The Use of Digital Technologies and Approaches for Real-Time Monitoring of Supplementary Immunization Activities

Good practices and lessons learned

unicef

Gavi
The Vaccine Alliance

Published by UNICEF
Division of Communication
3 United Nations Plaza
New York, NY 10017, USA

Contact: pubdoc@unicef.org

Website: www.unicef.org

Suggested citation. The Use of Real Time Monitoring Approaches and Tools for Immunization Campaigns: Good Practices and Lessons Learned
New York: United Nations Children's Fund (UNICEF), 2021.

Cover photograph: © UNICEF/UNI217677/Zaidi

Acknowledgements

UNICEF would like to extend special thanks to the external partners who provided strategic technical advice and support for the development of this report: from Gavi, Carine Gachen, Laura Craw, Riswana Soundardjee and Hope Johnson; from the Bill and Melinda Gates Foundation, Kendall Krause; from WHO, Carolina Danovaro; from Health Enabled, Patricia Mechael; and from the United States Centers for Disease Control and Prevention, Scott Brown, Mark Papania and Cheryl Williams.

The UNICEF Programme Division and the UNICEF Information Communication and Technology Division would like to thank the many UNICEF staff who provided technical advice and support for the development of this document, including the following members of the time-bound RTM for Immunization Campaigns Research and Guidance Reference Group: from UNICEF Egypt, Essam Allam, Gaia Chiti Strigelli and Olfa Tantawi; from UNICEF Indonesia, Mohammad Ruhul Amin, Khin Devi Aung, Kenny Peetosutan and Paul Pronyk; from UNICEF Lebanon, Gianluca Flamigni; from UNICEF Tanzania, Alex Mphuru; from UNICEF Uganda, Eva Kabwongera and Aguibou Ousmane Ndiaye; from UNICEF Zambia, Monjur Hossain and Ngawa Nyongani Ngoma; from the UNICEF Eastern and Southern Africa Regional Office, Antoinette Eleonore Ba, Sean Blashke, Abu Obeida Eltayeb, Karim Ghalani, Benjamin Grubb, Raoul Kamadjeu, Alfred Assey Mukasa, Anupma Sud; from the UNICEF Middle East and North Africa Regional Office, Abu Obeida Eltayeb, Lillian Luanda and Daniel Ngemera; from the UNICEF Regional Office for South Asia, Saadia Farrukh, Wojciech Koprowicz and Cary McCormick; from the UNICEF West and Central Africa Regional Office, Hawi Bedasa, Raul Castillo, Chris Ngwa and Antoine Ziao; and from UNICEF Headquarters, Joseph Barnes, Karen Carter, Niklas Danielsson, Ulla Griffiths, Mamadou Saliou Diallo, Karin Kallendar, Raoul Kamadjeu, Matthew McNaughton, Alex Muhereza, Sailas Nyarez, Maria Peel, Jennifer Requejo, Ian Thorpe, Evan Wheeler and Ahmadu Yakubu.

Johns Hopkins University's Center for Communication Programs was contracted to conduct the research and write this report. The key authors of the report are Saori Ohkubu and Eric Filemyr, under the guidance of Jennifer Orkis and Angela Acosta.

The preparation of this document was made possible with generous support and funding from the Gavi – the Vaccine Alliance.

This research was managed and commissioned by Imran Mirza of the UNICEF Programme Division and Raquel Wexler of the UNICEF Information Communication and Technology Division.

Contents

Acronyms

AEFI	Adverse events following immunization
DHIS 2	District Health Information Software 2
EOC	Emergency Operations Centre
EPI	Expanded Programme on Immunization
GIS	Geographic information system
GPS	Global positioning system
OPV	Oral polio vaccine
ODK	Open Data Kit
RTM	Real-time monitoring
SMS	Short message service
TCV	Typhoid conjugate vaccine
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
WHO	World Health Organization
WHO-AFR	WHO Regional Office for Africa

Executive summary

Supplementary immunization activities and mass immunization campaigns are effective strategies for delivering vaccination to children who have otherwise been missed by routine services.[1] Real-time monitoring (RTM) – activities that employ digital technologies to accelerate the sharing, analysis and use of data to improve campaign quality[2] – can enhance the quality of supplementary immunization activities and campaigns by helping implementers review progress against targets; identify issues and gaps; track supplies, human resources and vaccine sessions; and make prompt decisions about corrective actions.[3] In light of COVID-19 vaccine roll-out, the use of RTM to support immunization campaigns is more important than ever.

This report compiles the good practices and lessons learned from countries implementing RTM for immunization campaigns. Data and information were collected from various sources, including interviews with United Nations Children's Fund (UNICEF) and World Health Organization (WHO) regional and country office staff; consultations with key partners; a field mission to Pakistan; and documents and journal articles. Four countries with robust experience implementing RTM technologies for immunization campaigns – Indonesia, Pakistan, Uganda and Zambia – were included as case studies.

Pakistan conducted a national measles campaign in 2018 that reached 37 million children and a typhoid campaign in Sindh province in 2019 that reached 9.5 million children. In both campaigns, RTM data collected through RapidPro Surveyor, KoBo Toolbox and WhatsApp were used to target missed children and reach millions of people in short time frames. The Pakistan case illustrated how the combination of data and communication tools enabled prompt action and ultimately contributed to quality improvements at every stage of the campaigns.

Indonesia conducted a nationwide measles-rubella campaign targeting 68 million children in two phases. RTM using RapidPro facilitated timely and efficient tracking and analysis of coverage against targets. Users reported high rates of satisfaction with the platform, analyses showed consistency with official data submitted through the manual reporting system, and districts with higher reporting rates were more likely to achieve their target coverage rate. The case confirmed the importance of quality assurance measures and a theory of change to conducting successful campaigns and improving process and outcomes.

Uganda conducted a nationwide measles-rubella campaign targeting 18.1 million children and a polio/oral polio vaccine (OPV) campaign targeting 8.2 million children, beginning in October 2019. The national response team combined the data collection abilities of Open Data Kit (ODK) with a District Health Information Software (DHIS) 2 dashboard to promptly consolidate, visualize and analyse the data. RTM approaches supported timely campaign progress, results and feedback, which in turn facilitated corrective actions and helped Uganda save on costs associated with transporting data and printing forms.

Zambia has implemented RTM for cholera, measles-rubella and polio immunization campaigns for the past five years. RTM approaches were deployed for campaigns that vary greatly in scope (nationwide vs. targeted), delivery methods (static-site vs. school-based vs. outreach vs. house-to-house) and for a broad range of target populations (infant through adult age). Stakeholders and users reported satisfaction with

1 World Health Organization, 'Planning and Implementing High-Quality Supplementary Immunization Activities for Injectable Vaccines: Using an example of measles-rubella vaccines – field guide', WHO, Geneva, 2016.

2 Ramalingam, Ben et. al., 'Bridging the Gap: How real-time data can contribute to adaptive management in international development', USAID, June 2017.

3 Ibid; Oh, D. H. et al., 'Real-Time Monitoring of Vaccination Campaign Performance Using Mobile Phones—Nepal', Morbidity and Mortality Weekly Report, vol. 65, no. 39, 2016, pp. 1072-1076; United Nations Children's Fund, 'Learning How to Mainstream and Scale Digital Monitoring Solutions: National real-time monitoring systems strengthening and scale using RapidPro – lessons learned brief', UNICEF, 2018.

the speed of access to data, the ease of coordinating with colleagues at all levels, the ability to monitor activities everywhere (even in remote areas) and the level of teamwork.

In addition, relevant journal articles describing the effect of digital RTM tools for immunization were identified and reviewed. Out of 200 articles screened based on title and abstract, six relevant cases from the Democratic Republic of the Congo and Somalia (multi-country study), Haiti, Iraq, Malawi, Nepal, Nigeria and South Sudan were selected for the full-text review. The literature review found that RTM was associated with: outcomes that bolster campaign effectiveness, including improvements in data quality, timeliness and completeness; more accurate micro plans; stronger accountability of field teams; and better collaboration, partnership and communication at all levels. Challenges spanned both technological and programmatic areas. In some places, there were very short timeframes for planning, leading to insufficient stakeholder and user engagement. Network connectivity was a common challenge, and some countries' field teams had difficulty accessing their data on the same day due to a requirement for central level data cleaning/downloading/approval.

Overall, 13 country experiences and nearly 70 good practices and lessons learned are documented in this report.

High-level **benefits** of using RTM included:

1. RTM can contribute to the achievement of campaign targets
1. RTM enables the rapid use of data for decision-making and prompt corrective actions
2. RTM can improve data quality
3. RTM approaches help enforce accountability at all levels
4. RTM can support improvements in campaign planning
5. RTM can be used for media monitoring and addressing vaccine hesitancy and rumours
6. RTM approaches can refine outreach strategies
7. RTM can strengthen routine immunization systems
8. RTM approaches support rapid collection of standardized data and its integration with other digital solutions, over paper-based approaches
9. RTM supports daily immunization activity monitoring

High-level **good practices** included:

1. Using RTM before, during/intra and after campaigns;
2. Leveraging and aligning with existing technology and eHealth programme structures to strengthen national systems;
3. Consulting users and stakeholders continually;
4. Testing and iterating systems to meet user needs;
5. Choosing complementary and interoperable technologies;
6. Investing in the capacities of users at multiple levels of health systems;
7. Ensuring information technology and network assistance are available; and
8. Applying effective data use processes for RTM.

High-level **lessons learned** included:

1. RTM planning should be initiated early;
2. Government ownership and leadership are indispensable to accelerating adoption and ensuring sustainability;
3. For RTM approaches to function efficiently, the number of platforms and forms, the use of paper, and manual data processing and downloading should all be minimized;
4. The "real-time" (same day) element should be prioritized during platform selection, with appropriate processes in place to support accountability for decision making;
5. Training materials, data entry forms, dashboard templates and other tools should be developed at the global or regional levels for platforms used by multiple countries;
6. The use of RTM data can improve public awareness and strengthen local advocacy; and

7. Resources need to be in place for the use of RTM data.

As countries continue to adopt or refine their use of RTM for supplementary immunization activities and campaigns, a systematic approach to mapping user/stakeholder needs, ensuring integration with the broader eHealth and immunization landscape and addressing bottlenecks to real-time access to data will be critical for sustaining and enhancing the contributions of RTM.

The case studies show that real-time data systems can, in the right circumstances and with the right enabling conditions, facilitate real-time decision-making. Ultimately, the use of real-time data systems for real-time decision-making is not about technology. It is about a strategic and cultural environment that enables technology to be utilized as support to organizational decision-making and institutional digital transformation. While technology can certainly raise questions and opportunities, it cannot open the door to this kind of transformation – either within programmes or more broadly in organizations and alliances. As with other forms of evidence utilization, political, institutional and individual will are critical.

©UNICEF/Pakistn country office/2020

Introduction

Background

In recent years, global strategies to eradicate polio and reduce measles mortality have included vaccination campaigns targeting children of all ages. Supplementary immunization activities and mass immunization campaigns are effective strategies for reaching children with vaccination who have otherwise been missed by routine services (e.g., hard-to-reach and underserved children).[4]

Uniformly high coverage in target areas is critical to achieving herd immunity and reaching disease control goals. Real-time monitoring (RTM) – which is conducted using digital tools such as RapidPro, Open Data Kit (ODK) and District Health Information System (DHIS) 2 – facilitates high coverage through the rapid targeting of additional activities in low coverage areas and quality and timely corrective measures during supplementary immunization activities. By filling these gaps and enabling these adjustments, RTM tools can support the achievement of immunization targets established in the Global Vaccine Action Plan and the Sustainable Development Goals.

In this document, RTM refers to activities that employ digital technologies to accelerate the sharing, analysis and use of data to improve campaign quality.[5] RTM takes advantage of and is made possible by technological advances that enable the rapid submission, analysis and review of data. In contrast, traditional monitoring is often exclusively paper-based and involves the manual submission and/or compilation of data. Because traditional monitoring is slower and more prone to error, it poses few opportunities for the rapid review of progress and prompt course correction.[6]

Real-time data monitoring can be defined as follows:

Real-time data monitoring uses digital technologies (i.e., computers, tablets, mobile phones, sensors, etc.) and specialized software applications (RapidPro, DHIS2, KoBo Toolbox, etc.) to enable and accelerate the collection, sharing, management, analysis and reporting of data. The aim is to inform more rapid, timely and effective decision-making to improve the effectiveness and efficiency of a vaccination campaign.

RTM can enhance the quality of supplementary immunization activities and campaigns by assisting implementers to review progress against targets; identify issues and gaps; track supplies, human resources and vaccines sessions; and make decisions for prompt corrective action.[7] Switching from manual, paper-based systems to digital RTM systems at all stages of a campaign (pre, during/intra and post) can hasten the flow of information, reduce printing and transportation costs, and improve accountability and oversight. Ultimately, having more responsive, cost-effective, data-driven and transparent supplementary immunization activities can help countries reach their targets and eliminate vaccine-preventable diseases.

4 'Planning and Implementing High-Quality Supplementary Immunization Activities for Injectable Vaccines'.

5 Ramalingam, 'Bridging the Gap'.

6 Tozzi, A. E., et al., 'Can Digital Tools be Used for Improving Immunization Programs?' Frontiers in Public Health, vol. 4, no. 36, 2016.

Methodology

Objectives

Learning from the experiences of countries that have implemented RTM to support immunization activities is critical to achieving measles-rubella elimination by 2020. Between October 2019 and March 2020, UNICEF country, regional and global offices worked closely with the Johns Hopkins Center for Communication Programs to capture good practices and lessons learned from relevant country programmes and published literature. Key to the capture of country experience were consultations with the World Health Organization (WHO) in selected countries to learn of WHO experience with RTM, and the technical support and guidance provided by Gavi, The Vaccine Alliance. In this document, "good practices" are defined as steps or processes that appear to have worked well and may be replicable; and "lessons learned" are defined as insights that were unexpected and/or generate recommendations for changes to future implementation.

The study team's main objectives were to:

1. Collect detailed programme experiences from countries using RTM for supplementary immunization activities;
2. Identify the critical factors that facilitate the use of digital technologies for RTM and information generated for corrective action for supplementary immunization activities;
3. Identify examples of good practices and lessons learned to support countries interested in replicating and scaling similar efforts.

The methodology was designed based on the 2008 WHO Regional Office for Africa (WHO-AFRO) 'Guide for Documenting and Sharing "Best Practices" in Health Programmes'. It involved a literature review of available documentation, research and evaluations; remote key informant interviews and focus group discussions with UNICEF country and regional offices and partners; and a field mission to Pakistan.

Data collection

Literature review

The study team reviewed available documentation, research and evaluations describing the strategies, approaches and outcomes of UNICEF country and regional offices using digital technologies to monitor immunization campaigns in real time. The review also included other documents, such as press releases, news items, announcements, progress reports, evaluation reports, case studies, etc., illustrating RTM implementation processes and outcomes in immunization campaigns. Multiple channels were used to search for and obtain relevant resources, including Internet searches and consultations with UNICEF staff members at all levels.

Key informant interviews and focus group discussions

The study team conducted virtual interviews with key informants, including UNICEF regional and country office staff, representatives from partner organizations (e.g., WHO, HealthEnabled and Gavi, The Vaccine Alliance) in selected regions and countries. Most of the sessions were conducted in a group setting with several key informants (focus group discussions). The primary purpose of the key informant interviews/focus group discussions was to gain an understanding of RTM implementation and the use of digital tools in various settings. The study team aimed to capture a wide range of opinions and ideas regarding their experiences and practices with RTM and other digital tools (e.g., what worked, what did not work, what contributed to better programme outcomes, etc.). Each interview/discussion took 60 to 75 minutes and was conducted via Zoom. One team member led the discussion using the semi-structured interview/discussion guide and another staff member took detailed notes during the discussion. The research team obtained oral consent from participants for recording each session. Lists of data collection instruments and participants/participating regions/countries are provided in annexes 1 and 2.

Field mission

A team from UNICEF headquarters, regional offices and the Johns Hopkins Center for Communication Programs travelled to Pakistan to interview national, provincial and district level stakeholders to capture in-depth perspectives on the processes involved in RTM implementation and lessons learned.

Write-up and review

Among the countries and regions reviewed, Indonesia, Pakistan, Uganda and Zambia were found to have the most robust experience with implementing RTM technologies for immunization campaigns. Case studies were drafted and shared with the relevant country offices for fact checking and review with the country reference group, including stakeholders and partners such as government officials and non-governmental organization representatives. The UNICEF Headquarters team consolidated these reviews, and the study team addressed feedback.

Table 1. Summary of case studies

No.	Country	Immunization campaign	Phase	RTM tool	Year	Data sources
1	Pakistan	Measles and typhoid campaigns	Pre, intra, and post	KoBo Toolbox; RapidPro Surveyor; WhatsApp	2018, 2019	Field visit; interviews; reports
2	Indonesia	Measles-rubella campaign	Pre, intra, and post	RapidPro	2017, 2018	Interviews; reports
3	Uganda	Measles-rubella and polio campaigns	Intra	ODK; DHIS2	2019	Interviews; reports
4	Zambia	Cholera, measles-rubella and polio campaigns	Pre, intra, and post	OnaData; Power BI	2019	Interviews; reports

Limitations

The literature review and interviews with regional and country teams reflected positive RTM experiences. However, the added value of RTM was usually described qualitatively through anecdotes and not rigorously measured using qualitative methods. In some instances, the study team could not validate findings from interviews with additional data sources (e.g., campaign evaluation reports). Literature reviews are also prone to publication bias in that successful studies or experiences are more likely to be written up than unsuccessful ones.

The focus on supplementary immunization activities and campaigns meant that some issues related to routine immunization were not captured. Examples include stock management optimization; stock-out prevention; and linking campaign data with routine monitoring data and data storage/maintenance for future campaigns. In addition, future studies could expand on several topics such as the use of RTM in remote areas; personal data encryption when using global positioning systems (GPS); data storage and protection; the use of RTM in conflict settings; the inclusion of eLearning and job aids in digital RTM devices; and linkages with Periodic Intensification of Routine Immunization.

Finally, although the examples presented in this report note the potential for improving campaign outcomes by integrating digital tools to support RTM and facilitate timely data use for decision-making and corrective actions, further research is needed to quantify the linkages between the use of digital tools for RTM and improvements in campaign coverage and effectiveness.

Summary of key findings

The case studies and literature review concluded that the following enabling factors need to be in place for real-time data to contribute to real-time decision-making during immunization campaigns.

