Piloting an E-Registry & SMS Reminder System for Routine Immunization in Kuje, FCT, Nigeria: Baseline Evaluation

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Abstract- ***Routine immunization has remained low in Nigeria, and most of the unimmunized children are in communities where there are difficulties accessing healthcare services. Those that have access to healthcare services do not complete their vaccination doses for reasons such as lack of information, and lack of transport fare to the health facility among others. To improve immunization demand and uptake in Nigeria, we developed a web-based application that captures the child's data and sends SMS reminders to the parents on their child's immunization schedule. The system was developed using an iterative human-centered (HCD) approach. During the ideation phase, we conducted a baseline evaluation to further understand the reasons for RI dropout and some of the challenges faced by the caregivers in the Kuje Area Council of the Federal Capital Territory of Nigeria. Findings from the baseline shows that caregivers have understood the benefits of child immunization, however, the challenge of long waiting time is still a barrier to routine immunization uptake in Nigeria.***

Indexed Terms- ***Baseline Evaluation, mHealth, Nigeria, Routine Immunization, SMS reminder***

I. INTRODUCTION

Routine Immunization (RI) coverage is low, with over 50% of unimmunized childrenin Nigeria [1,2]. Most of these children are in poor and hard-to-reach communities where access to healthcare services is difficult. The low coverage has been attributed to a lack of information on the health facility vaccination day, caregivers not recalling the date(s) of their child's vaccination, and long waiting hours among others [4,2,3]. The traditional practice for vaccination reminders is via the child vaccination card, which contains the child's information, antigens to be taken, and the date of the next visit [6]. The child vaccination card is effective but may not be a good reminder as caregivers might misplace the cards or forget to check due to a tight work schedule and other daily routines [4]. Caregivers' low literacy also limits the use of immunization cards [3]. Therefore, there is a need for an effective communication system to increase child vaccination uptake and demand in Nigeria.

A reason for long waiting hours could be attributed to the time it takes the health workers to go pick up the vaccines from the storage facility and manually record children's information (name, date of birth, father and mother names, house address, and phone number) on the Child Immunization Register (CIR) and Immunization Card (IC) [4]. Other tools filled manually by the health workers include tally sheets and monthly immunization summary sheets which bring about data discrepancy.

Data error has also been a great challenge in the immunization space, especially in low-middle-income countries, as the administrative data at the health facility is either over *or* under-reported; there are also discrepancies between the administrative data and survey data [9,7,8].RI providers have been identified as the contributing factors to the RI data discrepancies, bringing about a lack of focus on the data quality, not understanding the effect of low data quality, and the high workload on RI providers [9].

To overcome these difficulties, the CIES-reminder system was established to eliminate the manual recording of child immunization information, improve data quality and increase immunization uptake and demand in Nigeria. CIES-reminder is a

web-based application, developed using a hypertext pre-processor (PHP) language – a widely used open-sourced scripting language for web development. The CIES-reminder system has 5 main components – SMS integration, data capturing/management, messaging, reporting, and user roles as depicted in figure 1.

