Mobile-based Effective Vaccine Management Tool: An m-health Initiative Implemented by UNICEF in Bihar

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Abstract

Background: UNICEF launched the mobile-based Effective Vaccine Management (EVM) system in Bihar in 2014 along with the state government to electronically capture information and identify gaps in the existing vaccine management system for appropriate action. **Objective:** This study accessed the implementation process of this initiative. **Methods:** Quantitative data related to vaccine supply chain management indicators were collected in November–December 2015 using factsheets and dashboards, representing the situation of the vaccine supply and cold chain management system at regular intervals since the launch. In-depth interviews were conducted with the program specialists to understand the initiative's genesis, its challenges and strengths. **Results:** This initiative resulted in an increased cold chain space from 49% (July 2014) to 87% (September 2015), deployment of sufficient human resource; 38 cold chain technicians for regular maintenance of the machines and equipment, installation of necessary equipment, and upgradation of state and regional vaccine stores. In health facilities, district vaccine stores, and regional vaccine stores, marked improvements were observed in the overall EVM criteria indicators (82%, 84%, and 80% in September 2015, respectively, as against 51%, 46%, and 43% in July 2014, respectively) as well as EVM category indicators (83%, 84%, and 76% in September 2015, respectively, as compared to 54%, 53%, and 54% in July 2014, respectively). **Conclusion:** The EVM mobile initiative was successfully implemented and it complies with its objective of providing experienced guidance to the human resource responsible for vaccine cold chain management. The initiative is scalable and its sustainability depends on its thoughtful merger with the existing immunization ecosystem.

Keywords: Immunization, m-health, vaccine management

Introduction

Immunization is one of the most cost-effective public health interventions and provides direct and effective protection against morbidity and mortality. With around 1.5 million children dying every year owing to vaccine-preventable diseases (VPD),[1] the developing countries display an in-commensurate picture of these child mortality rates.[2,3] India has a target of achieving 90% immunization coverage by 2020. Though the under-five mortality rate has declined from ~233 to ~63 (per 1000 live births) in the past five decades,[4] VPDs are still responsible for over 5 lakh deaths annually.[5] Despite the noticeable efforts and momentum achieved with the implementation of the Universal Immunization Programme 30 years back, India still grapples with a higher prevalence of VPDs than other countries. The

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reasons for this are factors that restrict accelerated and improved routine immunization coverage across the country, such as inequities due to poverty, gender, religion, caste, education status, geography, etc. Defaulter tracking, existence of wide gaps between various survey data, weak VPD surveillance system, poor community awareness, apprehension about adverse events following immunization, poor monitoring mechanisms, improper supply chain, and vaccine management system are impediments.[5-7]

Further, to minimize vaccine wastage, intensify the monitoring process, ensure vaccine availability to the last mile, and optimize the vaccine delivery costs, it is absolutely critical to revisit and mend the lacunae within the existing vaccine supply chain management (including cold chain management) and logistics system. In Bihar, the limited cold chain space was burdening the vaccine stores at various levels. Logistic issues prevailed, leading to repeated breakdowns of the cold chain system, posing a threat to the vaccines' potency and safety. An urgent need was felt by the State Task Force to increase the available cold chain space across the stores in the state. The National Cold Chain Management Information System (NCCMIS)[8] was defunct in Bihar; at that time, baseline data of the volume of cold chain space, storage capacity, distribution of equipment, etc., were unavailable. Thus, to conduct situational analysis and causality assessment for evidence generation, UNICEF, Bihar, introduced and implemented a mobile health innovation, the Effective Vaccine Management (EVM) tool, to electronically capture the condition of the present vaccine cold chain management system. This is a process for measuring efficiency of the vaccine supply chain system against the button-down practice of using paper forms for assessment, and has been introduced in Assam and Uttar Pradesh as well.[9]

The objective of this article is to assess the implementation process of this m-health initiative to improve vaccine supply chain management implemented by UNICEF in Bihar and the resultant changes.

Materials and Methods

A two-pronged methodology was used to collect data for this study between November and December 2015. To assess the effectiveness of the EVM tool, quantitative data were collected from the EVM website. There are factsheets and dashboards available for the state, regional, and district levels, with indicators having been measured at different time periods since the launch of the initiative. This includes data on vital indicators related to vaccine supply and cold chain management, i.e., vaccine arrivals, temperature control, storage capacity, infrastructure, maintenance, stock management, distribution, vaccine management, and information system. The change in the management system since the launch of the m-health initiative was assessed by comparing the indicators for different time periods.

In addition, in-depth interviews were conducted with the program specialists. These were conducted with consent, to understand the genesis of the initiative, including the development of the tool, the processes involved in the implementation of the tool, challenges faced, and recommendations thereof. A topic guide was used to frame the questions and field notes were taken during the interviews. These were used subsequently during data analyses.