Key enabling factors

- **Leadership and governance:** Government leadership in the design, implementation and assessment of RTM approaches is important to ensure alignment with existing systems and eHealth policies, as well as ownership and sustainability of approaches. To support the use of data for decision-making and corrective action, accountabilities must be in place to support information sharing and decision-making at all levels. Quality checks of real-time data are necessary and must occur in real-time to avoid bottlenecks. Multiple stages of verification may be necessary, combining digital and technical approaches for collecting, organizing, aggregating, analysing and using data.
- **Strategy and investment:** It is essential that a clearly defined vision, strategy and plan be developed and aligned at the national and sub-national levels to enable appropriate planning, implementation and assessment of the use of RTM approaches in immunization campaigns. Based on early RTM experiences, national partners may wish to adapt or expand RTM use to other geographic regions or opt to use different technologies. Pilot RTM experience can help inform government strategy and investment.
- **Legislation, policy and compliance:** Policies that support and reinforce the use of RTM approaches should be established, and RTM implementation should be aligned with existing eHealth policies and frameworks, including those related to data accessibility.
- **Standards and interoperability with existing eHealth and government structures:** RTM approaches should be aligned with international and national norms and standards, and RTM technologies should allow for interoperability whenever possible or alignment (at minimum) with existing eHealth systems, structures and national health system information infrastructure.
- **Infrastructure and connectivity:** Appropriate technology infrastructure, including hardware, software, data bundles and mobile services to be used by a wide range of stakeholders from village to national level should be established.
- **Services and applications:** appropriate technology and mobile services should be in place to support adequate planning on the use and integration of RTM approaches in immunization campaigns. This will also ensure support to devices in the event of their deterioration and the continuity of mobile service provision to stakeholders.
- **Human resources:** At all levels, persons involved in implementing RTM approaches, which may be new, need to be oriented to the approach and understand why a new approach is being employed. All personnel using digital technology require orientation to the technology hardware and software and understand data flows, the use of data, and accountabilities for the use of data.
- **Funding:** Financial resources are needed to ensure the effective planning, use and sustainability of RTM approaches for immunization campaigns.

Benefits of using RTM in immunization campaigns

The case studies and the literature review found that RTM bolstered campaign effectiveness. This was achieved through improvements in the quality, timeliness and completeness of data; more accurate micro plans; stronger accountability of field teams; and better collaboration, partnership and communication at all levels. Using RTM, campaign teams were better able to identify and take corrective actions promptly and achieve campaign targets. The following key benefits of using RTM approaches in immunization campaigns were identified:

RTM can contribute to the achievement of campaign targets

RTM systems provided daily feedback on progress against targets, which led to a decrease in the number of unvaccinated children and improvements in post-campaign coverage. In some cases, such as in Pakistan,

when low coverage was recorded in real-time, campaign managers immediately implemented behaviour change communication outreach in target communities, to generate demand for vaccination. In Nepal, RTM improved the quality of vaccination campaigns with faster data transmission, analysis and decision-making, and greater accountability among different levels of the health systems.

RTM approaches support faster collection of standardized data and its integration with other digital solutions, over paper-based approaches

The use of mobile information technology supports the collection of standardized data in real-time, to inform and improve decision-making for vaccination campaigns and immunization programming and response. Electronic data collection has been proposed as a solution to many challenges faced by paper-based surveys and is increasingly being adopted in a number of public health programmes, including the integrated management of childhood illness,[8] community epidemiology[9] and neglected tropical diseases.[10] Moreover, open source applications hosted on the Android (Google Inc.) platform, including ODK,[11] have enabled public health managers and epidemiologists with limited software programming experience to use mobile information technology for public health programming. Android-based smartphones offer additional capabilities, including built-in GPS functionality and other applications that can be integrated into electronic data collection, such as barcode scanning, digital photography and automated timestamp information. Mobile information technology also enables other data sources, including census and mapping data, and other tools for data visualization, including Google Maps, to be more readily integrated into the process of data collection, reporting and analysis.[12]

RTM supports daily immunization activity monitoring

The use of digital technologies for immunization campaign activities demonstrates benefits for daily activity monitoring. Descriptions of pilot programmes and feasibility studies report improvements in accountability and supervision, standardization of data and the ability to provide real-time feedback to field staff for follow-up on missed settlements.[13] Post-campaign coverage survey activities also benefit from the ability to collect real-time or near-real-time data on areas that did not reach target coverage levels.[14] All of these publications give promising indications that real-time campaign monitoring can benefit supplemental immunization activities. However, there is a need for studies demonstrating the quantifiable effects of RTM on the identification of missed areas and improved coverage rates.

RTM can refine campaign outreach strategies

RTM allowed programme staff to refine their outreach strategies during the campaign and plan for the next rounds. Refinements included identifying new communication and information sources; modifying campaign messages to correct erroneous community perceptions); targeting geographical areas; and modifying the campaign strategy from fixed post to mobile post, and eventually, door-to-door.

---

8 Mitchell M., et al., 'Using Electronic Technology to Improve Clinical Care—Results from a before-after cluster trial to evaluate assessment and classification of sick children according to Integrated Management of Childhood Illness (IMCI) protocol in Tanzania', BMC Med Inform Decis Mak, vol. 13, 2012, pp. 95–95.

9 Aanensen, D.M., et al., 'EpiCollect: Linking smartphones to web applications for epidemiology, ecology and community data collection', PLoS ONE, vol. 4, 2009.

10 King, J.D., et al., 'A Novel Electronic Data Collection System for Large-Scale Surveys of Neglected Tropical Diseases', PLoS ONE, vol. 8, 2013.

11 Open Data Kit, <www.opendatakit.org>, accessed 24 November 2020.

12 Kamadjeu, R. 'Tracking the Polio Virus Down the Congo River: A case study on the use of Google Earth™ in public health planning and mapping', International Journal of Health Geographics, vol. 8, no. 4, 2009; Stensgaard, A-S, et al., 'Virtual Globes and Geospatial Health: The potential of new tools in the management and control of vector-borne diseases', Geospatial Health, vol. 3, 2009, pp. 127–141.

13 Bawa, S., et al., 'Conduct of Vaccination in Hard-to-Reach Areas to Address Potential Polio Reservoir Areas, 2014-2015', BMC Public Health, vol. 18, no. 4, 2018; Teng, J. E., et al., 'Using Mobile Health (mHealth) and Geospatial Mapping Technology in a Mass Campaign for Reactive Oral Cholera Vaccination in Rural Haiti', PLoS Neglected Tropical Diseases, vol. 8, no. 7, 2014; Haskew, J., et al., 'Use of Mobile Information Technology during Planning, Implementation and Evaluation of a Polio Campaign in South Sudan', PloS one, vol. 10, no. 8, 2015; Oh, et al., 'Real-Time Monitoring of Vaccination Campaign Performance Using Mobile Phones—Nepal', pp. 1072-1076.

14 Kazi et al, 2017; Oh, et al., 'Real-Time Monitoring of Vaccination Campaign Performance Using Mobile Phones—Nepal', pp. 1072-1076.

RTM can enable prompt corrective actions based on rapid available data and information

In most countries, most monitoring results were available on the same day, and timely reporting improved supervision. Supervisors used data on reasons for non-vaccination to tailor vaccination strategies and take immediate actions, which had not been possible with paper-based rapid convenience monitoring.

RTM can improve data quality

In many countries, RTM improved the timeliness and completeness of reporting. The automated calculations and analyses displayed on dashboards eliminated the potential for manual calculation errors (a previous problem with paper-based rapid convenience monitoring data).

RTM can improve accountability

The tracking of vaccination teams and vaccination progress through digital means in some countries helped teams reach the settlements they were supposed to cover and helped supervisors monitor the level of coverage.

RTM can improve planning

Having an objective overview of vaccination progress through digital means enabled campaign managers to better forecast the campaign timeline.

RTM can support media monitoring and addressing vaccine hesitancy and rumours

Anti-vaccine messages, myths and negative media fuel distrust in vaccination. Negative messages about vaccines may come from the media, interest groups and others as rumours and stories. Such messages may include suspected adverse events following immunization (AEFI); conspiracies related to the government and the pharmaceutical industry; fear related to the debunked study linking vaccines with autism; or religious or naturalist beliefs. These negative messages build distrust in vaccination and give rise to vaccine myths. Monitoring public opinion in real-time allows authorities to learn about opinions, misconceptions and fears before they become widespread, and respond to them before they escalate. RTM is a first step towards anticipating a potential crisis, initiating a dialogue with the audience and managing uncertainty.

RTM can strengthen routine immunization systems

Reaching children that are chronically missed by routine immunization services is key to achieving Global Vaccine Action Plan and Immunization Agenda 2030 goals. The rapid advancement and accessibility of mobile technology in low and lower middle-income countries provides an important opportunity for applying novel, innovative approaches to providing vaccine services.

Programmes that have implemented real-time tracking of vaccinator teams see improvements in attendance and can ensure that all assigned catchment areas are covered, reducing the number of missed settlements.[15]

Box 1. ColdTrace sensor

The ColdTrace sensor – a wireless remote temperature monitoring solution – tracks refrigerator temperature and health facility power availability, and alerts health care workers via short message service (SMS) when vaccines are in danger. By providing real-time data, ColdTrace gets actionable information to the right people at the right time to ensure that children everywhere receive safe, effective vaccines, thereby strengthening the resilience of immunization systems. ColdTrace data also paints a real-time picture of power availability in remote clinics, giving governments information about the resilience and infrastructural soundness of their health systems. ColdTrace is currently in use in Cambodia, Ethiopia, Haiti, India, Kenya, the Lao People's Democratic Republic, Mozambique and Timor-Leste.

15 Chandir, S., et al., 'Feasibility of Using Global System for Mobile Communication (GSM)-baesd Tracking for Vaccinators to Improve Oral Poliomyelitis Vaccine Campaign Coverage in Rural Pakistan', Vaccine, vol. 35, no. 37, 2017; Gammino, V.M., et al., 'Using Geographic Information Systems to Track Polio Vaccination Team Performance: Pilot project report', The Journal of Infectious Diseases, vol. 210 (suppl_1), 2014 pp. S98-S101; Touray, K., et al., 'Tracking Vaccination Teams during Polio Campaigns in Northern Nigeria by use of Geographic Information System Technology: 2013–2015', The Journal of Infectious Diseases, vol. 213 (suppl_3), 2016, pp. S67-S72.

Box 2. Using RTM to improve immunization coverage and equity

The inaccuracy of recording is a widespread problem, due to the high volume of activity, increased number of service delivery points, multiple interventions, low priority, and non-use of child health cards during the periodic intensification of routine immunization activity. Several factors favour the overestimation of doses administered during these activities and this may carry forward, resulting in overestimates of routine immunization coverage. Experience from many countries suggests that greater attention should be given to recording and reporting before, during and after the periodic intensification of routine immunization event. Use of digital technologies can address this issue and vaccination teams can be followed-up on to monitor if they have covered planned areas.

The digital immunization registry system in Pakistan's Sindh province includes real-time tracking for vaccinators during working hours. In combination with geographic coordinates for every registered child, the vaccinator tracking system can provide managers with daily reports on the number of children reached and has been used during campaign activities to rapidly correct missed settlements or neighbourhoods.

Also, in Pakistan, the eVacc smartphone-based vaccinator monitoring application enables community vaccinators in Punjab province to record all community visits with geo-coordinate data that serves as both a management and an accountability tool. The system has contributed to improved vaccination coverage in the province and has promoted more supportive supervision relationships between community-based vaccinators and district managers.

The effective use of a vaccinator tracking system requires good supervisory roles to monitor vaccinator performance and implement corrective action to cover all settlements in respective catchment areas. These challenges can only be addressed through capacity building and human relationships, not by a technological solution. The intent of the tracking system, data security measures and corrective action should be made clear for all stakeholders involved in the tracking system. All of these issues require clear governance policies on the use of geographic information system (GIS) enabled tools, data sharing and privacy

The use of mobile phones or tablets with geo-navigation systems allow for an entirely new level of monitoring by enabling real-time tracking of immunization staff during campaign activities, regular outreach or supervisory visits. Combined with an accurate health system map and micro plans integrated into a web-based dashboard, vaccination team movements are accessible by all levels of supervisors to facilitate rapid corrective action, feedback on missed settlements and areas with poor coverage.

Case study participants overwhelmingly reported having positive experiences with RTM and expressed an interest in continuing and deepening their use of it. While most country examples demonstrated familiarity with using digital tools to take corrective actions during campaigns, a few examples showcased opportunities for expanding the use of digital tools and real-time data before or after campaigns.

While the case studies and literature review unanimously reflected that RTM was feasible and should be continued or expanded, there were also reports of technological and programmatic challenges. In some countries, short timeframes for planning meant that software developers only had one month to develop tools, which diminished stakeholder and user engagement. Some countries experienced an overload of data collection platforms and tools; while others felt they lacked sufficient data to take the right corrective actions. Network connectivity was a common challenge. Some field teams struggled to access their data due to required data cleaning/downloading/approval at the centralized level.

As countries continue to adopt or refine the use of RTM in campaigns, a systematic approach to mapping user/stakeholder needs, ensuring integration with the broader eHealth and immunization landscape and addressing bottlenecks to real-time access to data will be critical for sustaining and enhancing the contributions of RTM. "Why are we collecting data?" would be an essential question that implementors should ask to link RTM to action and acceptability and ultimately contribute to successful outcomes.

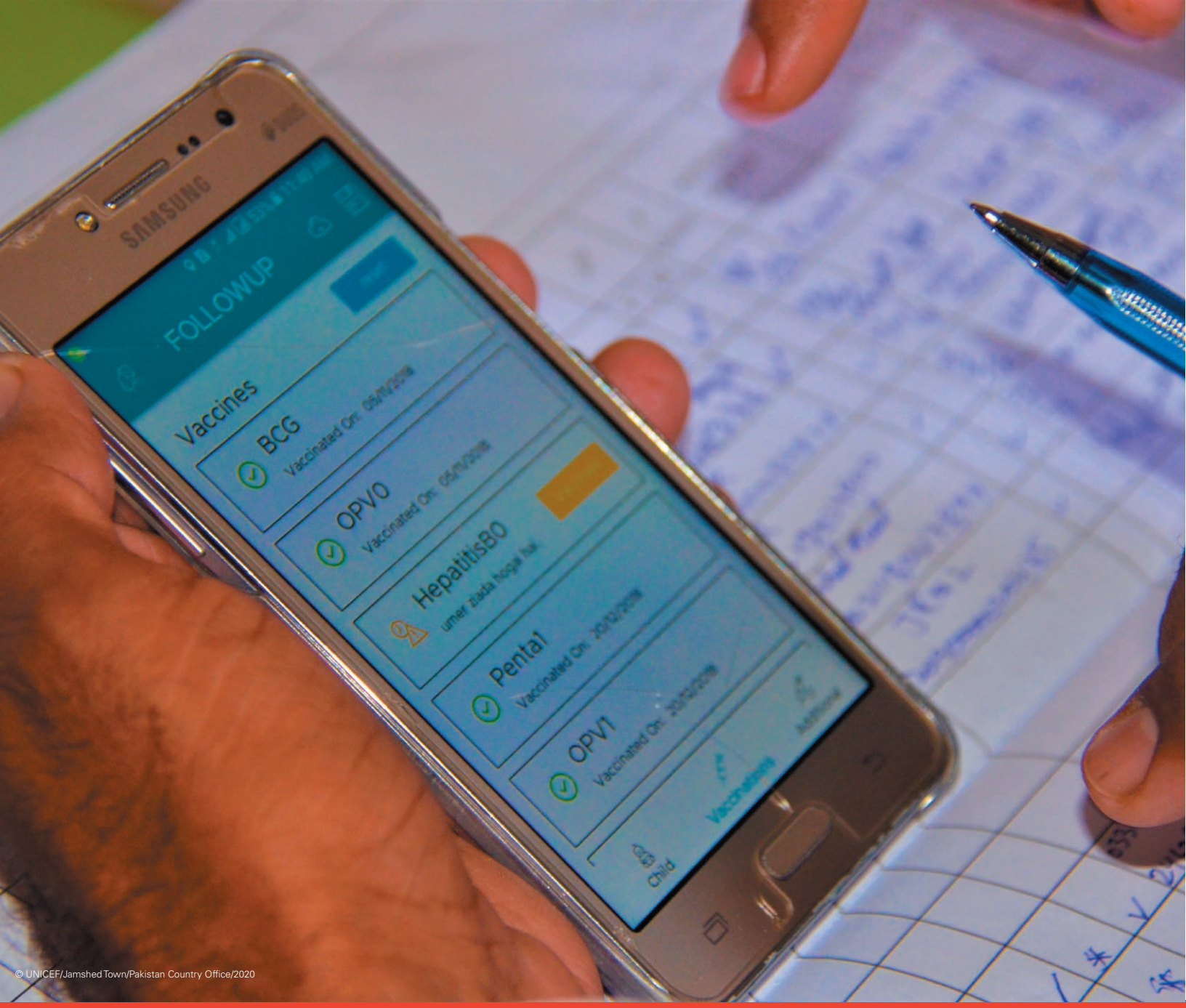
High-level good practices

1. **Use RTM before, during and after campaigns** to collect activity and coverage data; digitize registration data; validate micro plans; explain missed doses; forecast stock-outs; monitor adherence to standard operating procedures; and strengthen accountability.
2. **Leverage and align with existing technology and programme structures** to facilitate interoperability with existing national eHealth structures and strengthen national systems; while utilizing the staff, systems and processes developed through other vaccination initiatives (e.g., polio).
3. **Consult users and stakeholders continually** to gather the intelligence needed to take corrective action; and identify appropriate tools and processes for data collection, analysis, visualization and use.
4. **Test and iterate systems to meet user needs** when handling large amounts of data to identify and address bottlenecks.
5. **Choose complementary and interoperable technologies,** effectively pairing digital data collection tools with real-time data analysis and visualization and communication / coordination / management tools.
6. **Invest in the capacities of users at multiple levels of health systems** to empower staff to interpret data in real-time and conduct the necessary supervision and follow-up measures.
7. **Ensure information technology and network assistance are available** to make any necessary fixes to the software platform and ensure that users can navigate it successfully. Consider using flexible standing contracts with mobile networks to streamline the process of negotiating and contracting.
8. **Apply effective data use processes for RTM** such as established decision-making mechanisms to review RTM data; coordination that brings together staff from all levels to discuss issues; and the use of color-coded maps, lists, alerts, action-takers, and other RTM data outputs to facilitate meaningful discussions and corrective actions.

High-level lessons learned

1. **RTM planning should be initiated early.** Start contracting with software developers and mobile networks as soon as campaign planning starts. Consider using a human-centred/design-thinking approach that involves actual users in programme design.
2. **Government ownership and leadership are indispensable to accelerating adoption and ensuring sustainability.** Supporting agencies, such as UNICEF and WHO, should assist the government to identify potential bottlenecks, mitigate risks and quickly adapt to change management.
3. **For RTM approaches to function efficiently, the following practices should be practiced:** Minimize the number of platforms and forms; minimize the use of paper to transition to digital data entry; and minimize manual data processing and downloading (e.g., through automated flags to identify areas for corrective actions; automated data quality checks or data presentation; by facilitating granular data examination; and by allowing the use of real-time "interim" data for immediate corrective action).
4. **The "real-time" (same day) element should be prioritized during platform design.** The primary motivation for an RTM system is to ensure prompt corrective action during campaigns. This means automating processes such as data cleaning, flagging areas for corrective action, identifying the actions needed and confirming the actions to be taken. It also entails specifying information requirements, choosing user-friendly platforms, minimizing the data collection burden on field staff, and prioritizing timely communication and coordination across levels to clarify and address issues.
5. **Training materials, data entry forms, dashboard templates and other tools should be developed at the global or regional levels** for platforms used by multiple countries. These can then be locally tailored and contribute to cost savings.
6. **The use of RTM data can improve public awareness and strengthen local advocacy.** RTM data can be useful to promptly obtaining support from local leaders and the media. All campaign staff who interact with other sectors, the media and local leaders should develop their skills for interpreting and using RTM data for public advocacy.
7. **Resources need to be in place for the use of RTM data.** Reserve additional resources for implementing corrective actions (time, staffing and funding and to monitor whether corrective actions were taken) beyond what is normally budgeted for supervision.