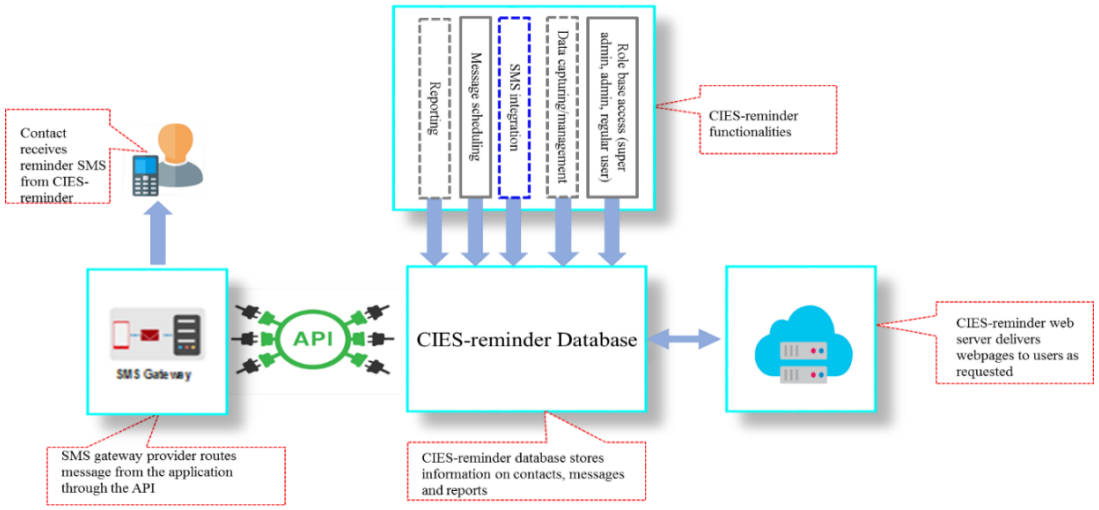

Figure 1: CIES-reminder architectural design

CIES-reminder is mobile health (mHealth) technology that allows the health worker to register children (between 0-4 weeks old) in an e-registry and sends immunization SMS reminders to the parent's registered phone numbers on their child's immunization due date. The reminder messages are sent one day before the child's immunization due date. To ensure automated messages are delivered from the CIES-reminder application to recipients, the system was integrated into an EbulkSMS (SMS provider) gateway using an Application Program Interface (API).

Mobile health (mHealth) technology is a vital tool that has been unified into the healthcare delivery system for engaging and delivering health information to patients, as most people either own or have access to a mobile phone [10,11]. Research has shown that there are over 5 billion mobile phone subscribers globally, and over 70% of them reside in low-and-middle-income countries including Nigeria [12]. Mobile phones can facilitate interactive and timely access to information via the call and text messaging (short message service (SMS)) feature [13]. SMS is widely used in sending and receiving messages and is supported by all mobile phones [11,10,13,6,15]. A single-page SMS has a length limit of 160 characters and can be delivered nationally or internationally within a short time [15].

mHealth has employed SMS for reminders, education, and monitoring of patients to improve access to healthcare services in different contexts [17,16]. mHealth also supports healthcare workers' performance by disseminating clinical updates, learning materials, and reminders, especially in underserved rural areas in low-and middle-income countries [16].

This paper describes the findings from the baseline evaluation conducted during the ideation phase of the Child Immunization E-Registry and SMS Reminder System.

II. METHODOLOGY

The CIES-reminder was developed using the human-centered design (HCD) approach because it follows the software development life cycle iteratively. Reference [19] defined HCD as "the mandatory upstream process that enables a design team to incorporate human requirements into the design of a

system", and reference [20] described HCD as "a creative approach to problem-solving that involves the end-user from the very beginning and places them at the centre of the digital design process". HCD has been widely applied in healthcare and other industries in designing interventions to the target population's needs and contexts. We used the HCD approach to design the CIES-reminder application through the core three phases of HCD – inspiration, ideation, and implementation explained in table 1.

Table 1: Human-Centered Design Phases

S/N	HCD Phases	Description
1	Inspiration	The inspiration phase involves learning directly from the people you are designing for as you immerse yourself in their lives and intensely understand their needs.
2	Ideation	This is a phase where we put together what we've learned at the inspiration phase; identify opportunities for design, and prototype possible solutions.
3	Implementation	In the implementation phase, our solution is brought to life, and eventually, to the market. At this point, we can also tell that our solution will be successful because the people we are looking to serve were involved in the process

With this approach, we designed the system with the end-user and revised it at different points of development to meet the user's needs. We conducted a desk review, consulted, and observed/immersed ourselves with caregivers and RI providers at the health facility to understand the challenges they faced during immunization. A letter was provided from the University of Abuja's Post Graduate school to the management of the Kuje Primary Health Care requesting that we should be granted permission and given the necessary support needed to pilot the study at the hospital.

Following the approval from the health facility management, we conducted a quantitative and qualitative interview in person. The facility RI providers and caregivers gave their consent to participate in the study. The interviews were guided by the questions below:

A. Do parents take their children for immunization?
B. Which parent normally takes the child for vaccination?
C. Do they understand the importance of immunization?
D. What prompts them to take their children for immunization?
E. How are they reminded about their child's immunization date?
F. How effective are the existing reminders?
G. What are the challenges faced during immunization?
H. Do community members have mobile phones?
I. Will they participate in the CIES-reminder study for their child's immunization SMS reminder?
J. What time of the day will they be willing to receive such reminders and in what language?