The quantitative and qualitative data were later triangulated to understand the process of implementation of the tool as well as the outcome resulting from its implementation.

The INAP project, of which this study was a part, was approved by the Institutional Ethics Committee of Indian Institute of Public Health-Delhi at the outset. The interviews did not include any beneficiary or vulnerable person. Written consent was obtained prior to each interview. To protect the anonymity of the participants, no information related to the identity of the participants has been presented in the article.

Results

The in-depth interviews provided valuable information regarding the mobile-based EVM (mEVM) initiative. The initiative was launched by UNICEF India in partnership with the Government of Bihar. The aim was to technically capture the information electronically, embedded within an Android mobile phone and to periodically assess the relevant indicators to check the workflow and identify technical gaps in the existing vaccine supply chain management system for appropriate action. The first phase was initiated in July 2014 and overlaid state wide across Bihar. Mobile Android phones were bought for the purpose of EVM,

covering health facilities, district, regional, and state vaccine stores. The mobiles were utilized by teams, each consisting of three people: District Immunization Officer, faculty or postgraduate student from the nearby medical college, and a cold chain technician. The following flowchart summarizes the process of data capture, analysis, and information generation through the EVM platform [Figure 1].

A free open source software having far reaching scope, owing to no-licensing cost, was utilized to build the electronic platform. The Google Open Data Toolkit (ODK) allowed form buildups for real-time capture of quantitative data, depicting the state of the existing vaccine management system at state level. It also provided a system for generating the geographical location of the facility and an opportunity to take photographs as well. The data were collected on electronic forms by trained teams. The questionnaire was developed in XML files, which were easily downloaded on Android phones. The XML files were coded for logic, validation, and skip pattern.

These forms were then submitted to the central server through mobile internet or Wi-Fi connection. While collecting data, on-the-spot advice was also provided by the medical college faculties on the importance of following best practices. The data were then cleaned and collated appropriately and presented in the form of dashboards and factsheets utilizing the UN-endorsed DevInfo Technology that measures and shows critical indicators relating to vaccine supply chain and cold chain management. The key features of the mEVM tool are summarized in Box 1.
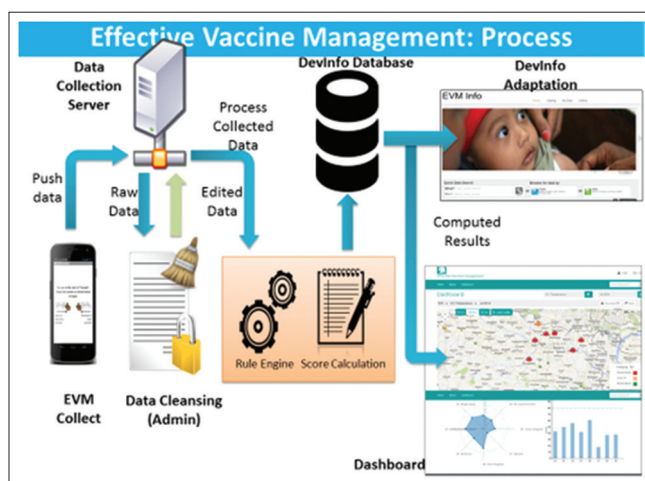

Figure 1: Effective Vaccine Management process flowchart

Effect of mobile Effective Vaccine Management implementation

Postimplementation of this initiative, there has been a noticeable improvement in the structure of the vaccine cold chain management system across the state of Bihar. According to the NCCMIS,[8] which is an independent web-based monitoring system developed by the Ministry of Health and Family Welfare in partnership with UNICEF, the cold chain space has increased largely from 49% in July 2014 to 87% in September 2015. Further, 38 cold chain technicians have been recruited for regular maintenance of the machines and equipment. Two walk-in-coolers have been successfully installed in Patna and one in Darbhanga with the technical and financial assistance of UNICEF, Bihar. In addition, state vaccine distribution centers were upgraded and two regional vaccine stores – Nalanda and Saharsa – were made functional.

It was observed that overall, 82% of health facilities, 84% of district vaccine stores, and 80% of regional vaccine stores met the criteria for vaccine supply chain management in September 2015, as compared to 51%, 46%, and 43%, respectively, in July 2014, indicative of proportionate improvement.

Similarly, improvements were observed for different categories of EVM at the health facilities, district vaccine stores, and regional vaccine stores, and these were reported to be 83%, 84%, and 76% in September 2015, respectively, as compared to 54%, 53%, and 54% in July 2014, respectively.[10] Tables 1 and 2 show the criteria and category-wise data at two different time periods after the implementation of the initiative.[10] Indicators related to criteria pertain to the technical components of the vaccine management system while those of the category relate to the administrative and logistics components.