©UNICEF/UNI350108/Ijazah



CASE STUDY 1 Pakistan

Using Real-Time Monitoring for Decision-Making in Measles (2018) and Typhoid Conjugate Vaccine Campaigns (2019)

Introduction

With a population of over 200 million people, a decentralized government, and a high degree of technological capacity, Pakistan possesses a digital health landscape that is vibrant, varied and fragmented. These traits can be seen in the way RTM systems were designed and implemented at scale for the 2018 measles and 2019 typhoid campaigns.

While Pakistan is very technologically savvy, its health information is fragmented and vertical, with some provinces more technologically advanced than others. This context, combined with Pakistan's decentralization, has generated various homegrown technologies, many of which serve only one programme or geographical area. There is a lack of interoperability among data from different systems, which can yield conflicting results. This fragmentation makes consistent national reporting difficult.

In 2017, Pakistan conducted a comprehensive assessment of health information systems and the role of these systems in generating health data for programme monitoring, performance monitoring, quality of care, planning and policymaking. The assessment found that health information systems in Pakistan fulfil only 40 per cent of the attributes of a functional health information system; and hence can be understood to have multiple and multi-dimensional weaknesses.

In 2018, a two-day scoping trip by a team from the University of Oslo to Punjab province identified more than 30 health information technology applications in the health sector by different groups in and outside of the health department.[16] Similarly, a 2018 report by the University of Oslo reported fragmented systems, lack of regulatory oversight, data duplication, data incompleteness, low quality, a lack of willingness to collaborate, and disorganized and muddled data.[17] To date, there is no national digital health policy.

The Pakistan National Health Vision 2016–2025 called for platforms to transform evidence into policy, and develop an integrated disease surveillance and response system covering the national, provincial and district levels. Data integration efforts have so far been more focused on routine health information, however, rather than campaign data.

The 2018 measles campaign

Programme design

Measles is one of the top 10 causes of childhood mortality in Pakistan; and in 2018, the country experienced an outbreak, with nearly 154 measles cases per 1 million people.[18] A supplemental immunization activity targeting 35 million children ran from 15 through 27 October 2018. Following successful experiences with RTM using eVacc, an Android smartphone programme, RTM technologies were adopted for the supplementary immunization activity, under the Government's leadership, with WHO and UNICEF support.

Three digital reporting platforms were employed for RTM: KoBo Toolbox, an open-source tool for mobile data collection; RapidPro Surveyor, an open-source platform using short message service (SMS) and interactive voice response; and WhatsApp, a cross-platform messaging app that allows users to send text and voice messages, make phone and video calls and share images and other media. WHO used KoBo Toolbox Collect to fill out digital checklists at the pre, during and post-campaign stages; UNICEF deployed RapidPro Surveyor to solicit responses to survey questions;[19] and UNICEF used WhatsApp to share information and receive updates from the field on the campaign's progress throughout the day.

19 UNICEF originally intended to use RapidPro (not RapidPro Surveyor). RapidPro is an open-source platform developed by UNICEF and Nyaruka Ltd to create SMS and Interactive Voice Response applications. RapidPro Surveyor was created to provide a chat-like interface on smartphones without network connectivity. However, UNICEF was unable to obtain the short code (a special 5-6 digit telephone number that is shorter than a full phone number and is used to send and receive SMS messages using mobile phones) needed to use RapidPro due to approvals required from different government departments so RapidPro surveyor was used instead.

Key factors that influenced the choice of these technologies were minimal cost implications, ease of use and successful past experiences. All three platforms were open source and could be used on smartphones for free. Given the high levels of smartphone ownership and network access throughout the country, mobile devices did not need to be purchased. WHO and UNICEF reported good past experiences using KoBo Toolbox and RapidPro Surveyor. WHO was already using KoBo Toolbox in Pakistan and appreciated its features for building data collection forms and its use of ODK, a de facto open-source standard for mobile data collection. RapidPro had been used successfully in Somalia and South Sudan and UNICEF staff valued it as a two-way messaging tool. Nearly all staff had UNICEF Pakistan staff conducted an internal mapping and consultation exercise to identify tools that were being used. RapidPro was valued because it created a two-way communication experience;RapidPro Surveyor worked like SMS messaging, where data collectors could also receive messages, feedback, and prompts. RapidPro had worked well in WASH programs in Pakistan, and data collection flows were easy to design. Finally, nearly all field staff had extensive experience with using WhatsApp to coordinate and communicate with others.

However, there were also challenges with the use of the KoBo Toolbox and RapidPro Surveyor applications. The KoBo Toolbox dashboard only shows national-level data and cannot disaggregate district or provincial data. Cluster and household-level data need to be manually merged and duplicate entries need to be manually removed. These issues required daily intervention by data analysts, which delayed the delivery of performance data to field staff to the following day. In addition, local field staff were unable to see the data they had submitted that day; as a result, many staff preferred to fill out paper forms in addition to using these tools so they could refer back to written records.

There were issues with the Kobo Toolbox and RapidPro Surveyor applications - Kobo Toolbox's dashboard only shows national-level data as it cannot disaggregate data from district or province. Similarly, cluster and household-level data need to be manually merged and the app does not block duplicate entries and these need to be manually removed. These issues required daily direct intervention by data analysts, so field staff usually received their performance data on the following day. Further, field staff at local levels could not see the data they had submitted that day. For this reason (among others), many staff preferred to fill out paper forms as well, since these could be easily referred to during nightly meetings.

Regarding RapidPro Surveyor, although users could technically send and receive pictures, this feature often did not work, so it was removed and WhatsApp filled this function. Users also reported that they were unable to correct typos; the app was slow and crashed in areas with poor network coverage; and the forms were too long, though this was more of a programmatic issue than a software challenge (UNICEF's checklists for the 2018 measles supplementary immunization activity were more elaborate on supplies, service delivery and community engagement).

Implementation

The Government of Pakistan led the measles campaign and UNICEF provided technical support. Gavi and WHO covered the costs of operations and vaccines (including for the RTM component). WHO developed the KoBo Toolbox platform and supported the development of the national guidelines for the measles supplementary immunization activity, facilitated its use during the national planning process, prepared checklists for all levels, and deployed nearly 200 consultants and monitors to assist with campaign implementation. UNICEF developed the RapidPro Surveyor platform and deployed 163 consultants for daily monitoring and technical assistance.

UNICEF contracted Viamo to mobilize communities via SMS and robocalls using a long-term agreement between the United Nations Development Programme (UNDP) and Viamo. Viamo used mobile network operator data to determine the proportion of subscribers in an area using text-based messaging, which yielded insight into the literacy levels of users. Robocalls – phone calls with a pre-recorded call to action message delivered by a locally recognizable human voice – work well for populations with low literacy. UNICEF's health/communication for development team worked closely with Viamo to bolster community outreach through targeted social mobilization exercises, including the dissemination of SMS and robocalls with specific calls to action in locations with vulnerable communities that were missed by or refusing vaccination due to misinformation.

Although the Expanded Programme on Immunization (EPI) information management system showed promise, it was not originally built to support campaigns and would have needed to be modified by a software developer. In part, WHO selected KoBo Toolbox for RTM instead of the EPI information management system because the checklists could be added to the software easily, in-house, without a software developer.

Both the KoBo Toolbox and RapidPro Surveyor applications required at least one day of training. WHO trained over 8,000 monitors to use KoBo Toolbox for the measles supplementary immunization activity. UNICEF trained its 163 district-level oversight monitors and federal/provincial staff on using RapidPro Surveyor to monitor vaccine supply, logistics and community engagement activities. While KoBo Toolbox training ran smoothly, reportedly due to the simplicity of the checklist, the RapidPro Surveyor training struggled with poor compatibility of the application with the Apple iPhone.

Implementation Overview

Over the course of the day, field monitors and observers completed survey forms and checklists via KoBo Toolbox and RapidPro Surveyor using Android phones. They also completed paper versions of many of these forms as a backup. The monitors and observers also shared photographs and qualitative observations via WhatsApp. KoBo Toolbox and RapidPro data were transmitted to the central level, where WHO and UNICEF staff downloaded and cleaned the data, which were then shared back with the provinces and districts the next day. Districts also hosted nightly meetings to review the data they had on hand, whether it was from the same day or the previous day (or both), and to plan corrective measures.

WHO and UNICEF used RTM to improve the quality of planning and implementation to increase demand for services and address vaccine refusals. RTM data were used to adjust the campaign on a daily basis using a four-step process:

1. Review: KoBo Toolbox and RapidPro Surveyor data were reviewed and evaluated every day of the campaign by provincial and federal EPI staff in their respective control rooms.
2. Propose adjustments: District officials, including supervisors, proposed changes in the campaign strategy when required.
3. Decision: Stakeholders collectively decided on changes of direction.
4. Action: Agreed-upon changes were enacted during the following day's activities.

Data were collected using digital platforms at every stage of the campaign:

Before Implementation

WHO district monitors used KoBo Toolbox to report on the desk review and field validation of union council-level (lowest administrative level) micro plans, and monitor the quality of trainings at all levels. This allowed higher-level supervisors to track the progress of micro plan validation, access and compile micro plan and training data and identify training issues. For example, KoBo Toolbox showed that while almost all trainings were attended by the relevant participants, many did not have required materials such as finger markers, pocket guides and operational guides. As a result, participants learned that training materials needed to be ordered earlier – a lesson that could be applied to campaigns that are rolled out in phases across the country. WHO district measles monitors used KoBo Toolbox for field validation. Nearly 6,800 out of 10,000 micro plans were reviewed. UNICEF's polio team in Pakistan also supported field validation of micro plans and trainings on interpersonal communication skills.

During Implementation

Government, WHO and UNICEF field monitors used KoBo Toolbox to monitor activities during the campaign by completing observers' checklists on injection safety, injection practice, logistics, health facility visits, social mobilization and vaccination team members' knowledge on how to handle AEFIs. Review of these datasets facilitated rapid responses to issues such as insufficient numbers of syringes or AEFIs, which helped to maintain the public's trust in the campaign.

RapidPro Surveyor was also used to monitor checklist data on vaccine supply and logistics. Unlike KoBo Toolbox – which sends data upwards from the field – RapidPro Surveyor facilitates instantaneous feedback to data collectors. For example, data collectors using RapidPro Surveyor receive reminders about unsaved submissions. The data were shared with the Department of Health and EPI staff for action at union council, district and provincial levels.

WhatsApp was used to compensate for gaps in the RapidPro Surveyor application, such as sending photos and short videos for documentation. Monitors sent photographs to demonstrate deviations from protocol. WhatsApp was also used to report qualitative findings that could not easily fit into the checklist used by RapidPro Surveyor. Monitors could report any observations instantly, without being hampered by the rigidness of a survey or checklist.

Finally, data on administrative coverage were submitted using KoBo Toolbox during rapid convenient assessment surveys. Monitors reported on the total number of eligible children against the total number of children who received the vaccine, reasons for refusals and the source of campaign information in communities. This information supported targeted advocacy with specific households or communities based on specific reasons for refusal, such as lack of parental permission, fear of AEFI, etc., to increase coverage in disadvantaged communities.

Post-implementation

After the campaign, KoBo Toolbox forms were used to monitor and submit post-campaign coverage survey data. RTM was also used during the post-campaign phase to track the receipt of and follow up on financial disbursements to field teams. WhatsApp groups continued months after the campaign, with groups sharing information on the status of overdue payments.

Outcomes

Using RTM data to adjust daily fixed and outreach vaccination plans to increase coverage, the partners were able to reach 37 million[20] children with measles vaccination during the campaign. Having real-time data on refusals allowed teams to follow up and achieve a 0.63 per cent refusal rate across Pakistan. Below are some examples of how RTM data informed demand generation/communication for development activities:

- Rapid convenient assessment information on refusal reasons were used to target communities with specific messages. For example, the communication for development team would inform Viamo of the union councils with high refusal rates, and Viamo would send SMS messages or robocalls targeting these areas the same or next day.
- Viamo was able to use data from mobile network companies to adjust the distribution of robocalls and SMS messages based on information such as how long people listened to a particular robocall before hanging up. Areas where people did not listen long enough to the message received more communication.
- Short videos by local community influencers were developed overnight based on information on communities refusing the vaccine that was gathered through WhatsApp groups. The videos were used by front-line polio staff and EPI social mobilizers through their mobile phones to convince refusal communities to vaccinate their children the next day.
- Evening vaccinations were offered in some refusal communities where fathers were decision-makers, so fathers could be present and approve the vaccination.
- Although catch-up post-campaign immunization activities were not included in micro plans, rapid convenience monitoring data from the campaign indicated that coverage was low in certain areas. Catch-up days facilitated the vaccination of nearly 778,000 additional children.

As illustrated in Table 2, RTM methods helped Pakistan receive and compile thousands of forms and millions of data points during 2018 measles supplementary immunization activities on the same or next day.

Being able to manage a high volume of data allowed EPI staff to quickly detect malpractice patterns or supply chain issues across multiple sites. In Sindh province, for example, 188 out of 569 sites reportedly capped the needles after use instead of throwing them out. District officials asked vaccinators and skilled persons not to repeat the malpractice the next day. In Balochistan province, after poor quality finger markers were identified through feedback received via RapidPro Surveyor and KoBo Toolbox, new stocks of markers were sent to these districts.

Government ownership of the campaign and of RTM approaches was evident. Despite high turnover, officials at all levels frequently referred to the data as "our data". Their positive experience with the use of RTM technologies in the measles campaign contributed to its use in the typhoid campaign the following year.

20 Official government estimate.

Desk review and field validation of micro plans	6,776 (67%)
Trainings on the independent monitoring checklist	1,750 (18%)
Number of observers who submitted forms	8,198
Number of observer checklists	283,128
Number of rapid convenience assessment forms received	155,485
Number of households monitored and data submitted	1,537,470
Number of children reported in households monitored	3,466,641

Table 2. Scale of reporting through KoBo Toolbox Collect[21]

The 2019 Typhoid Campaign

Programme design

Between 2016 to 2019, 11,000 people, mostly children under 15 years, contracted a drug-resistant strain of typhoid. WHO prequalified and recommended a new typhoid conjugate vaccine (TCV) for typhoid-endemic countries in January 2018. In November 2019, Pakistan was the first country in the world to introduce TCV into its routine immunization programme, starting in Sindh. To accompany this introduction, the Government, with WHO and UNICEF support, launched a catch-up campaign using a phased approach. The first phase targeted 10 million children ages 9 months to 15 years in Sindh. The campaign is being rolled out province-by-province in 2020 and 2021.

The Sindh campaign was the first large-scale typhoid campaign in the world. The Government and stakeholders were able to apply lessons learned from the nationwide measles campaign the year before, including how to utilize RTM for rapid decision-making and corrective action. Many of the RTM processes and systems established by the 2018 measles supplementary immunization activities were maintained and improved upon in the 2019 TCV campaign.

Polio front-line health workers used WhatsApp to routinely monitor over 400 households in their designated area. These groups are monitored by an area supervisor who then reports data (such as the total number of children under 5 years) upwards. This information was used at the district level to plan immunization coverage but had to be supplemented, because the polio workers did not collect data on children up to age 15. An important lesson learned was that if a regular/ongoing health survey will be used for different immunization campaigns, it should cover children of all ages.

21 This table only includes data for KoBo Toolbox Collect. The volume of the data shared through all three platforms is much higher.

Implementation

As with the 2018 measles supplementary immunization campaign, the typhoid campaign relied on KoBo Toolbox and WhatsApp. However, the measles campaign had experienced a major challenge – provinces usually received summaries of their performance on the day after submission, instead of the same day. Districts also had to wait to receive feedback from the provinces. While the local levels did not have access to dashboards, screenshots of dashboards were shared to disseminate the day's results.

Data analysts and field staff came up with imperfect workarounds to address these limitations. To speed up access to data at the lower levels, central-level data analysts linked the raw KoBo Toolbox datasets to Google Sheets. These Google Sheets had embedded macros that could automatically run some analyses. In theory, a data focal person at the district level could download the data and print the results for use during the nightly meetings. However, the system generated some errors, and the macros needed to be updated by central-level analysts every day.

Concurrently, field staff leveraged existing WhatsApp groups or created new ones to enhance reporting processes. WhatsApp had been used in the measles campaign to improve coordination. During the TCV campaign, for example, Jamshed Town used WhatsApp to submit structured coverage reports (see Box 4). Field supervisors consolidated indicators from their teams' forms and sent them up the chain, with every level aggregating their own data. Based on lessons from the measles campaign, the TCV campaign was prepared with more supervisors, which made the process smoother. District control rooms were staffed with people who monitored activities and incidents reported through WhatsApp and results were discussed during daily evening meetings. If the data indicated that an area had not hit its target, that area was prioritized for the next day.

Provincial-level staff noted that WhatsApp facilitated coordination among a vast number of field staff and linked people from different departments. Supervisors could not be everywhere at once, and WhatsApp allowed them to keep tabs on field activities through photos and videos from the field, in addition to other data. Similarly, senior management may not always be accessible to middle-level managers, and WhatsApp created an easy way to keep them informed.

WhatsApp users shared data, reported incidents and best practices. Schools were a vital partner in the TCV campaign. The targeted age group was all children under 15 years, and 45 per cent of targeted children were in schools. District education officers monitored WhatsApp groups to understand where school refusals were happening and why, and schools that were part of these groups shared and adopted practices that improved parental and student acceptance. WhatsApp data became a resource for advocacy. For example, an influential madrasa was persuaded to accept the campaign after being shown pictures of another madrasa doing so. Real-time WhatsApp reports of AEFIs – even minor ones – were swiftly addressed by AEFI focal persons and district team members (see Box 5). WhatsApp was also used for trainings. If attendance was reported as less than 100 per cent, a re-training for absentees was conducted.

