phone adoption rapid, which is also similar to the situation in Nigeria. As in this study where most respondents (93.1%) expressed desire for mHealth services, local exploratory studies in India revealed a high demand for mHealth services and the country has since begun to engage telecom companiesin the adoption of mHealth for their vastly underserved healthcare market in the areas of health communication, supply chain management, micro-insurance and as a human enabler in clinical decision making.[22]

There are numerous other applications of mHealth in LMICs including STI and HIV/AIDS control, malaria, malnutrition, and even monitoring and evaluation of programmes.[23] Most of these projects have not had major glitches that rendered them inoperable; instead they are thriving and conquering more ground. It is expected therefore, that Nigeria which shares lots of similarities with these countries would excel in mHealth as well as they.

In Nigeria so far, mHealth initiatives have been employed in a few sectors with milestone achievements. Amongst them arethe Mobile Application Data Exchange (MADEX) System used by the National Primary Health Care Development Agency on the Midwives Service Scheme (MSS). Midwives in the MSS are able to update a national maternal morbidity, birth and immunization registry system from their cell phones at remote health facilities.[24] The MobileAuthentication Service (MAS) used by the National Agency for Food and Drug Administration and Control (NAFDAC) in Nigeria has significantly reduced the spate of counterfeit drugs in Nigeria.[25] Drug companies are currently buying into the initiative while other countries are quickly adopting the strategy. Other programmes which have used mobile reminders in Nigeria include: the National Urban Reproductive Health Initiative (NURHI) which took advantage of the versatility of mobile devices to support uptake of family planning in 6 urban cities in Nigeria. They used mobile for family planning counselling, question and

answers, referrals, and client satisfaction surveys.[26] Society for Family Health (SFH) built call centres in Gombe State from where reminder calls were made to pregnant mothers in a 2-year long initiative tagged: *Iganta Rayuwar Iyali*. It aimed to improve uptake of antenatal care services.[27] Pathfinder International is currently using mobile technology to support clinical decision of Community Health Extension Workers and for sending reminder messages to mothers of missed ANC appointments and past delivery dates for twentyhealth centres in Abuja and Nassarawa State in Nigeria.[28]

Systematic reviews of effect of reminder systems on healthcare uptake shows that its use could improve healthcare uptake by up to 43 to 70 percent and even more.[29–31] On the contrary, another systematic review on the effect of home-visit programmes on uptake of childhood immunisation posits that they have not been shown to improve uptake; that other methods to improve uptake of childhood immunization need to be explored.[32] It is common knowledge though, that home-visits give a personal touch and human face to health programmes and is likely to improve their outcome a great deal; but it is also known that humans could be quite inconsistent – especially when unsupervised. The latter might have been the undoing of many home visit services. While automated messages do not give the level of interaction provided by home-visits, they are more likely to provide the consistency much needed for reminder systems and defaulter tracking mechanisms to thrive. This is much more so nowadays when scheduling of future reminders have become common place on web-based messaging platforms.

In this study, the interventional category had better outcomes of generally higher coverage rates, timelier receipt of DPT3, and fewer dropouts than both the controlgroup and baseline findings. Mobile phone-based text message reminders in this study resulted in an 8.7% increase in coverage and about 1.5 times greater likelihood of timely completion of scheduled vaccinations. Prolonged DPT stock-out witnessed during the period of the study likely resulted in this restriction of effect size, as most studies in the literature show a greater effect size than was recorded in this study. A study found the effect of inconsistent SMS prompts to be akin to inconsistent services and showed it to result in a no-effect to poorer outcomes in clients in a similar study on Reminder-Recall Systems in Rochester, New York, 1999.[33] Inconsistent SMS prompts can also be likened to having been invited for vaccination and meeting with a stock-out instead.