For each criterion and category, there are three color-coded grades on the website – score of 80% and above denotes good performance (green), score between 61% and 79% denotes average performance (orange), while a score

Box 1: Key features of mobile-based Effective Vaccine Management

Data collect: Android-based system for data collection
Data collate: Compile data from all facilities and compute the scores using online-ruled engine
Data visualize: Share through GIS dashboard, DevInfo (online/offline), factsheets, and data tree

of 60% and below denotes poor performance (red). Table 1 indicates that the health facilities, district vaccine stores, and the regional vaccine stores have shown substantial improvement in almost all the criteria, with the scores being either 80% and above, or just below 80% between July 2014 and September 2015. There has been an astounding improvement in use of the information system at all levels and distribution of vaccines and stock at the higher levels, which were missing before the implementation of the initiative. However, distribution of vaccines and other logistics at the health facilities and maintenance at the regional vaccine stores still continue to remain a concern, 15 months after the launch of this initiative. In addition, there is no data available on the vaccine arrival, which may be due to the unlinked supply chain system.

Similarly, definitive improvements were reported for almost all the categories [Table 2] between July 2014 and September 2015 for the health facilities, district vaccine stores, and the regional vaccine stores. While the overall performance was better at the health facilities and the district vaccine stores, categories of equipment and repair/maintenance reported poor performance at the regional vaccine stores on the basis of their scores. There was no data available for the category of vehicle at the health facilities.

The overall score for the state vaccine store was 36% for the criteria indicators and 43% for the category indicators in July 2014. However, scores for the subsequent periods were not available.

After the successful first phase of implementation, this initiative was scaled up in September–November 2015 to cover all the Primary Health Centers of Gaya and Purnia districts of Bihar, however their observations were not available for comparison.

Strengths
The program specialists highlighted the strengths of the tool. The use of this system aims to facilitate the

Table 1: Changes in the performance of criteria-wise Effective Vaccine Management dashboard indicators* (technical indicators) (2014–2015)

Criteria/indicator	Health facilities (*n*=172)		District vaccine stores (*n*=38)		Regional vaccine stores (*n*=7)	
	July 2014 (%)	September 2015 (%)	July 2014 (%)	September 2015 (%)	July 2014 (%)	September 2015 (%)
Vaccine arrival	Nil	Nil	Nil	Nil	Nil	Nil
Temperature control	59	79	61	77	43	80
Storage capacity	49	87	47	75	50	86
Buildings, equipment, transport	65	86	57	89	56	63
Maintenance	32	75	40	74	42	51
Stock management	52	85	51	85	61	97
Distribution	34	65	19	93	18	91
Vaccine management	66	94	44	89	37	92
Information system	Nil	88	48	91	38	78
Overall score	51	82	46	84	43	80

*The percentages in the tables denote the proportion of health facilities, district vaccine stores, and regional vaccine stores complying to the particular technical indicator in July 2014 and September 2015. 80% and above – good performance, 61%-79% – average performance, and 60% and below – poor performance

Table 2: Changes in the performance of category-wise Effective Vaccine Management dashboard indicators* (administrative and logistic indicators) (2014–2015)

Category	Health facilities (*n*=172)		District vaccine stores (*n*=38)		Regional vaccine stores (*n*=7)	
	July 2014 (%)	September 2015 (%)	July 2014 (%)	September 2015 (%)	July 2014 (%)	September 2015 (%)
Buildings	66	71	60	96	59	92
Capacity	59	83	56	70	56	83
Equipment	64	88	57	90	55	51
Management	48	82	39	82	35	89
Repair/ maintenance	32	74	40	74	42	51
Training	69	98	68	100	73	94
Vehicle	–	–	53	75	52	75
Overall score	54	83	53	84	54	76

*The percentages in the tables denote the proportion of health facilities, district vaccine stores, and regional vaccine stores complying to the particular administrative indicator in July 2014 and September 2015. 80% and above – good performance, 61%–79% – average performance, and 60% and below – poor performance

capture of real-time feedback from the field to produce realistic current data, as opposed to the conventional manual paper-based style of assessment, and provides information at a later time. These data can be used for real-time action for improving their supply chain performance. It is a user friendly model, the Google ODK makes handling of the electronic forms much easier. The software is cost-effective and can be utilized multiple times once bought. It is easy to download with an easy-to-use interface. Data can be entered and uploaded quickly into the software. Tracking becomes easier because the software includes applications for capturing images and generating the geographical location of the vaccine stores and facilities.