Box 4. Sample WhatsApp data submission text

Team 1
Target number of children: 138
Achievement - # of children vaccinated: 96

Team 2
Target number of children - 125
Achievement - # of children vaccinated: 126

Issue reported
Team: [number]
Staff: [name]
Issue: [staff name] requested finger markers for X reason.
Action: Inform UCMO

Figure 1. Quantitative data reported via WhatsApp

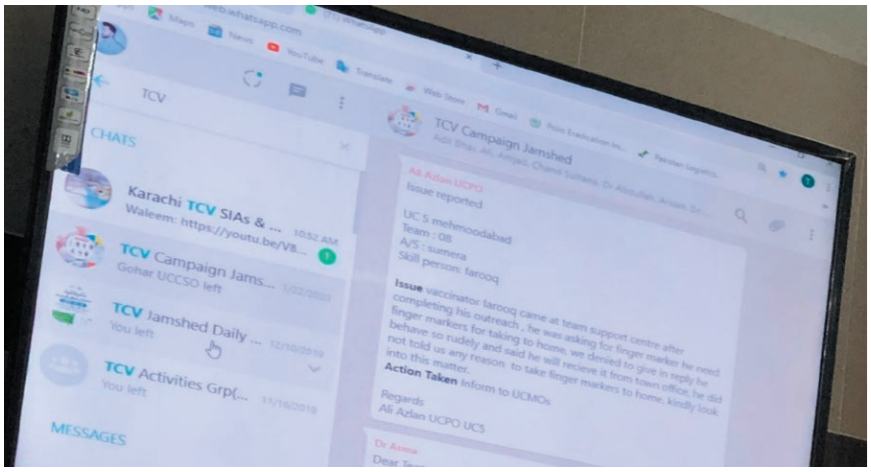
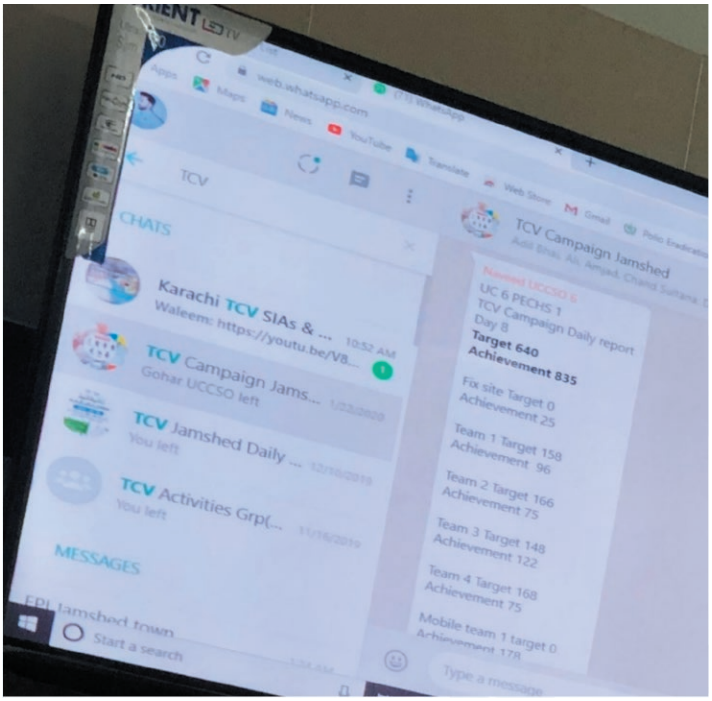


Figure 2. Qualitative data reported via WhatsApp



WhatsApp was far from perfect. The process of manually aggregating data created additional work; and supervisors at higher levels felt overwhelmed with the barrage of messages. In Karachi, one staff member noted that he was subscribed to nearly 1,000 WhatsApp groups for the campaign, and without assistance from relevant focal points, he would not have been able to identify critical issues.

Overall, however, field staff expressed satisfaction with the use of WhatsApp to improve coordination and responsiveness. They felt that their issues were noticed at the highest levels and corrective actions were taken as a result. While it might seem as though WhatsApp was functioning as a parallel system to KoBo Toolbox in some districts, this workaround facilitated the use of data on the same day and the use of KoBo Toolbox data to validate WhatsApp data.

Though it arrived late, KoBo Toolbox data provided important information for boosting campaign performance. KoBo Toolbox checklists captured the number of children in the eligible age group; the

number of children vaccinated by household; the reasons for vaccine refusal; and the source of campaign information. UNICEF's third-party monitors for the TCV campaign also used WhatsApp to report gaps in the dissemination of information, education and communication materials, social mobilization activities and the identification/vaccination of missed and out-of-school children in the higher age brackets. This data made it possible to create target messages for refusal communities, identify their specific concerns and leverage the most appropriate communication channels. It also helped flag low-performing vaccinators and provided coverage data that informed decisions about whether to prolong the campaign to meet targets.

Box 5. WhatsApp control centres enabled both timely use of data and rumour management

On the first day of the TCV campaign, a child experienced an AEFI, and the story quickly spread on social media. If immediate action was not taken, the campaign could have come to a standstill as rumours spread widely, and the campaign lost some of its credibility on the first day.

Fortunately, the communication/communication for development team was prepared with crisis communication management systems designed to deal with AEFIs. The team picked up the story on social media, immediately went into damage control mode and reported the situation to the control centre through established WhatsApp channels. The child was located, and local officials visited the family with the media to show that the child was fine and dispel rumours. The team also worked with Facebook to block rumours/misinformation about AEFIs on social media.

Outcomes

The TCV campaign in Sindh reached 9.4 million children aged 9 months to 15 years and achieved 95 per cent coverage. More than 8,000 skilled vaccinators and health workers, 20,000 social mobilizers and 2,000 supervisors and monitors, including international monitors, participated in the campaign; and more than 39,000 checklists were analysed through KoBo Toolbox. These results indicate that RTM may have contributed to improving campaign quality.

Good practices from Pakistan

1. Evening meetings facilitated the review and utilization of RTM data

Real-time data collection and reporting is only useful if corrective actions are taken in a similarly quick fashion. In both campaigns, there were several examples of decision-makers utilizing the data, particularly during evening meetings, to agree on corrective actions for the next day of the campaign to increase coverage and improve safety.

2. Existing vaccination infrastructure (the Polio Eradication Initiative) was leveraged

A key factor in the success of these campaigns was the support provided by the country's Polio Eradication Initiative apparatus. The polio emergency operations centres contributed to data collection and analysis; and the district polio eradication committees closely monitored and supported the campaign, especially in evening meetings. In return, the measles campaign supported the Polio Eradication Initiative by identifying areas missed in polio micro plans and successful strategies for coordinating with schools and mobilizing communities.

3. RTM data were used to fine tune community engagement

Both campaigns collected data on why vaccines were refused. They monitored the usefulness of different robocalls and SMS messages for different populations and adjusted their approach during the campaign to prioritize robocalls and SMS messages that were performing well. Community-specific issues shared by monitors through WhatsApp were used to develop new ways of engaging communities during the campaign.

4. Some resources for generating vaccine demand were reserved for corrective actions

During the measles campaign, only half of the planned SMS messages and robocalls were implemented

before and during campaign activities. Forty percent of these community engagement resources was set aside to address challenges such as high refusal rates, limited access to other communication channels or conservative communities; and 10 per cent was reserved for situations requiring significant crisis communication management. Having these resources set aside facilitated corrective, data-based actions.

5. Real-time data collection was complemented by real-time communication

WhatsApp facilitated communication in several ways. In addition to facilitating communication within field teams, WhatsApp, and to some extent, RapidPro, allowed actors at higher levels to send reminders and prompts to field teams. WhatsApp also enabled lateral communication and sharing of best practices, bolstered a sense of teamwork and accountability, and created a forum for recognizing good performance. The work of high-performing vaccinators, polio front-line staff and other social mobilizers was recognized through short success stories shared on social media platforms that were sometimes picked up by local media.

4. Users were kept in mind

All of the platforms used during the campaigns were selected because they were easy to learn and could be used on Android phones. WhatsApp is already widely in use across the country, which made it easier for local officials and community health workers with lower literacy and less technical savvy, including non-English speakers, to adopt during the campaigns.

5. Community engagement and social mobilization benefited from real-time social media monitoring

For the typhoid campaign, UNICEF supported the federal EPI to answer public queries and concerns via social media platforms, including Facebook, Twitter and Instagram. Federal and provincial teams worked around the clock to engage with families, parents and service providers via social media to debunk rumours of AEFI incidents. UNICEF also supported the Government to track and analyse public sentiment on social media and other digital platforms to improve community engagement interventions.

Lessons learned from Pakistan

1. Reduce the number of data entry systems

In addition to KoBo Toolbox and RapidPro Surveyor, districts reported through Google Sheets, the EPI information management system, WhatsApp and paper forms. Ideally, governments and partners should conduct a situation analysis of existing platforms, map out their strengths and limitations, and then decide on and use one, rather than building new applications. This will strengthen the existing system, minimize reporting burdens, improve data quality and reduce development costs and timelines.

2. Invest time to save time

Short timeframes made it difficult for partners to invest in more robust solutions. For example, had there been time to incorporate RTM into the routine EPI information management system, instead of using KoBo Toolbox, there would have been additional opportunities for automated data validation and staff would have had better access to their own data, ultimately reducing their workloads.

3. Minimize duplication in checklists

There was some overlap among the KoBo Toolbox and RapidPro Surveyor checklists for monitoring injection safety, injection practice and logistics. Each tool has different uses. For example, RapidPro Surveyor allows for two-way communication, but unlike KoBo Toolbox, it is not meant for conducting long surveys. For this reason, there are times when it makes sense for different platforms to collect similar data. Duplication should generally be kept to a minimum, and used to check the quality of data coming in from multiple sources. This process of joint review can also facilitate better alignment.

4. Automate the identification of problems

Problem identification can be automated and built into a software. For example, vaccine consumption data can be compared to coverage data to verify coverage. Red or green flags can quickly indicate if targets were met, or activities were of a certain quality. While programme staff were aware of such checks, data were primarily analysed or shown as frequencies or percentages relative to a target.

5. Provide feedback and analysis at local levels (e.g., union council level)

During the typhoid campaign, RTM data were analysed at the district level. However, districts in Pakistan are large, with populations as high as 2 or 3 million. Providing RTM data analysis summaries for the union council or lower levels will help refine corrective strategies.

6. Strengthen union council, district and provincial capacities to analyse data

KoBo Toolbox and RapidPro Surveyor data were cleaned at the central level. Training subnational data focal persons to do this would increase and sustain the pool of talent available for data analysis and build local government ownership of and investment in the data and data systems. In the short term, additional contractors can be hired to support subnational data analysts, and provinces that have completed campaigns can mentor other provinces.

7. Define minimum information needs and provide access to interim data

Municipal officials in Jamshed Town had to rely on WhatsApp data for RTM because they did not receive the information collected via KoBo Toolbox from the provincial office until the next morning. At the local level, stakeholders need information on whether the target was achieved or not and what issues may have hindered the campaign; at the same time, too much information may complicate local strategizing.

In addition to defining minimum information needs, consider providing access to the interim version of the data. Having objective criteria such as degree of missing data or range checks may help identify which union councils/districts/provinces have data that are sufficient for immediate field action.

8. Be judicious about what needs to be submitted on paper

Forty to sixty per cent of staff chose to submit paper forms. Some did this out of technological preference and others did it because it was easier to review the paper form at the end of the day. Once a more robust EPI information management system or other platform is introduced, this may be less of an issue. Ultimately, digital methods can reduce the cost of printing and paper waste, and digital information can be accessed anywhere. Consider prioritizing paper forms for reporting specific types of incidents rather than for all checklists.

9. Produce a comprehensive campaign report

A comprehensive report owned by the Government that reviews the campaign experience and highlights areas for improvement would be an important tool for flagging good practices and lessons learned.

10. Use human-centred design approaches to plan and implement at scale

The RTM methods deployed in these campaigns were not pilot tested. While these methods ultimately worked well because the tools had already been deployed in similar settings, there were also challenges and users had to improvise. Human-centred design approaches, such as in-depth, hands-on user testing during training, have been shown to improve the quality of RapidPro trainings. They can also help user groups anticipate issues that emerge during the development and preparation of subsequent campaigns. Government staff at all levels should be partners in development and testing.

11. Consider monitoring the monitors

One partner in Pakistan, the Tameer-e-Khalaq Foundation, developed an application for monitoring routine immunization. A monitor can use the application to flag issues, which can then be raised in the next visit and flagged for follow up. To demonstrate the effectiveness of monitoring efforts, it may be worth tracking how many issues identified by monitors have been resolved. This would make it easier to see how much of a campaign's success was due to good pre-campaign planning, versus responsive district actions taken during the campaign.

12. Strengthen government ownership and capacity to manage databases

The Government does not own many of the databases used in-country and may have to request data reports from the software developer, which can be challenging if the contract has expired. Consider formalizing government ownership of key databases such as DHIS2 (discussions are currently underway for making DHIS2 national) or the EPI information management system and training staff to adapt these databases as needed and provide trainings on their use.

13. Develop global training materials

Building on existing systems can minimize design costs and timeframes. Given the lack of education and training materials available on RapidPro Surveyor, a UNICEF consultant was tasked with developing guidance on how to access and complete a RapidPro survey and access the dashboard. These guides can now serve as resources for other countries. Similar training resources could be developed at the global level for RapidPro Surveyor and KoBo Toolbox and shared with countries for adaptation.

14. Establish communication protocols for managing information

In Karachi, district-level officials felt overwhelmed by the amount of data that they received via WhatsApp every day. The barrage of data made it difficult to identify problems that needed correcting. Consider establishing standard operating procedures for escalating issues to the next level, and/or designating a focal person for monitoring and escalating WhatsApp issues.

15. Digitize registration activities

For the typhoid campaign, community health workers conducted house-to-house registration exercises and collected enrolment data from schools. This information was compiled on paper. Digitization could have reduced data entry and compilation errors and digital data could have informed microplanning and other health and development programmes and supported demand-generation activities. In addition, ongoing health surveys should collect information that will be relevant to other campaigns.

13. Leverage micro-influencers to generate demand for vaccination

Interpersonal communication is very effective. Measles RTM data show that most people recall the campaign messages shared by lady health workers. Robocalls can reach local communities through pre-recorded messages from lady health workers and community leaders. Digitized registration data that includes phone numbers can be used to reach households with reminders from local influencers.

Conclusion

The 2018 measles and 2019 typhoid vaccination campaigns in Pakistan yielded many good RTM practices. In both campaigns, RTM data were used to target missed children and helped vaccinators reach millions of people quickly. Campaign planners and staff were also able to adapt, for example, by using RapidPro Surveyor with WhatsApp when RapidPro was unavailable. The combination of survey data collection platforms with communication tools enabled prompt action.

These campaigns also yielded several important lessons. Partners should work with each other and with the Government to streamline their RTM systems for optimal efficiency. This includes identifying the minimum ideal number of platforms; automating data analysis as much as possible; and presenting results at all levels of decision-making. If this process of streamlining is conducted in close collaboration with partners and government representatives from all levels, it will strengthen national and subnational ownership and capacities. These lessons can be applied to any large-scale health and development activity.

Contact

Ayesha Durrani
C4D Specialist – Health
UNICEF Pakistan
adurrani@unicef.org

Shah Nawaz Jiskani
Monitoring and Evaluation Officer
WHO Pakistan
jiskanis@who.int

©UNICEF/Indonesia country office/2020

CASE STUDY 2 - Indonesia

Pilot to Scale Up: The use of RapidPro as an SMS tool for RTM during the national measles rubella campaign of 2017–2018

Introduction

There are 1.9 million children in Indonesia who are under-immunized – the fourth largest number of under-immunized children globally. In 2017, the Government of Indonesia launched its most ambitious vaccination campaign to date: to reach more than 68 million children aged 9 months to 15 years in 2017 and 2018 to eliminate measles-rubella by 2020.[22]

Indonesia's health system is decentralized, and much of the planning and management of health service delivery falls under the oversight of provincial and district governments. Although there is a national health information system, many districts and provinces use their own systems, which can make it difficult to share and aggregate data.[23] Moreover, immunization campaigns have historically relied on paper-based reporting, which makes quick adaptations difficult.[24]

> We hadn't seen that before from other campaigns...how the coverage was going up with each day, which areas were doing great, which areas weren't. Having real-time data also gave us a means to showcase to donor leadership, [so] it was an advocacy tool as well. It was quite an accomplishment.
>
> *- Khin Devi Aung, UNICEF East Asia and the Pacific Regional Office*

To address these challenges, the Ministry of Health, with the support of UNICEF and WHO, deployed RapidPro to collect real-time coverage data on the measles-rubella campaign. The initiative was considered a success: users reported high rates of satisfaction with the platform; analyses showed concordance with the official data submitted through the manual reporting system; and districts with higher reporting rates were more likely to achieve their target coverage rates.[25]

Programme design and implementation

RapidPro was initially introduced as a pilot to facilitate real-time monitoring, reporting, data visualization and feedback during the nationwide measles campaign. The tool was tested during Phase 1 and refined and scaled up to cover Phase 2.

The platform was selected for its simplicity and easy access to technical support. RapidPro provided data collectors with a simple SMS experience and health programme staff could develop simple SMS question-and-answer flows without computer programming skills. An SMS platform was chosen based on the high mobile phone penetration rate in Indonesia. Technical assistance was readily available from UNICEF global and regional teams.

Before the campaign, users registered on the system using the free SMS number, the keyword (i.e., MR) and their health facility code. District managers were trained in person in their respective districts and then trained health facility staff. A manual and short video were disseminated through existing social media networks for further reference. To protect data security and privacy, RapidPro was only used to collect only aggregated data; individual data were recorded using the paper-based manual system only.

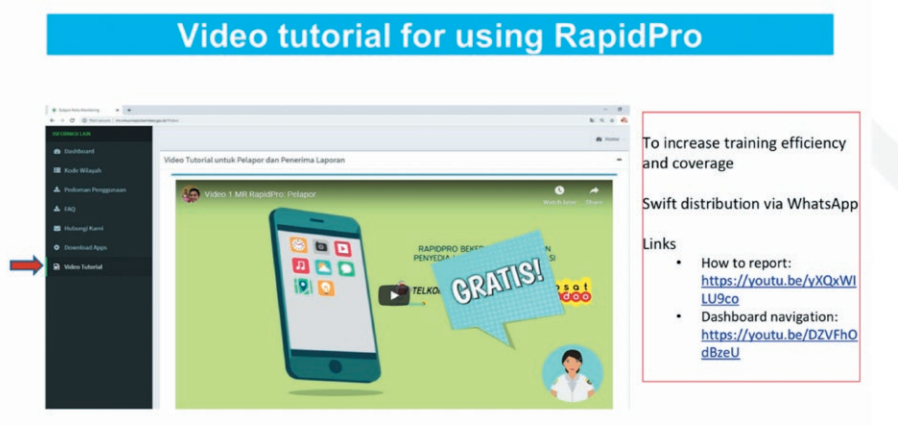
22 Jusril, 2019.

23 Mahendradhata, Y., et al., 'The Republic of Indonesia Health System Review', Health Systems in Transition, vol. 7, no.1, WHO Regional Office for South-East Asia, 2017.