The cost effectiveness analysis proved beyond reasonable doubt that SMS reminders are a cheaper alternative than home visiting in improving on timely immunization completion and increasing coverage. Estimate cost for home visits was about 4 times what it cost using SMS reminders, peradditional child immunized in the first year; ₦107.28 versus ₦27.50. It is true that home visits bring a certain personal touch with them that text messages do not bring since it involves human-human interactions; but in the face of present realities of economic instability, fears of insecurity, loss of community life to urbanization and the turmoil of making a living, this less personalized option of reminder might just be the much awaited ace. Furthermore, a meta-analysis of 11 studies in Britain concluded that home visits have not been shown to be effective in increasing the uptake of scheduled immunization.[32]

It is also important to remember that anytime human resources are employed there would be a need for motivation, promotions and increments in remuneration as time goes by to assuage the hygiene factors domiciled in every man. There also would be an increased need for monitoring and supervision, and the attendant burden of complicated human inter-relationships that might accompany it. Meanwhile, a text messaging system can be supervised right in an office and only a few personnel would ever need involvement; thus reducing the complexities of person-person relations. A text message can cross barriers and literarily scale over walls where gates might never be opened. Text messages could even be given a more humane face by periodic evaluation of service quality and incorporating in it a correspondence mechanism for feedback. Again, atext message reminder-recall system would become cheaper to run as the duration of its use increases, as is the case for most activities carried out with machines. If human resources are used, running costs would increase in leaps with the passage of time and may eventually include pensions and accumulated gratuities on the long run.

## CONCLUSION

In this study, routine immunization performance was significantly better in the Intervention group who received SMS reminders compared to the controls who did not. Since this occurred at a cheaper rate than projected costs of home visits, in a habitual stock-out situation, this is ample evidence for health policy-makers in LMICs to leverage the ever expanding mobile telecom platforms for future sustainable improvements in routine immunisation performance and even other disease control efforts in Nigeria. Adoption of mHealth into the Nigerian Health system holds promise of better performance, reliability and cost. Evidence from countries with similar circumstances already abound. This vista of opportunities must be harnessed speedily especially since its sustainability holds much hope and its gains innumerable.

## REFERENCES

1. United State Agency for International Development. Immunization Essentials – a practical field guide. USAID, Washington DC, USA; 2003.
2. Stern MA, Markel H. The History of Vaccines and Immunization: Familiar Patterns, New Challenges. *Health Affairs, USA.* 2005; **24:** 611–621.
3. Tengs TO. Five-hundred lifesaving interventions and their cost-effectiveness. *Risk Analysis,* 1995; **15:** 369–390.
4. Plotkin S, Orenstein W, Offit P. Vaccines, 5th ed. Saunders, 2008.
5. Routine Immunization: India's Achilles' heel. *Indian Pediatrics,* 2008; **45:** 625.
6. Olise PO. Primary Health Care for Sustainable Development. *Ozege Publications. Abuja, Nigeria.* 2002; **6:** 187–234.
7. Feilden Battersby Health Systems Analyst. State of immunization in