It also allows the data entered into the forms to be cleaned appropriately after reaching the central server through an internet or Wi-Fi upload. The data were analyzed systematically and displayed effectively through the UN DevInfo Technology in the form of factsheets and dashboards, using simple graphical and tabular illustrations which are easy to interpret and draw valid inferences.

The mEVM initiative is an initiative implemented by UNICEF along with the Government of Bihar and provides a clear advantage and superiority over the erstwhile paper-based assessment. It addresses a context with high visibility on the health policy agenda. The initiative has been efficacious in reducing the amount of time and the cost required for data collection and dissemination. Though there has been no external evaluation, the results are clearly palpable through the online server containing the current information on the identified global indicators of vaccine cold chain management. Monthly monitoring by the UNICEF consultants and the on-the-spot encouragement and recommendations given by the field investigators are valuable exercises that have driven the initiative into being a success.

Challenges

Despite the strengths of the initiative, few challenges were highlighted during the in-depth interviews. Although the mEVM has been steady in achieving its objectives, it still needs improvement and a long-term plan to build platform maturity. It needs to be linked with the immunization and supply chain structures so as to shape a possibility for advice on maintenance, disposal of useless and procurement of new equipment,

and identify gaps in supply chain and link the cold chain status with human resource as well as with outcome indicators such as full immunization coverage. Erratic power supply and limited internet connectivity are also major challenges. There was an initial apprehension about the data being uploaded onto an online server that might have technical difficulties or get corrupted and lead to subsequent loss of data. However, after launching the initiative, the results were able to dissuade the inhibitions of the stakeholders.

Discussion

This mobile health initiative launched for improving vaccine management system is an innovation that focuses on strengthening the vaccine cold chain and logistics system by capturing real-time data and conducting bottleneck analyses for appropriate and timely action. Since the implementation of the initiative, the overall situation of vaccine management in health facilities, district vaccine stores, and regional vaccine stores has improved. Supportive supervision by medical college faculties and their on-the-spot advice has led to improvement in the accepted global vaccine management indicators.

The use of the m-health technology in this initiative has proved to be beneficial for the health-care providers as well as for planners and policymakers.[11] This technology is being used not only for capturing coverage of a wide range of health services including immunization, but also for obtaining and sharing information related to availability of health services, health planning, management and monitoring, resource mapping, data capture, drugs and treatment options, maternal and child health issues, etc.[12] Mobile health technologies have also been implemented in other countries for increasing vaccine availability, safeguarding vaccine potency, and for improving supply chain efficiency. Similar models have been introduced in Mozambique and South Sudan utilizing mobile phones for improving vaccine management.[13,14] All these initiatives follow the principles of m-health and have been useful in advancing the quality of health services.

It facilitates revamping and upgradation of the overall situation of the vaccine cold chain management system. The current mEVM initiative neglects the supply chain ecosystem. It is critical to identify gaps in the supply chain system and sufficiently act upon them, while

linking the same with the EVM tool at the earliest, without which a holistic approach stands missing. If this tool incorporates all the components of the supply chain network, by reducing information asymmetry between supply and demand, the overall system can "self-organize" in a manner that stocks are appropriately re-distributed, thereby improving availability at the point of care.

At a time when India is relying heavily on Mission Indradhanush,[15] this m-health initiative can complement the efforts of the program by improving the vaccines' logistics management information system across the country. This will allow assembling of information on the cold chain infrastructure to identify gaps and provide a database for advice on maintenance, procurement of additional equipment, and disposal of defunct equipment for smooth functioning of the program. Introduction of newer vaccines into the immunization program would also affect the available cold chain space; the tool should incorporate the need for expansion of the logistics system with appropriately calculated projections. The cold chain and logistics inventories should be sufficiently linked with equipment projections, thus identifying district and regional stores' priorities with the greatest need for new equipment. The cold chain technicians recruited should be provided adequate training to enable them to use the tool and the equipment judiciously. The vaccine logistics management system and the Health Management Information System should be used to facilitate linkages between cold chain availability and actual supply to identify supply chain issues. The website may further be improved to allow inventory data from the stores across the state to facilitate decision-making regarding vaccine stock management. A strong focus on the management and distribution of vaccines is still required across the state of Bihar to safeguard vaccine potency, increase availability, and improve supply chain efficiency by reducing staff time and costs for logistics.

Conclusions

This initiative is a scalable model which should be adopted by other states in India. The sustainability of the initiative depends on how quickly and efficiently the existing tool can be integrated and upgraded with other immunization components. In addition, the financial and technical assistance that would be available for sustaining the initiative post-UNICEF support needs to be considered, without which the innovation might stand incomplete.

Conflicts of interest
There are no conflicts of interest.

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