24 Accone, Tanya, 'Harnessing Real-Time Data for Indonesia's Largest Immunization Campaign', UNICEF, 2017.

25 Jusril, 2019.

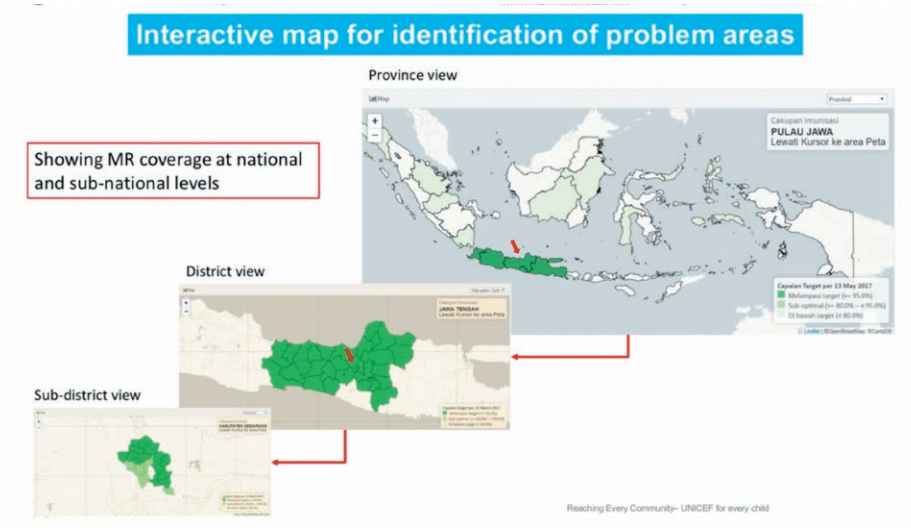
Figure 3. Sample training material



Source: UNICEF Indonesia

At the end of each reporting day, health facility staff sent a text message via RapidPro on the number of children immunized that day. An automatic reminder was sent every evening to prompt staff to send their report. The RapidPro system automatically aggregated data for each district and province. An online dashboard visualized progress in interactive maps and comparisons with other districts and provinces. Health facility users and programme managers received an automated SMS at the end of each day about their progress; and a motivational message thanking them for their work every Sunday.

Figure 4. Example of an interactive RapidPro map



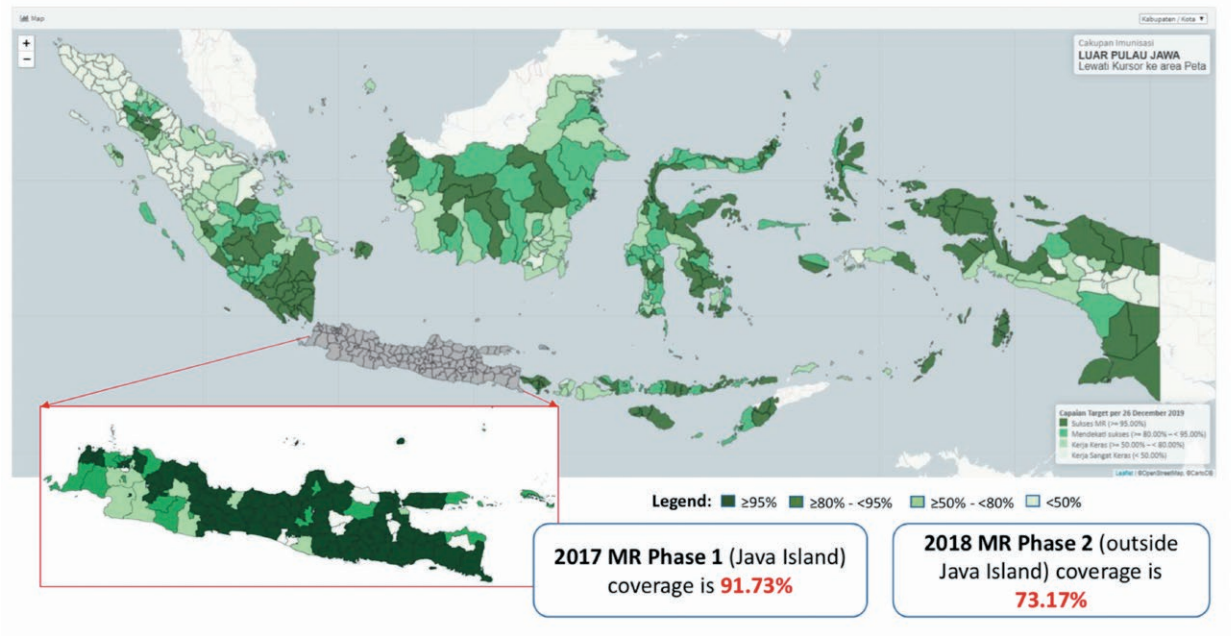
Source: UNICEF Indonesia

Outcomes

During Phase 2, a large-scale assessment was conducted to evaluate the potential contribution of the platform to immunization coverage and programme performance. Of the 6,462 health facilities registered to use RapidPro in 28 provinces and 395 districts, only a handful were unable to use RapidPro due to poor mobile network connectivity. Provinces and districts achieved a wide range of coverage rates, as indicated

in Figure 5. Nationally, Phase 1 reached 92 per cent coverage and Phase 2 reached 73 per cent coverage.[26] In Phase 2, many areas faced significant implementation challenges, including earthquakes, a polio outbreak and vaccine hesitancy.

Figure 5. Interactive map of Indonesia with immunization data



Source: UNICEF Indonesia

The assessment found that RapidPro positively influenced overall immunization coverage, particularly in sites impacted by vaccine hesitancy. In those sites, which were more likely to have achieved targets, respondents indicated that RapidPro supported problem identification and corrective action. Districts with higher reporting rates were more likely to reach 100 per cent coverage. Users generally reported high satisfaction with their experience with using RapidPro.

However, some users reported that they needed more detailed information from RapidPro to inform problem identification and corrective action. Although campaign managers could identify which areas were not meeting daily targets, they did not have access to other details such as data disaggregated by sex, age group, villages or types of immunization sites (such as health centres or schools).[27]

While not all participants utilized the dashboards, those who did favoured the map and facility level visualization. These visualizations were used to inform and monitor follow-up actions and conduct advocacy during cross-sectoral stakeholder meetings. There were no observed correlations between dashboard utilization and overall campaign performance.[28]

Good practices from Indonesia

1. The pilot-to-scale process enabled quality assurance

During Phase 1, RapidPro was meant to complement the paper-based manual reporting process, which provided the official data at the end of the campaign. These two datasets were compared to assess the quality of reporting. A less than 5 per cent variance was found, suggesting that the RapidPro system was ready to scale.

26 Ibid.
27 Ibid.
28 Ibid

2. The use of a theory of change enhanced system and assessment design

A theory of change was used connect the RapidPro system to improved health outcomes. The theory of change helped drive improvements between Phase 1 and Phase 2 and informed the prioritization and assessment of outcomes of interest. It also helped streamline the integration of RapidPro into the broader Ministry of Health reporting package and campaign trainings.

Table 3. Excerpts from the theory of change

3. The simplicity of data collection requirements contributed to high user satisfaction

Levels of change	Expected contribution of RapidPro to the measles-rubella campaign
Impact	Improved routine immunization coverage through the measles-rubella campaign
Outcomes	Effective use of RapidPro to track routine immunization coverage data alongside the campaign. This was defined in two ways: 1) Facility reporting at least one time per 'immunization day', every day during the measles-rubella campaign until it reaches its target 2)District, provincial and national immunization campaign focal people receiving an SMS once per "immunization day" every day during the measles-rubella campaign until the district reaches its target and using the data to engage facilities to reach targets faster and/or identify problems and address them.
Outputs	Number of health workers, number of health facilities and number of administrators trained by level
Inputs	RapidPro curriculum and training materials developed and training conducted

Compared with the manual reporting system, which asked for detailed logistics and individual-level data, RapidPro was designed to be a straightforward SMS question-and-answer experience. RapidPro asked only a few simple questions about the total number of children immunized and their locations, which meant minimal training and effort for health workers.

Lessons learned from Indonesia

1. Ensure that leaders buy in to the adoption of RapidPro

In Phase 1, health facilities in East Java hesitated to use RapidPro because they were comfortable with their manual reporting system. The project team used the dashboard to present the benefits of RapidPro to the governor, who then advocated for it. Within a few weeks, the reporting rate in East Java improved. In Phase 2, government leaders' endorsement of RapidPro as the national RTM platform for the campaign facilitated broad acceptance.

2. Consult with users on the minimum information needed

While RapidPro helped identify coverage gaps, it did not collect enough data (e.g., reasons for vaccine hesitancy) to help campaign staff identify corrective actions. Having this information could have helped further increase coverage.

3. Use RTM data to improve public awareness, strengthen local advocacy and generate demand

Vaccine hesitancy was a major issue in the measles-rubella campaign. In several cases, district health officers used RapidPro data to address vaccine hesitancy in meetings; and one district provided graphs and coverage data to the local media. Future programmes could benefit from incorporating this use of data into planning; providing training on the use of RapidPro dashboard data for cross-sectoral advocacy and media engagement; and using RTM data to identify areas that could benefit from rapid behaviour change communication to generate demand.

Conclusion

The use of RapidPro for RTM of a national measles-rubella campaign proved to be feasible and beneficial in Indonesia. RapidPro provided timely and efficient tracking of coverage against targets and could be modified to collect additional data to better inform corrective action. Campaign staff may also benefit from additional training on cross-sectoral advocacy measures – including the use of RapidPro data – to address bottlenecks encountered during implementation. The Ministry of Health should provide additional leadership to scale up the platform for future immunization campaigns, routine immunization and related health delivery activities.

Contact

Dr. Suci Wulandari
Data Centre Specialist
UNICEF Indonesia
swulandari@unicef.org

CASE STUDY 3 - Uganda

Effective Alignment with the National eHealth Strategy: The use of DHIS2 and ODK during the 2019 measles-rubella and polio supplementary immunization activities

Introduction

The Government of Uganda's 2017 eHealth strategy recognizes eHealth as beneficial for reducing the cost of doing business, improving collaboration and facilitating performance monitoring. However, following several digital health pilots projects that stalled when partner funding ended, in 2012, Uganda initiated a moratorium on such projects, demanding that future interventions prioritize interoperability, sustainability and conformity to existing Ministry of Health cyber laws and data requirements prior to approval for scale up.

Uganda implements a handful digital health programmes at scale, such as health management information systems, DHIS2, the Human Resources for Health Information System, the Open Medical Records System, the Logistics Management Information System and mTrac.[29] The country also has a National Data Centre that provides centralized hosting services for the Government.

Uganda's current eHealth strategy requires new initiatives to align with one or more of the above systems.

> "The difference between a successful and a failed campaign is how fast you respond to every issue that comes up."
>
> *– Andrew Bakainaga, WHO Uganda*

The aims is "to strengthen the health management information system by integrating existing system, vertical programme, referral data, and community-based health data into DHIS2." Along these lines, Gavi's 2019 targeted country assistance plan calls for increased access to and training on DHIS2 for all district heath management information system and EPI officers.

Programme design

In October 2019, the Ministry of Health, through the Uganda National EPI, with support from Gavi, WHO, UNICEF and other partners, conducted the country's largest ever measles-rubella and oral poliovirus (OPV) vaccination campaign. The campaign targeted 18.1 million children aged 9 months to 15 years for measles-rubella vaccination and 8.2 million children aged 0 to 5 years for polio vaccination. The first three days targeted children in school and the final two days targeted children at home who had been missed during the school vaccinations.

Drawing on the country's positive experience using ODK for acute flaccid paralysis surveillance for the past four years, the Ministry of Health decided to implement ODK for the measles-rubella campaign. Forms could be created easily for use on ODK; and users could fill out and submit forms using their mobile phones. However the tool lacked user-friendly visuals, so ODK was complemented by a DHIS2 dashboard that would promptly consolidate, visualize and analyse the ODK data.

DHIS2 is an open source, web-based platform used as the health management information system in 67 low and middle-countries. It has the ability to store data and provide data visualizations that allow policy-makers and managers to generate analyses in real-time. It is adaptable and extendable through its ability to interface with web applications and can be used for both health and non-health sectors.

29 mTrac is used by health facility workers to submit routine, weekly health surveillance data by SMS using their own basic mobile phones. It is part of the Ministry of Health's national e-health management information system, which also includes DHIS2, a digital platform for collecting and analysing facility and community health management information system data.

Implementation

The WHO-AFRO GIS Center provided technical assistance to the WHO Uganda Country Office on the use of ODK through a campaign monitoring checklists that was uploaded to the ODK system. The Health Information Systems Programme supported the development and integration of the DHIS2 dashboard; procured hardware; provided data plans and air time; provided information technology support during the campaign; developed user manuals; and conducted training. Other than hiring the Health Information Systems Programme, there were no additional human resources costs because the campaign was managed using existing human resources.

Following the design and development of the RTM tools, the Health Information Systems Programme tested each component to ensure that data flowing from the ODK online server were processed instantly and displayed in real-time via DHIS2. A series of modifications were made during the testing phase to improve efficiency and functionality. Training on data collection and reporting using the RTM system was incorporated into health system training at all levels; and national coordinators were trained on how to use the dashboard. A user guide shared with the lower levels covered how to submit data and use the dashboard application.

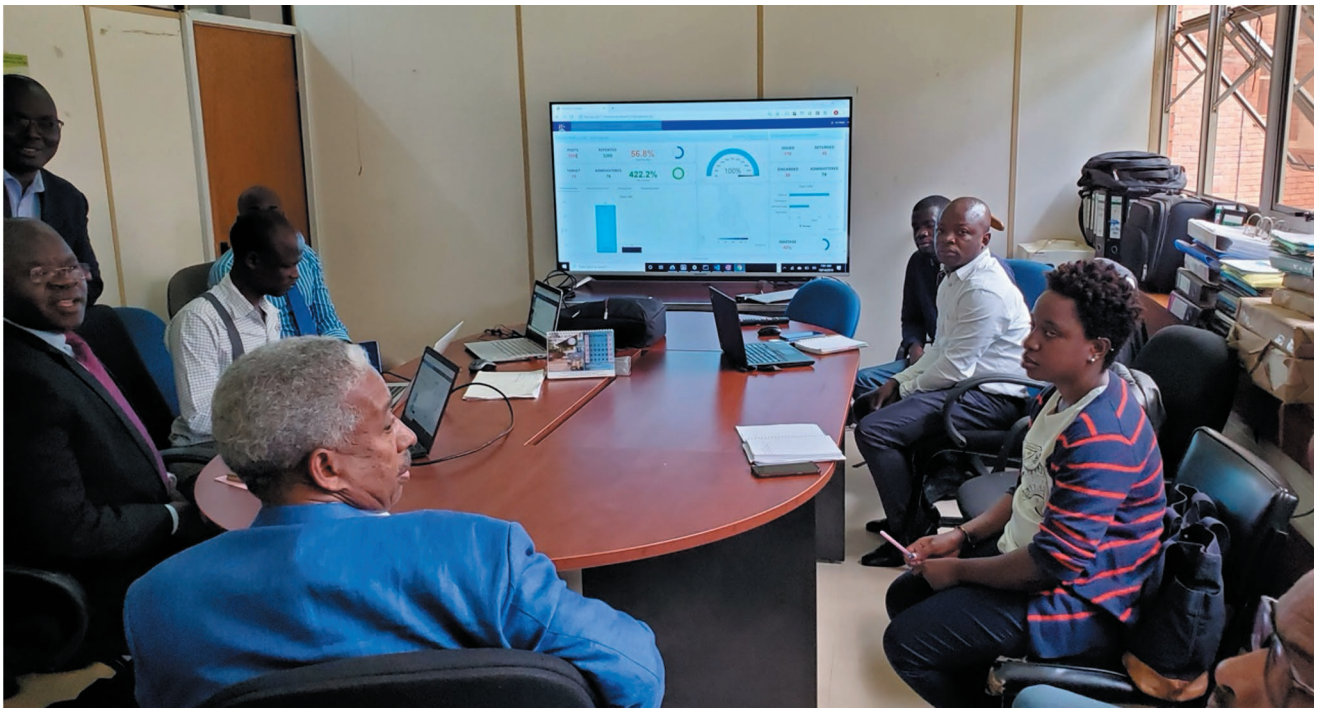
The ODK-DHIS2 RTM system was only used during the intra-campaign phase. A number of key performance indicators related to coverage, stocks, vaccine wastage and staff workload were incorporated into the dashboard (see Table 4). Qualitative narratives on reasons for over- or under-performance were captured on the ODK forms as well. These ranged from delayed starts to inadequate information about school registration, rain inhibiting travel, etc. Although quantitative information on reasons for missing children was captured on the form, users tended to focus on qualitative responses.

The system worked as follows: When monitors submitted data, the data were sent to both the ODK and DHIS2 servers. The system checked for consistency between the two datasets and the DHIS2 server updated the dashboard. The National Command Center viewed the interactive dashboards using a smart television that allowed users to view lower (regional, district, sub-county, etc.) levels to better understand where issues were occurring and toggle between graphs and maps. At the sub-national (regional and district) level, teams viewed the dashboards using their phones and met daily to discuss corrective actions.

Figure 6. Ministry of Health National Command Center

Vaccination performance
Children under 15 years of age (target population)
Number of children vaccinated (both measles-rubella and OPV)
Vaccination coverage (both measles-rubella and OPV
Stock and vaccine wastage
Number of doses issued (both measles-rubella and OPV)
Number of doses used (both measles-rubella and OPV)
Number of doses discarded (both measles-rubella and OPV
Vaccine wastage rate (both measles-rubella and OPV)
Number discarded by reason (partial use, contamination, vaccine viral monitor colour change and other factors (both measles-rubella and OPV))

Human resources
Number of health workers deployed
Average health worker workload



Source: DHIS2 Community

A call centre was established at the National Command Center to provide feedback to districts and supervisors when errors or low coverage were noted. Districts and supervisors also called the National Command Center to seek guidance and provide updates on follow-up actions. Supervisors had access to a supervisory dashboard that they could use to quickly identify necessary interventions.

Dashboard use appeared to be highest at the national level and lowest at the lowest levels (sub-county and village). This may have been because the lower level actors prioritized first-hand support in the field over reviewing dashboards on mobile phones. On the other hand, the national-level team had good Internet connectivity, was able to scrutinize incoming data and had a mandate to relay issues to the lower levels. Supervisors at the sub-county and village levels participated in daily team meetings to discuss how the day went, check stock status and track progress against targets.

Figure 7. Dashboard as viewed from the National Command Center

Outcomes

Ultimately, the campaign reached nearly 19.5 million children, including 18.1 million children who were vaccinated against measles-rubella (100 per cent of the target) and 7.96 million children who were vaccinated against polio (97 per cent of target). The campaign required tremendous coordination, involving 16,000 schools, 20,000 vaccination posts, 134,000 community health workers, 67,000 village councils, as well as local government structures at the parish, sub-county, health sub-district and district levels. In a press statement, the Minister of Health remarked that, "as a result of this mass immunization campaign, most of our isolation wards have since returned to their measles-free status."

While there were some challenges with the implementation of the RTM approach, including Internet connectivity and hardware issues, these were considered minor issues that did not stymie ongoing interest in RTM. In some places, the quality of registration data was a problem, particularly since private school enrolment was sometimes unavailable and/or enrolment data in general was out-of-date. During the campaign, more children were vaccinated than targeted, illustrating the incompleteness of registration data.

Decision-makers/programme managers at every level were able to review data and take appropriate action. RTM data were used to anticipate and prevent stock-outs; identify and target locations with vaccine hesitancy; and make timely decisions to extend the campaign for two more days, when needed. All of these actions helped the campaign achieve its targets.

Having real-time data was also hugely motivational for government staff and partners and increased efficiencies. Top leadership, including the Minister of Health and WHO and UNICEF country representatives visited the National Command Center every day to observe the campaign's progress. District management teams noted the extent to which their health teams used the dashboard. In 2019, inspired in part by this example, the education sector piloted a DHIS2 dashboard for their Education Management Information System in select districts. Plans are currently underway to install health system-wide management dashboards for the Permanent Secretary and Minister of Health.