Nigeria and reasons for current problems. Revised version, 2005.
8. Federal Ministry of Health, Nigeria. National immunization Policy. *FMOH, Abuja–Nigeria*. 2003; **1:** 7–25.
9. National Programmeme on Immunization. Reaching Every Ward (REW) Field Guide: A Guide for Health Management Teams at Ward/LGA Levels. Federal Government of Nigeria, January 2007.
10. Treweek S, Oxman AD. Do parent reminder and recall systems improve the rates of routine childhood immunizations? A SUPPORT Summary of a systematic review. August 2008. Available from: www.support collaboration.org/summaries.htm. cited Aug. 21, 2013.
11. Vann JC, Szilagyi P. Patient reminder and patient recall systems for improving immunization rates. *Cochrane Database of Systematic Reviews,* 2005; 3.
12. UNICEF: State of the world's children; child Survival, 2008. UNICEF, Hatteras Press, Inc. New York 2007
13. United Nations. Millennium Development Goals, Targets and Indicators. Available from: www.un.org/specialrep/ohrlls/lldc/MDGs. cited Aug. 21, 2013.
14. United Nations Foundation. mHealth and Mobile Telemedicine – an Overview. In: Making the eHealth Connection. (Internet). Available from: http://ehealth-connection.org/content/mhealth-and-mobile-telemedicine-an-overview. cited February 13th, 2014.
15. Oluwadare C. The Social Determinants of Routine Immunization in Ekiti State of Nigeria. *Ethno-Med, Kamla-Raj*. 2009; **3:** 49–56.
16. Nigerian Communications Commission (NCC). Subscriber Data 2013. Available from: http://ncc.gov.ng/index.php?option=com_content&view=article&id=125&Itemid=73. Cited Aug. 21, 2013.
17. Lopreiato JO, Ottolini MC. Assessment of Immunization Compliance among Children in the Department of Defence Health Care System. *Pediatrics*, 1996; **97:** 308–311.
18. Rodewald LE, Szilagyi PG, Humiston SG, Barth R, Kraus R, and Raubertas RF. A Randomized Study of Tracking with Outreach and Provider Prompting to Improve Immunization Coverage and Primary Care. *Pediatrics*, 1999; **103:** 31–38.
19. National Population Commission (NPC) [Nigeria] and ICF Macro. 2009. Nigeria Demographic and Health Survey 2008. Abuja, Nigeria: National Population Commission and ICF Macro.
20. Ray on storage blog. Mobile health (mHealth) takes off in Kenya. (Internet). Available from: http://silvertonconsulting.com/blog/2012/02/24/mobile-health-mhealth-takes-off-in-kenya/#sthash.5BllZmHp.dpbs. Cited Feb. 5th, 2014.
21. Population and Family Health. Mobile Technology for Community Health. (Internet). Available from: http://www.mailman.columbia.edu/academic-departments/population-family-health/research-service/mobile-technology-community-health. Cited Feb. 5th, 2014.
22. Lunde S. The mhealth Case in india: Telco-led transformation of healthcare service delivery in India. Wipro Council for Industry Research. 2012; 3–4.
23. Royal Tropical Institute. mHealth Projects: Examples from Low- and Middle-Income Countries, In: mHealth in Low Resource Settings. (Internet). Available from: http://www.mhealthinfo.org/projects_table. cited Feb. 11, 2014.
24. Taskier M. Celebrate Solutions: The Midwives Services Scheme, Nigeria. Women Deliver, January 24th, 2011 (Internet). Available from: http://www.womendeliver.org/updates/entry/celebrate-solutions-the-midwives-services-scheme-nigeria. cited Feb. 12, 2014.
25. Ayodokun JO. The Use of Mobile Phone to check for the Authenticity of Pharmaceutical Products in Nigeria a case study of Mobile Authentication Service (MAS). (Internet). Available from: http://www.ifra-nigeria.org/IMG/pdf/joseph-_ayodokun-identification-drugs-MAS.pdf. cited February 12, 2014.
26. Saad A, Böse K, Speizer I, Odeku M. Mobile Phones: A New Opportunity to Support Urban Family Planning Programmes. National Urban Reproductive Health Initiative. PPT. Available from: http://www.nurhi.org. cited January 17, 2013.
27. Ojeme V. 60,000 women saved in Gombe from pregnancy-related deaths – SFH. Vanguard Newspaper Online, March 8, 2012. Available from: http://www.vanguardngr.com. Cited Jan. 17, 2014.
28. Pathfinder International. Antenatal care Services in Nigeria: App for Clinical decision support, Data collection and reminders during Antenatal in remote clinics [Internet]. Available from: https://www.commcarehq.org/exchange. cited Jan. 17, 2014.
29. Rodewald L *et al.* A randomized study of tracking with outreach and provider prompting to improve immunization coverage and primary care. *Pediatrics*, 1999; **103:** 31–38.
30. English T. Patient Reminders Boost Immunization Rates. Center for the Advancement of Health. Washington DC. July, 2005.
31. Irigoyen MM, Findley S, Earle B, Stambaugh K, Vaughan R. Impact of Appointment Reminders on Vaccination Coverage at an Urban Clinic. *Pediatrics,* Oct 2000; **106:** 919–923.
32. Kendrick D, Hewitt M, Dewey M, Elkan R, Blair M, Robinson J*et al.* The effect of home visiting programmes on uptake of childhood immunization: a systematic review and meta-analysis. *J Public Health Med.* 2000;**22:** 90–8.
33. Rodewald LE, Szilagyi PG, Humiston SG, Barth R, Kraus R, Raubertas RF. A randomized study of tracking with outreach and provider prompting to improve immunization coverage and primary care. *Pediatrics*. 1999; **103:** 31–8.