III. RESULTS

A total number of 27 people were interviewed, 14 responded to survey questions, 11 participated in a focus group discussion, and 2 in key in-depth interviews. The majority (93%) of the respondents, were community members and were needed to provide a comprehensive picture of the challenges faced during immunization to inform the intervention design. 81% of the community members were females. Respondents' ages ranged from 24 - 40 years and their educational status was slightly high. The majority, 88% had a formal education, 26% attained secondary school and 44% attained a higher degree.

We developed themes for the qualitative analysis and they include access to immunization, existing reminder methods, immunization challenges,

suggested solutions, mobile phone ownership, willingness to enrolinthe CIES-reminder system, reminder timing, and preferred language.

- Access to Immunization: We found that community members take their children for vaccination because they are aware of the importance of immunization and the dangers that come with lack of immunization – sicknesses, and diseases.
  Respondent 1: *"I take our child for immunization to prevent him from sicknesses and diseases".*
  Respondent 2: "*We take our children for immunization because we have been enlightened about it".*
  Respondent 3: *"We take our children for immunization for his well-being".*

- Existing reminder methods: Community members mentioned that the child immunization card is the existing immunization reminder and it's effective. However, they sometimes do not remember despite the card. One RI provider informed that they sometimes call the caregivers who do not bring their children for vaccination to know why, and the feedback they received is that they couldn't recall the date.

- Immunization challenges: The major challenges reported were long waiting times and not recalling the vaccines the child is due for.

Respondent 1: *"We spend so many hours immunizing our children. Some of us are workers and we haveto take permission from work to come here because we know the importance of immunization. The health workers are not organized which is why we spend so much time. If they could immunize each child after weighing, it will reduce the waiting time".*
Respondent 2: *"In some health facilities, if you don't know the vaccines your child is receiving, he/she will not be immunized which is not good. Not every parent can remember".*

- Suggested solutions: The community suggested that RI providers should immunize immediately after weighing instead of weighing every child before commencing vaccination to reduce waiting time.

Respondent 1: *"After filling registers and sorting cards, they will tell us to undress our children for weighing, after which we sit and wait until all children are weighed before they start immunizing. Since they are about 4 to 5 RI providers here, they can share the task. One person is weighing and the other is immunizing at the same time to hasten the process".*

- Mobile phone ownership: The majority of community members have mobile phones. An RI provider informed us that about 98% should own a phone. Among the community members that were interviewed, only one mother did not own a phone but her husband does own a phone.
- Willingness to enrol in the study: Community members are willing to enrol in the CIES-reminder system, to enable them to receive SMS reminders for their children's immunization dates. An RI provider was confident that community members will happily enrol since the message is from the health facility. She stated: "*they will be willing to take part so long it is from us".*

Respondent: "*I am willing to take part so I can be reminded of our next appointment".*

- Reminder timing: Though many community members felt the reminder SMS should be delivered in the evening a day before the child's due date, others were comfortable with any time of the day.
- Preferred language: Most (68%) community members were comfortable with receiving messages in the English language while 32% preferred the Hausa language.

For the quantitative survey, we provided options for respondents to select from. Questions were asked about access to immunization and the challenges faced at the hospital during immunization. We found that all 14 parents take their children for immunization because they want their children to be healthy and free from diseases. Also, 9 (64%) parents selected long waiting times as a challenge as depicted in figure 2.

In terms of SMS reminders, 46% of registered phone numbers received SMS reminders from the CIES-reminder system. This implies that parents who did not receive the SMS reminder may not remember to

take their children for vaccination on the due date. To evaluate the system performance and validate the data reported on the system, we interviewed the parents whose messages were shown delivered from our system and they confirmed receiving the SMS reminder. Parents who received the SMS visited the facility upon receiving the reminder, and their immunization status was updated after vaccination. However, the data is insufficient to draw any conclusions.

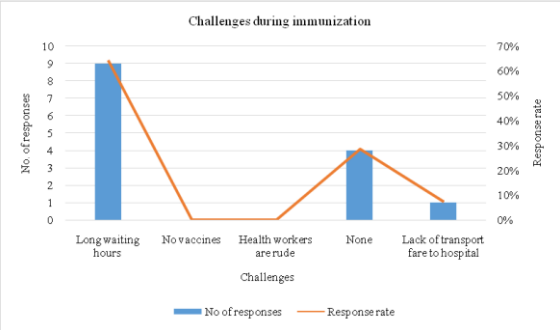

Figure 2: Responses to the challenges faced during immunization

In terms of the existing reminder system, 9 (64%) selected the child immunization cards as the reminder system as depicted in figure 23. Also, 8 (57%) believed their existing reminder method is very effective in reminding them about when to take their child for vaccination.