Good practices from Uganda

1. The RTM system was effectively aligned with the national eHealth strategy and existing eHealth structures

The RTM system both made use of and buttressed national systems and structures. The integration of ODK with DHIS2 made it easier for users at all levels to interact with the RTM system because Ministry of Health staff at all levels were familiar with DHIS2. They were also able to leverage and support the local DHIS2 partner (the Health Information System Programme).

2. ODK and DHIS2 were complementary and interoperable

The ODK-DHIS2 system combined the strengths of the two platforms. ODK was known for effective field-based mobile phone data collection but had weak dashboard/data visualization features. Pairing it with DHIS2 allowed Uganda to have the best of both worlds.

©UNICEF/UN0357133/Kabuye

3. Data visualization facilitated analysis, understanding and communication of information at all levels

Interviewees reported that the data visualization dashboards were easy to use and required little additional input. All they needed to do was make sure that the data kept flowing in. To use the dashboards, they just logged into the system, looked at spot maps, and tapped on the maps to zoom in and identify problems.

4. Information technology assistance was available to teams at the national and sub-national levels

A team of information technology specialists from the Health Information System Programme were stationed at the National Command Center and provided remote fixes and phone consultations during the campaign. Access to this support alleviated frustrations for campaign staff and facilitated learning relevant to future campaigns.

5. Going paperless increased efficiencies

In past campaigns, Uganda printed paper forms and a team of supervisors ensured that data was being collected and transported the data to the next level. Going paperless helped the country saved on costs related to printing paper forms and transporting forms and data.

6. Awareness of accountability measures increased

ODK monitored where teams and vaccinators were and what they were doing. Teams were aware that they were being tracked, which increased accountability, helped improve the quality of the data and reduced fraud and its associated costs/impacts.

Lessons learned from Uganda

1. Start contracting software developers as soon as campaign planning starts

Selecting and contracting software developers can be a lengthy process and delay the timely availability of an RTM system. It is also important to factor in the time needed to build, test and finalize dashboards, and incorporate the input of high-level managers, before the campaign starts.

2. Provide software developers with campaign plans before implementation

Information such as administrative units, vaccination posts and targets should be available before the campaign begins so dashboards can be developed and tested. Much of this information is usually known early in the process and may even be built into existing data libraries (such as health facility names and geocodes).

3. Use RTM at the pre-campaign stage

Introducing the digital process early from the pre-planning process – and linking it to the DHIS2 interface – might be facilitate test runs and help identify and resolve issues during the pre-campaign stage.

4. Implement interactive smart television screens at the regional and district levels

The interactive screen motivated national partners when discussing and identifying issues for corrective action. The same effect was not felt at the sub-national levels because campaign teams used their mobile phones to view the data. In future campaigns, large screens could be brought to the provincial and district levels.

5. Stress-test ODK and other data capture systems

Some challenges with ODK resulted in data loss. These included system time-outs due to large volumes of data, the inability to resubmit data in case of mistakes, and loss of data due to high server loads during peak reporting hours. Stress-testing ODK and other data capture systems (such as the new DHIS2 Android app) might help prevent similar issues in the future.

Conclusion

Uganda's case demonstrates an effective use of national eHealth systems and structures to design an interactive RTM system. RTM approaches facilitated the timeliness of campaign progress, results and feedback, which supported corrective actions and helped Uganda save on costs associated with transporting data and printing forms. Because DHIS2 is used widely (60+ countries), other countries may wish to consider leveraging and strengthening their experience with DHIS2 as they design and implement RTM systems.

Contact

> "The power of real-time monitoring is beyond data…. The use of live data [creates] huge momentum for people to work together. It is very helpful for partnership management and decision making."
>
> *– Monjur Hossain, UNICEF Zambia*

Andrew Bakainaga
WHO Uganda
bakainagan@who.int

Eva Kabwongera
UNICEF Uganda
ekabwongera@unicef.org

CASE STUDY 4 - Zambia
Strengthened partnerships and coordination: RTM immunization campaign experience

Introduction

In the past decade, the Government of Zambia's EPI has used several digital health monitoring systems, including the SmartCare Electronic Health Record system; the Electronic Immunization Registry; mVacc, an SMS-based reporting system used in the Southern Province; and Logistimo, a supply chain management software.

Zambia's rich experience in digital health for immunization extends to supplementary immunization activities and surveillance. Before 2012, Zambia used personal digital assistants to collect data for post-campaign surveys of measles supplementary immunization campaigns; however, the information was not available in real-time because data collectors had to return to base to synchronize the data. With the maturation of digital technologies and the expansion of network connectivity, Zambia transitioned to using KoBo Toolbox Collect on smartphones in 2012 and to OnaData in 2017. Zambia also currently uses the e-Surveillance mobile app for polio surveillance.

> "The power of real-time monitoring is beyond data…. The use of live data [creates] huge momentum for people to work together.It is very helpful for partnership management and decision making."
>
> *– Monjur Hossain, UNICEF Zambia*

Programme design

While Zambia's EPI has seen improvements on several fronts, occasional outbreaks of cholera (2016), measles-rubella (2016) and polio (2019) have required supplementary immunization activities. Since employing RTM technologies during post-campaign evaluations of the 2016 cholera and measles-rubella campaigns, Zambia has used RTM to collect data on all stages (pre, during and post) of subsequent campaigns to improve preparedness, supervision, campaign quality, coverage and surveys. Key partners in these RTM initiatives include the Ministry of Health, WHO, UNICEF, the United States Centers for Disease Control and Prevention and the United States Agency for International Development.

Most recently, during the early 2020 polio outbreak response in Luapula province, health workers used ODK monitoring and supervision tools on their mobile phones to collect and transmit real-time data. The data were aggregated and visualized with Power BI so emergency operation centres could understand what was happening in the field and promptly take corrective actions.

The choice to use RTM in Zambia was influenced by regional trends and communities of practice. Zambia participates in annual meetings with EPI managers and surveillance officers from across the African continent. Through these fora, they have learned about how other countries use RTM technologies for surveillance and routine and supplementary immunization activities.

KoBo Toolbox and OnaData were chosen because both are open source tools based on ODK. While they have similar functionalities, the Zambia team found OnaData to be slightly easier to use. For example, although both systems allow anyone to develop a data collection form on Microsoft Excel and upload it to the application, the Zambia team favoured OnaData because the syntax was easier and could be handled by programme managers without programming knowledge. ODK-based tools are used by several African countries and technical assistance for ODK (among other technologies) is available through WHO-AFRO. Power BI is commonly used to generate reports and data visualization dashboards that can be viewed using a mobile phone or a computer.

Implementation

WHO has played a leading role in facilitating the adoption of RTM for vaccination campaigns in Zambia by reviewing existing tools used in the region and across the world and supporting their adaptation to the national context. The Ministry of Health has provided implementation and policy support for RTM, and UNICEF and other partners have supported the various technical working groups involved in overseeing supplementary immunization activities.

In Zambia, the technical working groups, with Ministry of Health oversight, determine what programme data is needed; data collection tools are finalized based on this need; and RTM planning begins on that basis. Once the data tools are available, WHO Zambia enters these forms into the ODK platform and WHO-AFRO develops the dashboard. To facilitate cross-border coordination, WHO also helps harmonize Zambia's indicators with the indicators used by neighbouring countries.

RTM data is used to meet the following objectives:

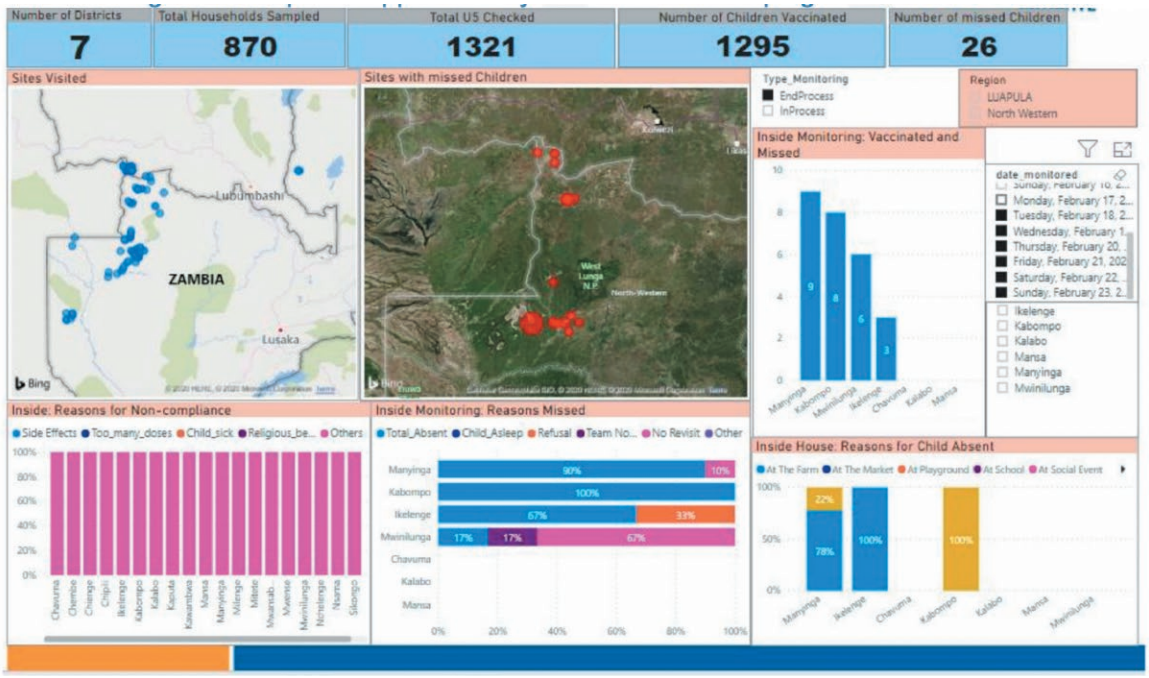
- **Pre-campaign:** To assess the readiness of districts and health facilities using a preparedness self-assessment checklist. This allows the Emergency Operations Centre (EOC) based in Lusaka to track, in real-time, the state of campaign preparedness for districts as far as 1,200km away and provide immediate feedback or supportive action. During a recent spate of flooding, for example, the EOC tracked the distribution of vaccines, supplies and the movements of staff/vaccinators. Based on these data, additional resources were provided to facilitate access/movement.
- **Intra-campaign:** a) To track the vaccination teams' and supervisors' deployment relative to the micro plan; and b) to monitor the quality of the supplementary immunization activity using the in-process checklist. For example, round 2 of the 2020 polio campaign took place during a time of significant community distrust marked by violence against perceived "outsiders". Following intensive advocacy and community engagement, the EOC monitored community acceptance using specific indicators on the dashboard such as "polio discussion in the community." Five (5) out of 9 districts had scores of less than 90 per cent on these indicators by day 1 and day 2 of the campaign. The EOC engaged with these districts to understand why and identify strategies to improve performance.
- **Post-campaign:** To monitor how well the district quality assessment and independent monitoring survey processes are being carried out, and validate administrative coverage estimates.

Some of the data collected and shown on the Power BI dashboard during the polio campaign are listed in Box 6. Figure 8 shows a screenshot of the dashboard data available during the same phase. Using the dashboard, administrative data were assessed and missed children were vaccinated.

Box 6. Box 6. Power BI dashboard data

Performance of team supervision	Quality of supplementary immunization activity implementation
1. Vaccine vial monitor knowledge 2. Number of children missed 3. Daily sufficiency of logistics and supplies 4. Team movement plans 5. Type of teams (local or not) 6. Surveillance knowledge (reporting on suspected acute flaccid paralysis areas)	1. Households visited 2. Number of children seen 3. Number of children finger-marked 4. Number of children missed 5. Reasons for not vaccinated 6. Geographical coverage through GIS

Figure 8. Screenshot from end-process monitoring by the intra-campaign team in Chavuma district during the 2020 polio supplementary immunization campaign



All data are hosted by the Ministry of Health on the same server. Questionnaires for surveillance, outbreak response, routine immunization and supplementary immunization activities are also hosted on this server and downloaded into mobile devices by field supervisors.

RTM training is integrated into broader campaign trainings. For example, the micro plan training covers the three types of checklists used in the pre- and intra-campaign phase, as well as training on other aspects of microplanning. There is a separate module that covers how to install and use ODK, identify the variables that should be monitored via dashboards and customize the dashboards to these ends.

©UNICEF/Zambia country office/2020

At the national level, the EOC reviews the data. Smart television screens are used to visualize the data – including using maps – so the emergency response team can identify coverage gaps and determine where to intervene (e.g., by extending the number of vaccination days or reinforcing sensitization activities). Local levels can also access the dashboards at any time. The national level team prepares daily situation reports with service coverage and social mobilization data highlighting progress and challenges. These reports keep programme stakeholders and senior staff of the Ministry of Health and partners apprised of the campaign's status. Technical working group meetings (i.e., for vaccines and supply chain, data management and social mobilization) are convened to review issues and make decisions on corrective actions. The national team also sends feedback (i.e., via phone calls, analysed extracts and web links to the dashboard) to local levels with guidance on how to adjust. District and provincial teams communicate with health facility officers via field managers/supervisors.

Outcomes

These campaigns have generally performed well. A post-campaign coverage assessment of the 2016 reactive cholera campaign showed nearly 70 per cent coverage of at least one dose, which is in line with coverage achievements for urban areas in other countries. National coverage for the 2016 measles-rubella campaign was 95 per cent, with provincial rates varying from 86 to 97 per cent. In an evaluation, Gavi noted that the measles-rubella campaign faced challenges, including official population figures not matching the actual targeted population, resulting in maldistribution of vaccines and other supplies; vaccine cards and ink running out in some places; the late start of the campaign in some places; and transport challenges. However, these challenges were mitigated through timely communication and response at national, provincial and district levels. Since then, other ongoing challenges experienced with RTM have included: Internet connectivity, power supply and the costs of buying and maintaining Internet bundles. Insufficiently trained personnel/limited capacities at the district and provincial levels have also been bottlenecks.

Good practices from Zambia

1. Existing decision-making structures can be effectively leveraged to review RTM data

Zambia uses existing structures such as the incident management system and technical working groups to review RTM data and make decisions about campaign directions. This combination promotes agility in the response, partner coordination, country ownership of the solutions proposed and access to technical expertise.

2. Daily situation reports using RTM data provide decision-makers with vital information

Delays in data transmission can make it difficult to provide informative updates to decision-makers. Situation reports informed by real-time data can provide decision-makers with snapshots of the evolving situation, highlight the types of support needed and facilitate the engagement of senior officials.

3. Real-time feedback mechanisms facilitate cross-level coordination

The real-time feedback mechanisms established in Zambia enable national level stakeholders to discuss potential problems and solutions with provincial, district and health facility level stakeholders for prompt resolution. Feedback can be transmitted via SMS and WhatsApp or discussed on a conference call. In Zambia, these discussions can be cross-level, bringing together stakeholders from the provincial, district and health facility levels to resolve a problem.

4. RTM can make granular data accessible

In Zambia, all levels, from the national level to the facility level, can access dashboard data and refresh the platform to see daily updates. This information can be detailed and granular, down to the facility, community and household levels, helping decision-makers develop targeted solutions.

5. The first step is to clarify what the problem is

One national-level stakeholder described the process of following up with the lower level as "first, clarifying if the problem is as we both understand it." Because the lower levels are more likely to be attuned to the nuances of the situation, this practice of clarifying the problem first – regardless of how it may be presented on the dashboard – prevents higher level stakeholders from making assumptions about what interventions are needed.

6. A centralized, country-owned RTM system promotes sustainability

In Zambia, the RTM system's software elements – the server, data storage and forms – are housed within the Ministry of Health. While not every country needs or is able to have their own server, it is vital that the Government decide where data will be kept – whether in-country, with WHO-AFRO or with a private, cloud-based company – and that the forms and data are accessible to EPI teams even following staff turnover.

Lessons learned from Zambia

1. RTM strengthens coordination among partners

Zambia has combined real-time access to data with the use of established decision-making structures, cross-level communication and advocacy. In combination, these factors foster dedication among partners, the EOC, managers and field staff. Although Zambia's cross-level coordination skills were recognized as early as 2016 (when RTM methods were only being used for post-campaign surveys), stakeholders also note that its current use before and during campaigns has added significant value.

2. Inter-agency coordination is vital to the current and future interoperability of platforms

Interoperability is a priority in digital health approaches in Zambia, and efforts are underway to link various platforms. Moving forward, the Government and partners need to develop shared specifications and/or

criteria for designing and adopting new technologies; and outline a collaborative process for conducting the review. The ways in which different partners can support capacity strengthening, data management, maintenance and use of those technologies should also be articulated. Given Zambia's strong regional ties and the importance of cross-border coordination, much can be gained by learning the specifics of what neighbouring countries are doing and sharing the specifications/approaches being used in Zambia.

3. Build in-country capacity

Zambia has benefited from technical assistance from WHO-AFRO. There is currently a plan to train government and partner surveillance, communication for development/health promotion and health information officers on how to design and run the RTM system. There is also a need for training on data use and reporting for provincial and district-level counterparts, since it was also identified as a challenge in some areas.

Conclusion

The Government of Zambia has implemented RTM for various immunization campaigns over the past five years. Stakeholders report satisfaction with the speed of access to data, the ease of coordinating with colleagues at all levels, the ability to monitor activities everywhere (even in remote areas), and the level of teamwork. Challenges have included maintenance costs such as Internet data plans and training/re-training.

Notably, the Government has been able to deploy RTM approaches for campaigns that vary greatly in scope, (nationwide vs. targeted), delivery methods (static-site, school-based, outreach, house-to-house), and for a broad range of target populations (infant to adult). For this reason, the good practices and lessons learned outlined in this case study are applicable to any country wishing to use RTM approaches, regardless of campaign strategy.

Contact

Belem Matapo
WHO Zambia
matapob@who.int

Ngawa Ngoma
UNICEF Zambia
nnngoma@unicef.org

©UNICEF/ UNICEF/UN0300712/Zaidi

Literature Review

Literature Review

In addition to the case study research conducted, the study team identified relevant journal articles describing the use of digital tools for RTM to support immunization campaigns. A search strategy was developed and PubMed and Google Scholar were used to identify over 200 articles based on their titles and abstracts. A full-text review was conducted of six relevant cases from the Democratic Republic of Congo and Somalia (multi-country study), Haiti, Iraq, Malawi, Nepal, Nigeria and South Sudan. The articles reviewed are listed in Table 5 and Annex 3. The articles reviewed are listed in Table 5 and Annex 3. The findings of these cases are presented in the following section.

Table 5. Experiences with the use of digital tools for RTM to support immunization campaigns

Country	Source	RTM tool	Immunization campaign	Lead agency
	Real-time coverage surveys and monitoring during emergency vaccination campaigns in insecure humanitarian contexts of the Democratic Republic of the Congo and Somalia. (Fu, C., et. al., 2019)	Not specified	Emergency outbreak vaccination campaigns for yellow fever in the Democratic Republic of the Congo and cholera in Somalia	Save the Children International, Vaccine Institute
Haiti	Using mobile health (mHealth) and geospatial mapping technology in a mass campaign for reactive oral cholera vaccination in rural Haiti. (Teng, J.E., et. al., 2014)	mHealth tool	Oral cholera vaccination campaign	Ministry of Health, Partners in Health
Iraq	Use of real-time data transmission method for polio vaccination campaign monit =oring in Iraq (Kakakhan, J., 2016)	Survey123 for ArcGIS Epi-info (visual dashboard)	Polio campaign	WHO, Iraqi Red Crescent Society, Ministry of Health, Esri
Malawi	Stop the spots: Measles vaccination in Malawi. (Eros, E. and A. Schmeltzer, 2017)	ODK Portable OpenStreet Map	Measles-rubella supplementary immunization campaign	American Red Cross in partnership with the Malawi Ministry of Health, UNICEF, WHO, Centers for Disease Control and Prevention

Table 5. continued

Country	Source	RTM tool	Immunization campaign	Lead agency
Nepal	Real-Time Monitoring of Vaccination Campaign Performance Using Mobile Phones—Nepal, 2016 (Oh, D. H., et. al., 2016)	Zegeba Pilot testing of rapid convenience monitoring using mobile phones Tableau (real-time data visualization) WhatsApp support group	Measles-rubella supplementary immunization campaign	Ministry of Health, WHO
Nigeria	CGPP Nigeria program: Use of mobile phone technology for improved quality of reporting (Usman, S. no date) Tracking vaccination teams during polio campaigns in Northern Nigeria by use of geographic information system technology: 2013–2015. (Touray, K., et. al., 2016) Using geographic information systems to track polio vaccination team performance: pilot project report. (Gammino et. al., 2014)	Vaccine tracking system ODK for dashboard	Polio campaign	The CORE Group Polio Project, Catholic Relief Services, Save the Children, International Medical Corps, the Centers for Disease Control and Prevention, WHO, Ministry of Health
South Sudan (Data	Use of mobile information technology during planning, implementation and evaluation of a polio campaign in South Sudan (Haskew, J., et. al. 2015)	ODK	Polio campaign	Red Cross

Real-time Monitoring Outcomes

Benefits

RTM can contribute to the achievement of campaign targets

In Iraq, the RTM system ensured daily feedback, which led to a decrease in the number of unvaccinated children and improvements in post-campaign coverage. In Nepal, RTM improved the quality of vaccination campaigns with faster data transmission, analysis and decision-making, and greater accountability among different levels of the health systems. The 95 per cent coverage achievement was at least partly due to the fact that vaccinators were able to identify the 42 per cent of areas visited by rapid convenience monitors where action was required. In South Sudan, the number of payams with vaccination coverage under 90 per cent decreased from 25 to 11 between the pre- and post-campaign surveys. Finally, in the Democratic Republic of the Congo and Somalia, daily coverage surveys helped identify low-coverage sites and attain 93 per cent and 99 per cent final coverage rates, respectively.

RTM can refine outreach strategies

RTM allowed programme staff to refine their outreach strategies during the campaign and plan for the next rounds. Refinements included identifying new communication and information sources (Democratic Republic of the Congo and Somalia); modifying campaign messages to correct erroneous community perceptions (Democratic Republic of the Congo and Somalia); targeting geographical areas (Nepal, Nigeria and South Sudan); and modifying the campaign strategy from fixed post to mobile post, and eventually, door-to-door (Haiti).

RTM can enable prompt corrective actions

In Nepal, most monitoring results were available on the same day, and timely reporting improved supervision. Supervisors used data on reasons for non-vaccination to tailor vaccination strategies and take immediate actions, which had not been possible with paper-based rapid convenience monitoring. In Iraq, RTM made daily feedback to the provincial, district and health facility levels possible, and as a result, vaccinators were able to follow up with missed children identified through the RTM system.

RTM can improve data quality

In Nepal, RTM improved the timeliness and completeness of reporting. The automated calculations and analyses displayed on dashboards eliminated the potential for manual calculation errors (a previous problem with paper-based rapid convenience monitoring data). In Iraq and South Sudan, the use of mobile information technology during the polio campaign supported the collection and analysis of standardized, coded data. Similarly, in Nigeria, the use of mobile devices improved the effectiveness, efficiency, accuracy and quality of data collection and reporting compared with past manual data collection efforts.

RTM can reduce some costs

In Haiti, though RTM required upfront financial investments in hardware, personnel and training, it reduced the need for costly and time-consuming printing and manual data entry. Other studies provided low-cost mobile phones (Nepal), tablets (Iraq) or GPS devices (Nigeria) to field staff.

RTM can improve accountability

Nigeria reported that GPS tracking of vaccination teams helped teams reach the settlements they were supposed to cover and helped supervisors monitor the level of coverage. Nepal and Malawi had dashboard indicators for monitoring the movement/activities of teams, as well as vaccination-specific indicators.

RTM can improve planning

In Haiti, having a birds'-eye view of progress across all localities enabled campaign managers to better forecast the campaign timeline. In Iraq, RTM was used over the course of four national rounds of polio

immunization, and data from each round improved planning for subsequent polio rounds. In Nigeria, mapping data from RTM improved microplanning in subsequent campaigns.

RTM can facilitate advocacy

In Nigeria, images showing the GPS locations of vaccination teams were considered helpful during meetings with local officials, many of whom were very interested in an objective and visual view of the teams' activities. Having validated maps may have also increased the perceived value of the campaign given their other potential applications.

RTM investments can yield "public goods" for future work

In Haiti, the RTM system led to the creation of an electronic registry with population-level census data. In Nigeria, RTM was used to validate micro plan maps. Both datasets could be used to inform various other health and other sector programmes.

Challenges

The study authors generally stated that the use of digital technologies during supplementary immunization activities was feasible and desirable. However, the following challenges were noted.

Poor or slow network connectivity

Disrupted or slow Wi-Fi was reported in Haiti and Nepal, particularly in rural areas. In Haiti, data uploads took hours, and sometimes, uploading was incomplete before tablets had to be sent back into the field the next day. However, the data were usually available every day or every two days, which was still faster than a paper-based system. In Nepal, finding and connecting to 3G or Wi-Fi networks to submit real-time data was challenging.

Preparatory timelines were too short

This challenge was mentioned in Malawi. The RTM methods and website were developed in less than a month, which made it difficult for the lead organization to sensitize partners. Preparatory/design timelines should build into the timeline for the first supplementary immunization activity that will deploy RTM.

Data cleaning, though reduced, was still necessary

In both Haiti and Nepal, although the RTM system improved data quality, manual data cleaning still had to be done in some cases. In Haiti, field teams occasionally reported multiple, systematic errors that had to be edited in the database. Developers also had to troubleshoot some issues with the software. In Nepal, data analysts had to correct duplicate data entries or clean community names.

Field staff did not always adhere to GPS protocols

In South Sudan, GPS coordinates were recorded for fewer than half of all households surveyed, which may highlight a gap in training and supervision. In Nigeria, GPS receivers were occasionally kept on during non-observation hours, creating false tracks. Other receivers were intentionally turned off or fresh batteries were switched for dead batteries; possibly to eliminate any record of remote or hard-to-reach areas that were avoided intentionally by the teams.

Good practices from the literature review

1. RTM was used before, during and after immunization campaigns

In Iraq, RTM was used for the intra-campaign survey and post-campaign monitoring. In South Sudan, pre-campaign household surveys were conducted to map immunization coverage and identify areas not included in previous vaccination campaigns; intra-campaign monitoring took place during the campaign; and a post-campaign survey was conducted immediately following the campaign. In Nigeria, digital technology was used validate micro plans at the pre-campaign stage and monitor accountability and coverage during the campaign.

2. Coverage rates and other key information was captured and used to identify corrective actions

In Haiti, in addition to monitoring coverage daily, daily case-finding reports were generated so registered individuals who had yet to receive their first or second dose could be reached by door-to-door teams. Data on the volume of beneficiaries vaccinated was used to adjust the daily focus locations of vaccinators and to adapt local vaccination strategies from fixed-site to door-to-door. Data quality was monitored to provide targeted support to enumerators with recurrent data quality issues. Nigeria's vaccination tracking system application was used to identify missed settlements and monitor vaccination teams' compliance with prescribed routes.

3. The added value of RTM was measured

Nepal monitored RTM-specific outcomes such as the timeliness and completeness of data reporting,

where monitoring was done, areas monitors may have missed, and the percentage of areas that required corrective vaccination activities. These RTM-specific outcomes were measured on dashboards, in addition to standard monitoring data. Nepal also surveyed supervisors, data collectors and stakeholders to assess the acceptability and desirability of the RTM system. Malawi also had an indicator for the percentage of rapid convenience monitoring clusters that required corrective actions.

4. RTM was used to explore how to strengthen routine vaccination

Social mobilizers in Malawi collected information from caregivers about the routine immunization status of their young children and entered the data into ODK. While it is not clear whether these data were used during the campaign's implementation, it could have helped local health staff follow up with children with a history of missing routine vaccinations to ensure that they are reached by the health system, and/or inform social mobilization activities/messages.

5. Modifications to the RTM system were tested

To improve the linkages between the campaign and routine immunization, Malawi also tested whether adding questions to the RTM tool was scalable. The tool (ODK Android app) randomly assigned Red Cross volunteers to ask the additional questions; other volunteers used the standard digital forms and another used paper forms. The goal was to measure the time required for the extra data collection and determine whether it could be done on a larger scale.

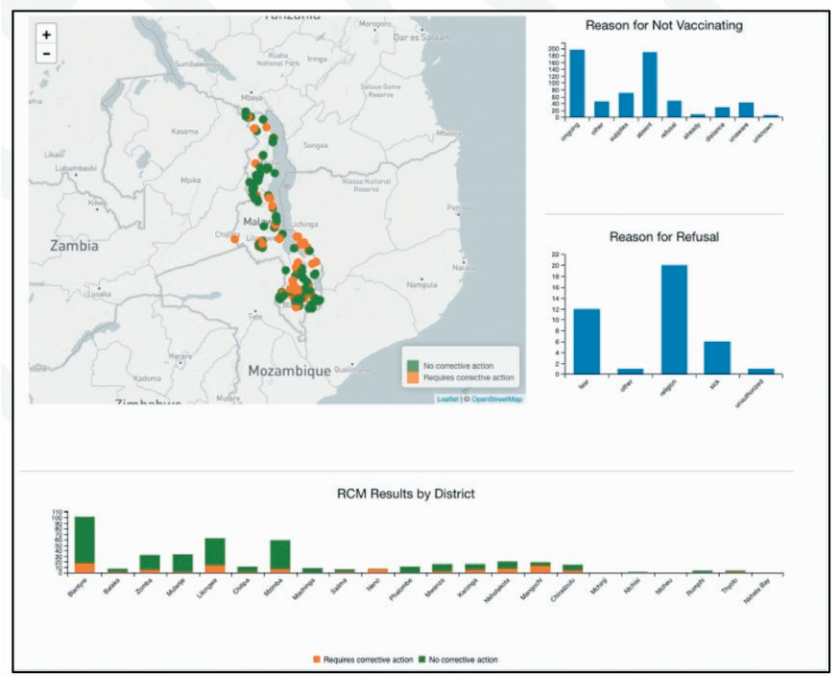
6. Data quality measures were implemented

Nearly every country's digital software included automatic data validation features, such as logic branching and required responses, to ensure accuracy and completeness before saving. For the two-dose oral cholera vaccination campaign in Haiti, a refresher training was conducted before the second dose was given to review software functions, updates to data collection forms, feedback from the previous dose for improved data quality, and practice scenarios. During data collection, supervisors accompanied enumerators and conducted spot checks to ensure that enumerators were filling out forms correctly.

7. Automatic flags were created to identify areas requiring corrective actions

Nepal's dashboard included an indicator called "action," which automatically calculates and flags which communities require follow up. Colour coding and mapping makes it easier to see which communities require action and where they are clustered. Malawi used a similar dashboard in its 2017 measles-rubella campaign where clusters were flagged as orange for "requires corrective action" and green for "no corrective action." Automated decision rules and visuals like these streamline the process of data use.

Figure 9. Malawi dashboard showing areas requiring corrective action and reasons for low uptake



8. Barcodes were used to automate data entry

Haiti's use of barcodes on registration cards streamlined data entry during campaign implementation. When beneficiaries presented for vaccines, their personal census information (name, age, gender, locality of residence) was automatically populated and linked with service data (enumerator and supervisor names, vaccination date, dose and manufacturing batch number). These administrative data were then triangulated with GPS data to generate summary maps of population coverage. Using tablets and barcodes saved time during data retrieval at vaccine posts, shortening each encounter and allowing immunization staff to vaccinate more people every day. The barcodes accurately linked records to the same patient across different points of contact (ex: during registration, first dose, second dose), and increased the campaign's flexibility; any vaccine post could link a beneficiary to his/her census data, even if he/she was outside his/her locality. This approach may be best applied to multi-dose vaccines such as cholera or for geographic areas where two or more supplementary immunization activities are planned for a given year.

9. Geographic data was used to validate micro plans

In Nigeria, during a 2010 polio supplementary immunization activity, the actual movement patterns of vaccinators were compared with hand-drawn micro plan map routes. These maps illustrated catchment area boundaries, settlements and daily routes for vaccination teams. Given the absence of formal maps at this level, micro plan maps were based on local knowledge. Researchers observed that vaccination teams frequently improvised and deviated from the prescribed routes. The actual distances between landmarks on hand-drawn maps were also significantly different from satellite images and route designations lacked sufficient detail to provide adequate guidance. GPS data were subsequently used to validate micro plans for the 2012 and 2013 supplementary immunization activities.

10. Geographic data was used to improve accountability

In Nigeria, GPS tracking helped ensure that teams reached the settlements they were supposed to cover. Very detailed maps were also available in Malawi, where, thanks to a separate open-source mapping activity, volunteers mapped the locations of buildings. These maps could be overlaid with household visit locations to see which buildings were visited.

Lessons learned from the literature review

Implementation

1. Avoid manual downloading and data processing

Iraq had attempted to use digital technologies for campaign monitoring in the past, but the previous method (with Epi-Info) had involved daily downloads to a Dropbox folder and manual compilation at the national level, causing two to three-day delays in sending feedback. Ultimately, feedback was sent only twice during each round of the polio campaign, and focused on providing an overall evaluation of the round rather than on corrective action. With the new Survey 1-2-3 system introduced in 2015, data were continuously uploaded to the server, validated and presented in dashboards, and geocoded lists for missed children were available each day. As a result, daily feedback sessions were possible, leading to improved coverage rates.

2. Monitor whether corrective actions were taken

Nepal tracked which communities needed corrective action. Supervisors suggested adding the ability to track whether corrective action was actually taken.

3. Use time stamps

The Nigeria study recommended adding time stamps to reports, in addition to GPS tracking. Combined, these could ensure that teams were in place at the right times, help programme managers understand how much time they were spending at different sites, and improve efficiency.

4. Consider using RTM in insecure settings

In the Democratic Republic of the Congo and Somalia, RTM (with daily coverage surveys) was used because good pre-campaign information on the size of the target audience and causes of low coverage was not available and post-campaign activities were likely to be limited or delayed.

5. Increase supervision/feedback

This was mentioned in South Sudan to help capture GPS coordinates more often; and in Nigeria to reduce operator errors in GPS devices. In Haiti, additional time for individual feedback was suggested to improve the quality of data collection generally. In Malawi, additional training days were needed. Broadly, these experiences point to the value of sufficient training (to begin with), wide availability of job aids, encouraging peer-to-peer training and support, and building in flags to identify individuals needing more data quality assurance support from supervisors.

6. Establish flexible standing contracts with mobile networks

Due to the emergency nature of the polio campaign in South Sudan, it was not possible to establish a data contract with the mobile phone operator to ensure real-time synchronization as planned. Instead, data were uploaded from the Android-based smartphones to a server on the team's return to base and this database was subsequently downloaded, coded and cleaned. It may be worth considering having standing contracts with mobile networks in places that are likely to have emergency or reactive supplementary immunization activities.

Technological

7. Make software (not just data entry forms) available in the native language

In Haiti, although forms were written in the local language, the software interface itself was in English.

8. Use mobile phones and cell phone networks instead of tablets and Wi-Fi networks

In Haiti, the study noted that this would allow for continuous data synching and eliminate the time and personnel required to connect and sync tablets every evening.

©UNICEF/Pakistan country office/2020

Appendix 1: Data collection instruments for regions and countries

The study team used these master lists and tailored questions for each of the interviews conducted with the UNICEF regional and country offices and partner organizations (e.g., WHO, Gavi and HealthEnabled).

Questions for introductory regional meetings (master list)

Objectives

This is an overarching question guide to guide initial discussions with regional colleagues prior to any tailored focus group discussions with country teams.

1. **Country selection:** Which countries in your region would you recommend we prioritize for focus group discussions and/or interviews? The criteria for selection are:
   a) The immunization programme that used RTM has been implemented (it is not in the pipeline stage) and has results.
   b) The programme has substantial potential for identifying lessons learned (we may use a sample with both high vs. poor performing programmes depending on the number and types of programmes identified).

2. In your opinion, what factors make these experiences "useful" case studies for future programmes? (probes: they were very effective, easy/feasible to duplicate/replicate/adapt; it was cutting-edge, substantial potential for cost-savings/sustainability; and the opposite, so as to learn from failures, i.e., certain elements worked very poorly).

3. **Identification of key themes:** Please tell us a little more about each programme.
   a) For what kinds of tasks did national partners use RTM technology? (e.g., microplanning, training, supply chain management, quantification of population, find unvaccinated children, quality of data, work of monitors and/or supervisors, etc.).
   b) Which technolog(ies) did each country use, and what were the reasons they chose it?
   c) To your knowledge, in which areas did the country tend to do well in (in terms of design, planning, coordination, training, implementation, use, etc.)? What were the reasons?
   d) To your knowledge, in which areas did the country tended to struggle/fall short (e.g., user testing, localization, etc.)? What were the reasons?

4. **Preparation for country interviews:**
   a) Can you please share documents about the programme? (e.g., planning tools, visuals of dashboards/entry forms, outcome reports, etc.)
   b) Regarding next steps for being introduced to country teams (the country office will have already identified the key informants); who would be best to interview one-on-one vs. in group discussion?

5. Input on draft outline for the guidance document:
   a) Who would be the main users of a step-by-step guide on RTM for immunization?
   b) What types of information would be useful to them? (probe: which of these pieces would be MOST useful?)
   c) Please take a minute to look at the draft outline (attach deliverable 6). What changes, if any, are needed?