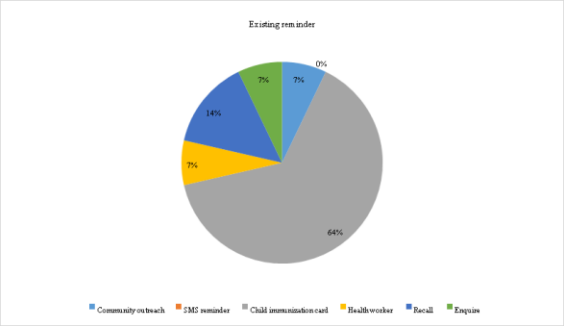

Figure 3: Responses to the existing immunization reminder system

14 (100%) of respondents were willing to enrol their children in the CIES-reminder. 7 (50%) preferred to receive SMS reminders in the evening, and 9 (64%) preferred messages in the English language either because it is a common language in the community or because community members can read and write the language.

IV. DISCUSSIONS

To improve the Routine Immunization (RI) coverage in Nigeria, a Child Immunization E-registry and SMS Reminder System was developed using the Human-Centred Design Approach. As part of the inspiration phase of the system development, we conducted a baseline evaluation to understand the challenges faced by the caregivers during immunization and also the reasons for low immunization coverage. 64% of the caregivers we spoke to said long waiting time was a challenge, as they spend hours waiting to have their child(ren) vaccinated. This was a challenge reported in similar interventions [4,2,3] and was also observed during the RI sessions as we immersed ourselves to understand the user's experience. A caregiver recommended that instead of taking the weight of all children before commencing vaccination, the weighing and vaccination can be done concurrently by different staff to reduce the waiting time - since the hospital has about four staff in the RI unit.

The caregivers were asked about the existing immunization reminder, 64% said the traditional reminder which is the child immunization card was their major source of reminder. A survey conducted in Ilorin, Nigeria also reported that the traditional practice for vaccination reminders is the child vaccination card, which contains the child's information, antigens to be taken, and the date of the next visit [6].

57% of the caregivers we spoke to believed their existing reminder method (vaccination card) is very effective in reminding them to take their child for vaccination. Similar research has shown that the child vaccination card is effective but may not be a good reminder as caregivers might misplace the cards or forget to check due to a tight work schedule and other daily routines [4].

CONCLUSION

To ensure we don't interfere with the immunization sessions, we were only permitted by the hospital management to interact with the caregivers after they

have received their child's vaccination for the day. However, the parents were not patient enough to listen to us as their children were crying after receiving vaccines. In developing similar innovations, it is pertinent to work together with the health providers to ensure that the questionnaires are administered before children are administered vaccines for improved participation. Feedback received from caregivers indicates that long waiting time is still a challenge in Nigeria. There is a need for RI providers and health facility management to address this issue by ensuring that children are attended to on time to minimize dropout rates.

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REFERENCES

[1] Antai, D. (2009). Inequitable childhood immunization uptake in Nigeria: a multilevel analysisof individual and contextual determinants.*BMC infectious diseases*, *9*(1), 1-10.

[2] National Population Commission (NPC) [Nigeria] and ICF. (2019). Nigeria Demographic and Health Survey (2018). Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF.

[3] Obi-Jeff, C., Rakhshani, N. S., Bello-Malabu, J. I., Nwangwu, C., Nwaononiwu, E., Eboreime, E., &Wonodi, C. (2020). Vaccine indicator and reminder band to improve demand for vaccination in Northern Nigeria: A qualitative evaluation of implementation outcomes. *Vaccine*, *38*(26), 4191-4199.

[4] Abdulraheem, I. S., Onajole, A. T., Jimoh, A. A. G., & Oladipo, A. R. (2011). Reasons for incomplete vaccination and factors for missed opportunities among rural Nigerian children.*Journal of Public Health and Epidemiology*, *3*(4), 194-203.