Questions for country offices

General

1. How do you think RTM approaches and related technologies can make a difference in immunization campaigns?
2. What digital technology strategies and approaches have been used for immunization activities? Why was digital technology considered, i.e., what programme bottleneck was being addressed?
3. Which technologies have worked for the RTM Immunization work and which haven't, and why?
4. What are the critical factors to promote the successful implementation of RTM using RapidPro/ other technologies (e.g., ensuring campaign quality, preparedness, rapidly and effectively reaching target audiences, changing their knowledge, attitude, and practice, contributing to improvements in health outcomes)?
5. Please describe the nature of the immunization programme in which you used RTM technology (probes: campaign vs. routine, mop-up, fixed point vs. door-to-door, disease area, scale of implementation).
6. For what kinds of problems/tasks did you use RTM technology? (e.g., microplanning, mapping, training, supply chain management, quantification of population, find unvaccinated children, quality of data, work of monitors and/or supervisors, etc.). Ask for specifics of problems/tasks, not just general areas; ask about the context - why wasn't the previous system sufficient?
7. How was the RTM information used for corrective action at all levels? What difference did RTM approaches make?
8. Sustainability: Can you describe the national ownership arrangements, including if there was handover, and sustainability-related factors that affected design and implementation?
9. What was UNICEF's role in the planning, implementation and assessment phases?
10. What lessons learned from the existing experience would be relevant for other countries interested in undertaking immunization and/or other primary health care activities with the support of mobile technology (for UNICEF staff and national partners)? What guidance would have been helpful to you, before embarking on your RTM initiative?
11. Were other individual platforms (KoBo Toolbox, DHIS2, ODK, DEEP, etc.) considered and how and why was the platform used and decided on?
12. What recommendations can be drawn from these findings (e.g., programmatic evidence of best practices and lessons learned)? What worked and what did not work from your perspective?
13. What partners used the RTM information?
14. Following the campaign, what adjustments have been made to improve RTM for immunization campaigns?

Preparation

1. What sectoral ecosystem considerations were factored into the development of the initiative?
2. What existing governance mechanisms were used or established to enable the RTM component and which entities were involved?
3. How was the RTM component linked to existing systems? What were the interoperability considerations and challenges, if any?
4. Were national partners already conversant in RTM approaches and, if yes, in which sectors
5. How did partners determine the specific information to be collected for RTM purposes? Is the information related to the monitoring and evaluation frameworks in place?
6. How did you come to focus on the specific RTM technology employed as a solution?
7. What practical steps and considerations were taken when deploying the RTM platform used, including engagement with mobile network operators /aggregators, etc. (RapidPro in Pakistan case)?
8. Please describe who the intended users were, and how they were supposed to interact with the system (probes: who inputs data, who reviews the results, how is the data validated, how does the system support decision-making and corrective actions, e.g., reassigning teams to poorly vaccinated areas, modifying the timing of vaccination, or conducting mop-up vaccination activities)?
9. Please walk us through the main activities involved in planning, setting up and implementing the

system (probes: design, training, roll-out, etc.; if not mentioned, ask about the process of user-testing and localization)
10. Who were the key implementers and collaborators? (probes: did you work with telephone companies?)
11. What are the timeline, costs and step-by-step process/requirements (how to do and tools/job aides/checklists, etc. for each step) from conception, planning, implementation monitoring and evaluation, and documenting/reporting of real-time digital technology use?
12. What type and level of training was required for different stakeholders at different levels to enable the RTM initiative? What would you have done differently?
13. What incentives (if any) were in place/established for respondents to report using the RTM platform?
14. What was the costed amount of the RTM initiative? Did budget execution align with plans?
15. What was the financial contribution of UNICEF, the government and others?

Implementation

1. How well did the system work? (probe about outcomes: How well did the intended users take up the system? How useful was the system for informing decision-making? At speeding up access to data or complementing other data sources? How reliable was the data - how was it validated?) Do you have data/documentation of these outcomes?
2. From a human-centred design perspective, how easy was it for partners and others to understand and use the technology?
3. How easy were partners able to understand and use the information generated? Were dashboards created? And if so, who used them?
4. How easy was it for national partners and front-line workers to use RTM technologies and approaches? What were the major bottlenecks?
5. What immunization monitoring and evaluation needs were met, and which could not be met and why?
6. Was real-time digital technology used for geospatial mapping? If so, how? If not, why?
7. Can you speak to cost efficiency and cost-effectiveness considerations?
8. How was real-time data and information used to support training?
9. How was real-time data and information used to support the cold chain?
10. How was real-time data and information used to monitor coverage gaps?
11. Have partners jointly reviewed implementation experience?
12. How did social media complement RTM solutions and approaches?

©UNICEF/Pakistan country office/2020

Appendix 2: List of persons interviewed

Pakistan case study key informants

- Arshad Chandio, National Programme Manager, Federal EPI
- Raafia Azher, Federal EPI
- Aneeqa Rao, Federal EPI
- Aasim Zaki, Federal EPI
- Wajiha Kanwal, Federal EPI
- Sohail Bin Saeed, Additional Project Director EPI, Government of Sindh
- Akram Sultan, Project Director EPI, Government of Sindh
- Sohail Bin Saeed, Project Director EPI, Government of Sindh
- Akbar Burfat, Data Management Officer, Government of Sindh
- Ashfaq Ahmed, District Health Officer East, Government of Sindh
- Muhammad Shafi Saand, Chief Medical Officer Jamshed Town, Government of Sindh
- Keshwar Jahandad, District Surveillance Officer Jamshed Town, Government of Sindh
- Nasreen Shah Nawaz, Assistant District Officer Jamshed Town, Government of Sindh
- Arslan Memon, EPI Focal Person Jamshed Town, Government of Sindh
- Taj Shaikh, Deworming Officer, Government of Sindh
- Tahira Bano, District Superintendent Vaccinator, Government of Sindh
- Abdul Samand, Town Superintendent Vaccinator, Government of Sindh
- Fazal Raza, Data Support Officer Polio, Government of Sindh
- Irfan Khan, Union Council Communication Officer, Polio, Government of Sindh
- Yasmeen Abdul Latif, Area Supervisor Polio, Government of Sindh
- Saima Abdia, Community Health Worker, Government of Sindh
- Shaheen Saima, Community Health Worker, Government of Sindh
- Abdullah Saqib, former Country Director, Viamo Pakistan
- Osman Anwar, Country Director, Viamo Pakistan
- Sohail Iqbal, Project Manager, Pakistan Electronic Logistics Management Information System
- Mata ur Rahman, Technical Director, PaceTech
- Lubna Hashmat, Community Health Partnership
- Ahsanullah K Bhurgri, Riz Consulting
- Noshad Ali, PHC Global
- Vijay Kumar, Program Manager, Interactive Research and Development Zindagi Mehfooz
- Lala Aftab, Project Manager, Tameer E Khalaq Foundation
- Tariq Masod, Technical Advisor, JSI
- Ahsan Burgri, Technical Officer, Bill and Melinda Gates Foundation
- Shah Nawaz Jiskani, Monitoring and Evaluation Officer, WHO Pakistan
- Omer Qureshi, WHO EPI
- Kelash Babu, Technical Officer, WHO
- Fahat Jabeen, Polio Eradication Officer, WHO
- Asma Waheed, Polio Eradication Officer, WHO

UNICEF staff

- Aida Girma, Pakistan Representative, UNICEF
- Hari Krishna Banskota, Chief of Health, UNICEF
- Ayesha Durrani, Communication for Development Specialist – Health, UNICEF
- Alamgir Mirza, Information and Communication Technology Officer, UNICEF
- Pawan Tuladhar, Information and Communication Technology Specialist, UNICEF
- Ferhet Chaalni, Senior Supply Associate, UNICEF
- Marziyya Malik, Consultant, UNICEF
- Zara Jamil, Innovation Officer, UNICEF
- Germain Mirindi, Information Communication Technology Specialist, UNICEF
- Hanadi Mostafa, Health Specialist, UNICEF
- Ayaz Hussain, UNICEF
- Qurrat ul Ain Ahmed, Immunization officer, UNICEF
- Khalid Nawaz, Immunization Specialist, UNICEF
- M. Jaohar Khan, Health Specialist, UNICEF

- Robert Carr, Chief Planning and Monitoring, UNICEF
- Zeeshan Lateef, Programme Specialist Planning and Monitoring, UNICEF
- Umbreen Ijaz, Programme Budget Officer, UNICEF
- Tahir Manzoor, Health Specialist, UNICEF
- Muhammad Amjad Ansari, Immunization Officer, UNICEF
- Dominic Stolarow, Chief of Field Operations, UNICEF
- Cristina Brugiolo, Chief Field Office Sindh, UNICEF
- Adriana Rietsema, Health Manager, UNICEF
- Suneel Raja, Communication for Development Officer, UNICEF

Indonesia case study

- Mohammad Ruhul Amin, Immunization Specialist, UNICEF
- Patricia Mechael, Health Enabled
- I Made Suwancita, Technology for Development Officer, UNICEF
- Suci Wulandari, UNICEF

Zambia case study

- Monjur Hossain, Chief of Health and HIV, UNICEF
- Belem Matapo, Surveillance Officer, WHO
- Ngawa Nyongani Ngoma, Immunization Officer, UNICEF

Uganda case study

- Andrew Bakainaga – Country Advisor, WHO Uganda
- Eva Kabwongera – Health Specialist, UNICEF

Appendix 3: Resources

Country exam for RTM in immunization campaigns

Democratic Republic of the Congo and Somalia

Fu, C., et al., 'Real-time Coverage Surveys and Monitoring during Emergency Vaccination Campaigns in Insecure Humanitarian Contexts of DRC and Somalia', International Journal of Infectious Diseases, vol. 79, no. 127, 2019.

Haiti

Teng, J. E., et al., 'Using Mobile Health (mHealth) and Geospatial Mapping Technology in a Mass Campaign for Reactive Oral Cholera Vaccination in Rural Haiti', PLoS Neglected Tropical Diseases, vol. 8, no. 7, 2014.

Iraq

Kakakhan, J., et al., 'Use of Real-time Data Transmission Method for Polio Vaccination Campaign Monitoring in Iraq', 2016.

Malawi

Eros, E. and A. Schmeltzer, 'Stop the Spots: Measles vaccination in Malawi', Missing Maps, 10 August 2017, <www.missingmaps.org/blog/2017/08/10/malawi/>, accessed 1 December 2020.

Nepal

Oh, D. H., et al., 'Real-Time Monitoring of Vaccination Campaign Performance Using Mobile Phones—Nepal, 2016', Morbidity and Mortality Weekly Report, vol. 65, no. 39, 2016.

Nigeria

Gammino, V.M., et al., 'Using Geographic Information Systems to Track Polio Vaccination Team Performance: Pilot project report', The Journal of Infectious Diseases, vol. 210 (suppl_1), 2014 pp. S98-S101.

Touray, K., et al., 'Tracking Vaccination Teams during Polio Campaigns in Northern Nigeria by use of Geographic Information System Technology: 2013–2015', The Journal of Infectious Diseases, vol. 213 (suppl_3), 2016, pp. S67-S72.

Usman, S., 'CGPP Nigeria Program: Use of mobile phone technology for improved quality of reporting', Nigeria Secretariat, CGPP (no date).

South Sudan

Haskew, J., et al., 'Use of Mobile Information Technology during Planning, Implementation and Evaluation of a Polio Campaign in South Sudan', PloS one, vol. 10, no. 8, 2015.

Other journal articles used as reference

Bhatti, U. A., et al., 'Recommendation System for Immunization Coverage and Monitoring', Human Vaccines & Immunotherapeutics, vol. 14, no. 1, 2018, pp. 165-171.

Cutts, F. T., et al., 'Monitoring Vaccination Coverage: Defining the role of surveys', Vaccine, vol. 34, no. 35, 2016, pp. 4103-4109.

Kretsinger, K., et al., 'Transitioning Lessons Learned and Assets of the Global Polio Eradication Initiative to Global and Regional Measles and Rubella Elimination', The Journal of Infectious Diseases, vol. 216 (suppl_1), 2017, pp. S308-S315.

McClung, M. W., et al., 'Managing Public Health Data: Mobile applications and mass vaccination campaigns', Journal of the American Medical Informatics Association, vol. 25, no. 4, 2017, pp. 435-439.

Oliver-Williams, C., et al., 'Using Mobile Phones to Improve Vaccination Uptake in 21 Low- and Middle-Income Countries: Systematic review', JMIR mHealth and uHealth, vol. 5, no. 10, 2017, e148.

Smith, W., 'Software and Resources for M&E Professionals', Devex, 2019.

Rosencrans, L. C., et al., 'Mapping for Health in Cameroon: Polio legacy and beyond', The Journal of Infectious Diseases, vol. 216 (suppl_1), 2017, pp. S337-S342.

Teng, J. E., et al., 'Using Mobile Health (mHealth) and Geospatial Mapping Technology in a Mass Campaign for Reactive Oral Cholera Vaccination in Rural Haiti', PLoS Neglected Tropical Diseases, vol. 8, no. 7, 2014.

Tozzi, A. E., et al., 'Can Digital Tools be Used for Improving Immunization Programs?' Frontiers in Public Health, vol. 4, no. 36, 2014.

Resources and guidelines by UNICEF and partner organizations

UNICEF

- 'Lessons Learned Brief: Learning how to mainstream and scale digital monitoring solutions: national real-time monitoring systems strengthening and scale using RapidPro' (2018)
- National Real-Time Monitoring Systems Strengthening and Scale through RapidPro Initiative
- RapidPro Introduction Guidance
- RapidPro User Guide
- RapidPro Online Courses

WHO

- 'A Realist Review of What Works to Improve Data Use for Immunization: Evidence from low- and middle-income countries' (2019)
- 'Guide for Documenting and Sharing "Best Practices" in Health Programmes' (2008)
- 'Lessons from the Big Six–Closing the immunity gap for measles elimination and rubella/CRS control' (2018)
- 'Planning and Implementing High-Quality Supplementary Immunization Activities for Injectable Vaccines: Using an example of measles and rubella vaccines – field guide' (2016).
- 'WHO Guideline: Recommendations on digital interventions for health system strengthening' (2019)

Other partners and agencies

- 'Highlights from the Meeting of the Strategic Advisory Group of Experts on Immunization' (2019)
- Ramalingam, Ben et. al., 'Bridging the Gap: How real-time data can contribute to adaptive management in international development', USAID, June 2017.
- 'Report of the SAGE Working Group on Quality and Use of Immunization and Surveillance Data' (2019)

Country-specific resources

Indonesia

Published papers

- Jusril, et al., 'Assessing the Effects of a Digital Health Intervention on Immunization Coverage during a National Campaign in Indonesia: A large-scale effectiveness evaluation' (Currently in press: include if published on time)
- Jusril, et al., 'Evaluating the Effective Use of RapidPro for the Measles and Rubella Campaign in Indonesia', Reconstra and Health Enabled, 2019.
- Mahendradhata Y., et al., 'The Republic of Indonesia Health System Review', Health Systems in Transition, vol. 7, no.1, Asia Pacific Observatory on Health Systems and Policies, 2017.

Presentations

- Grubb, B., 'UNICEF Support to the Government of Indonesia Measles-Rubella campaign 2017-2019', 2018.
- United Nations Children's Fund, 'RapidPro for Measles and Rubella Campaign Monitoring' (no date).

Blogs and stories

- Accone, Tanya, 'Harnessing Real-Time Data for Indonesia's Largest Immunization Campaign', UNICEF, 2017.
- Accone, Tanya, 'Health Workers Harness Real-time Data to Support Indonesia's Largest Immunization Campaign', UNICEF, 2018.
- Wexler, Raquel et al., 'Digital Monitoring in Support of National eSystems Strengthening: Lessons learned', UNICEF, 2018.
- NOKIA, 'mHealth in Indonesia with UNICEF', NOKIA (no date).
- Rogers, Cory, 'Mobile Health Pilot Boosting Immunization in Urban Java', UNICEF, 2017.

Research registry

- Evaluating the effective use of Rapid-Pro (Real-time SMS Reporting and Feedback Platform for the Measles and Rubella Campaign in Indonesia

Pakistan

Published papers

- Durrani, A., M. Coleman and M. Malik, 'Beyond Messages: Promoting demand for measles SIA' (no date).
- Government of Pakistan Ministry of National Health Services, Regulations and Coordination, 'Health Information Systems 2020-2024: National health information system action plan & provincial roadmaps', 2019.
- Government of Pakistan Ministry of National Health Services, Regulations and Coordination, 'National Vision 2016–2025 for Coordinated Priority Actions to Address Challenges of Reproductive, Maternal, newborn, Child, Adolescent Health and Nutrition', 2019.
- Meer, M., et al., 'Progress Towards Measles Elimination - Pakistan, 2000-2018', Morbidity and Mortality Weekly Report, 2019.
- United Nations Children's Fund Pakistan, Government of Pakistan, Village Reach, 'Immunization Supply Chain Improvement Roadmap for Pakistan', UNICEF, 2018.
- World Health Organization, 'WHO Report on National Measles Campaign Pakistan 15th-27th October', 2018.

Presentations

- 'Integrated EPI MIS (Online Software for all EPI Activities)', 2020.
- 'Leveraging Technological Innovation for RTM in UNIVEC Funded RI Monitoring Projects', 2020.

Internal reports

- 'Effective Design, Implementation, Integration, and Evaluation of Digital Health Systems to Enhance the Strategic use of Data for Immunization Programming' (HealthEnabled inception report for GAVI).
- PaceTech, 2016-2019, Integrated EPI MIS
- 'RapidPro Surveyor Use', 2018.
- RapidPro Surveyor User Manual
- 'RapidPro: Viewing Data Generated by Flows during Measles SIA', 2018.
- 'Report on UiO Mission to Punjab May 28-29', 2018.
- 'Report on UiO Mission to Sindh May 30', 2019.
- Typhoid Conjugate Vaccine Catch-up Campaign, Pakistan 2019 Observer's Checklist
- Typhoid Conjugate Vaccine Catch-up Campaign, Pakistan 2019 Rapid Convenience Assessment

Zambia

Published papers

- Ferreras, E., et al., 'Delayed Second Dose of Oral Cholera Vaccine Administered Before High-Risk Period for Cholera Transmission: Cholera control strategy in Lusaka, 2016'. PloS one, vol. 14, no. 8, 2019.
- Ferreras, E., et al., 'Single-dose Cholera Vaccine in Response to an Outbreak in Zambia', New England Journal of Medicine, vol. 378, no. 6, 2018, pp. 577-579.
- Lamanna, C. and L. Byrne, 'A Pilot Study of a Novel, Incentivised mHealth Technology to Monitor the Vaccine Supply Chain in Rural Zambia', The Pan African Medical Journal, vol. 33, 2019.

Training/how-to guides

- Microplan ODK training slides
- mVaccination District Training slides
- mVaccination Job Aid for Health Facilities, 2017.
- mVaccination Job Aid for Volunteers
- RapidPro administrator guide, 2017.
- Power BI Dashboard Training, 2020.
- Zambia Polio Outbreak Response Situation Report, Bulletin no. 24, 2020.

Strategy document

- Republic of Zambia Ministry of Health, Zambia eHealth Strategy 2017-2021.

Uganda

Report

- Health Information Systems Program – Uganda, 'Real-time Data for Action during the Mass Measles-Rubella and Polio Campaign Uganda', DHIS2 Community, 2019.
- Health Information Systems Program – Uganda, Setup of Measles-Rubella Campaign Command Centre, 2019.
- Republic of Uganda Ministry of Health, 'Uganda National eHealth Strategy 2017–2021', 2016.

Press release

- World Health Organization, 'Statement from Uganda's Minister of Health on the National Measles-Rubella and Polio Immunisation Campaign', 2019.