[5] Abbas, A. H., & Yusof, Y. (November 2011). Children's vaccination reminder via SMS alert.In 2011 International Conference on Research and Innovation in Information Systems (pp. 1-5). IEEE.

[6] Ibraheem, R. M., & Akintola, M. A. (2017). Acceptability of reminders for immunization appointments via mobile devices by mothers in Ilorin, Nigeria: a cross-sectional study. *Oman medical journal*, *32*(6), 471.

[7] Baguune, B., Ndago, J. A., &Adokiya, M. N. (2017). Immunization dropout rate and data quality among children 12–23 months of age in Ghana. *Archives of Public Health*, *75*(1), 1-8.

[8] Dunkle, S. E., Wallace, A. S., MacNeil, A., Mustafa, M., Gasasira, A., Ali, D., ... & Sandhu, H. S. (2011). Limitations of using administratively reported immunization data for monitoring routine immunization system performance in Nigeria. 2014. *The Journal of infectious diseases*, *210*(suppl_1), S523-S530.

[9] Omoleke, S. A., & Tadesse, M. G. (2017). A pilot study of routine immunization data quality in Bunza Local Government area: causes and possible remedies. *The Pan African Medical Journal*, *27*.

[10] Schnall, R., Rojas, M., Bakken, S., Brown, W., Carballo-Dieguez, A., Carry, M., ... & Travers, J. (2016). A user-centered model for designing consumer mobile health (mHealth) applications (apps).*Journal of biomedical informatics*, *60*, 243-251.

[11] Gurman, T. A., Rubin, S. E., & Roess, A. A. (2012). Effectiveness of mHealth behavior change communication interventions in developing countries: a systematic review of the literature. *Journal of health communication*, *17*(sup1), 82-104.

[12] World Health Organization (2011).mHealth New horizons for health through mobile technologies.Available from: https://www.who.int/goe/publications/goe_mhealth_web.pdf/. [Accessed August 2021]

[13] Mekonnen, Z. A., Hussien, F. N., Tilahun, B., Gelaye, K. A., &Mamuye, A. (2019).

Development of an automated text-message reminder system to improve the uptake of child vaccination in Ethiopia. *Online journal of public health informatics, 11*(2).

[14] Direct Consulting and Logistics (2011). Evaluating SMS messaging for immunization demand generation in Nigeria: Immunization Reminder and Information SMS System (IRISS). Available from: https://dclnigeria.com/wp-content/uploads/2021/04/IRISS-updated-technical-brief.pdf/. [Accessed August 2021]

[15] Chan, K. C., & Tien, D. A. (2013). multi-tenant platform for SMS-integrated services.*International Journal of Computer Networks & Communications*, *5*(6), 205.

[16] Amoakoh-Coleman, M., Borgstein, A. B. J., Sondaal, S. F., Grobbee, D. E., Miltenburg, A. S., Verwijs, M., ... & Klipstein-Grobusch, K. (2016). Effectiveness of mHealth interventions targeting health care workers to improve pregnancy outcomes in low-and middle-income countries: a systematic review. *Journal of medical Internet research*, *18*(8), e5533.

[17] Hamine, S., Gerth-Guyette, E., Faulx, D., Green, B. B., & Ginsburg, A. S. (2015). Impact of mHealth chronic disease management on treatment adherence and patient outcomes: a systematic review. *Journal of medical Internet research*, *17*(2), e3951.

[18] Forenbacher, I., Husnjak, S., Cvitić, I., & Jovović, I. Determinants of mobile phone ownership in Nigeria. 2019. *Telecommunications Policy*, *43*(7), 101812.

[19] Guy André Boy (2011). Introduction: A human-centered design approach.Available from: https://www.cambridge.org/core/services/aop-cambridge-core/content/view/F726100E2E7D0C825CB526FD7412C48E/S2053470117000087a.pdf/human centered_design_of_complex_systems_an_experiencebased_approach.pdf /[Accessed September 2021]

[20] Miklos Philips. The Importance of Human-centered Design in Product Design. https://www.toptal.com/designers/ux/human-centered-design/[Accessed September 2021]

[21] Forenbacher, I., Husnjak, S., Cvitić, I., & Jovović, I. (2019). Determinants of mobile phone ownership in Nigeria. 2019. Telecommunications Policy, 43(7), 101812.