Investigating the Use of Digital Solutions in the COVID-19 Pandemic

An Exploratory Case Study of eIR and eLMIS in India

CERGAS, Center for Research on Health and Social Care Management, SDA Bocconi School of Management, Bocconi University, Via Sarfatti 25, 20136 Milano (MI), Italy

MMGH Consulting GmbH, Kuerbergstrasse 1, 8049 Zurich, Switzerland

*Correspondence: viviana.mangiaterra@sdabocconi.it

This case study is part of a comprehensive evaluation of electronic Immunization Registries (eIR) and electronic Logistics Management Information Systems (eLMIS) in Guinea, Honduras, India, Rwanda, and Tanzania commissioned by the Bill & Melinda Gates Foundation (BMGF), with the support of Gavi, the Vaccine Alliance (Gavi) and the World Health Organization (WHO).

Abstract

Drawing upon primary and secondary sources, this case study showcases the quick adaptation of India's existing eLMIS (eVIN) to accommodate the COVID-19 vaccine roll-out needs, as well as the development of an electronic registration system (CoWIN) to effectively register priority groups, schedule appointments, generate vaccination certificates, and monitor adverse events following immunization (AEFI). While it is premature to draw firm conclusions, the findings in this case study demonstrate that context-specific digital solutions can be flexibly leveraged to support COVID-19 vaccination and maintain routine immunization during a pandemic, provided that investments backed by strong political commitment are made in digital infrastructure and in training the health workforce to overcome equity gaps through the use of the systems.

Background

India was severely hit by the COVID-19 pandemic, with the second wave starting in March 2021 causing record numbers of new infections and deaths, peaking at a rate of approximately 400,000 cases and 4,000 deaths, respectively, every day during May 2021 (WHO, 2021). According to experts, this high COVID-19 toll was attributable to the timing of easing restrictions from the first wave, localized waves in epicenters, such as the cities of Delhi and Maharashtra, mass gatherings for political rallies and religious celebrations, as well as public claims that the pandemic had been beaten (Thiagarajan, 2021a), coupled with the emergence of the delta variant of SARS CoV-2 that was more transmissible than the ancestral virus. The delta variant has since become the predominant variant circulating. The second wave hit India during the initial COVID-19 vaccine roll-out and lead to straining of healthcare resources allocated for the management and treatment of infections as well as for vaccination, resulting in medical supply shortages and slow vaccination rates (Pandey et al., 2021).

With its longstanding experience in running the Universal Immunization Programme (UIP), which targets 26.7 million newborns and 29 million pregnant women every year, India conducts the world's largest routine vaccination programme. Given the size of the target population, the COVID-19 vaccination effort was also one of the largest in the world. Starting on 16 January 2021, 6 million people were vaccinated in the first 24 days with the Covishield™ (AstraZeneca) vaccine (Bagcchi, 2021). In the vaccination response against COVID-19, the responsibility for the delivery of vaccination has been delegated to the respective state governments. The first vaccination phase aimed to reach 300 million beneficiaries by August 2021, starting with healthcare and other frontline workers. It was initially slower than expected, with the country facing vaccine shortages (Pandey et al., 2021). India has since achieved delivery of more than one billion doses as of October 2021 ramping-up vaccinations in more than 61,000 centers, both public and private (BBC, 2021).

Description of digital solutions

Predating the pandemic, India had been using the electronic Vaccine Intelligence Network (eVIN) since 2015, an eLMIS, using a licensed software deployed under overall leadership of the government and with the financial and technical support of Gavi, the Vaccine Alliance and the United Nations Development Programme (UNDP). eVIN was migrated to a locally developed open-source platform in 2020. The system has been scaled nationally in all public health facilities and oversees the logistics of India's Ministry of Health and Family Welfare's (MOHFW) UIP and is now fully managed and funded by the government (Pant, 2021). As a mobile application, it allows for the digitized management of vaccine inventories by cold chain handlers directly from their smartphones, providing real-time information on vaccine stocks and flows, and monitors the storage temperature in those cold chain points where it is implemented. eVIN was leveraged when introducing the COVID-19 vaccines, a decision driven by the system's scale and demonstrated ef-

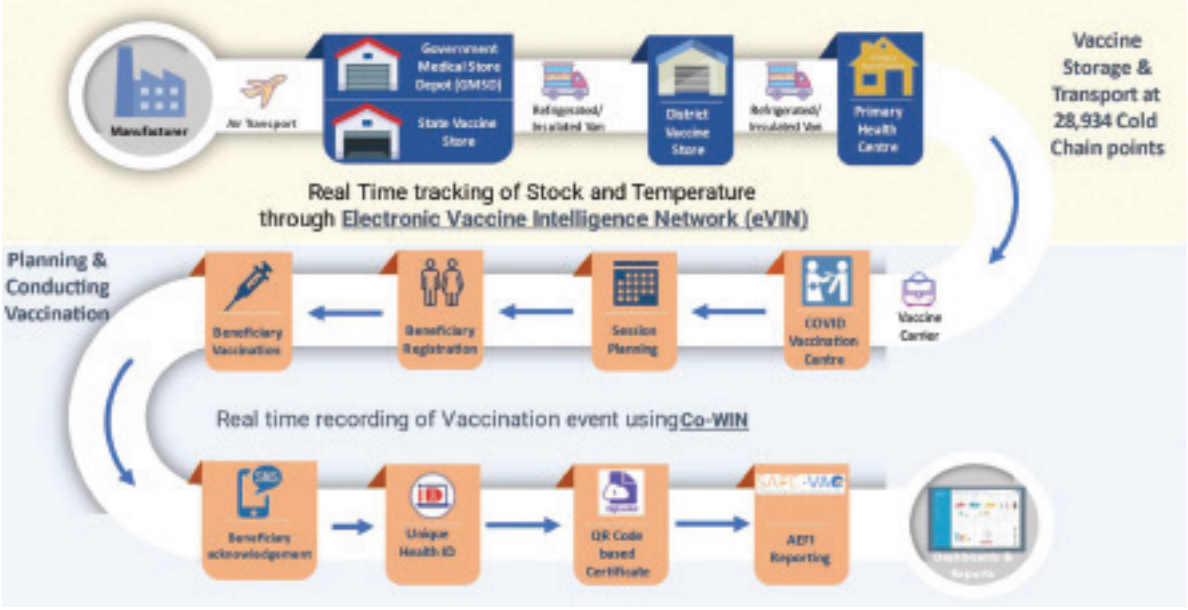

Figure 1: COVID-19 vaccine delivery management system (Pant, 2021)

fectiveness, with eVIN being operational in all of India's 29,500+ cold chain points today. It ensures >99% availability of routine immunization vaccines compared to <85% before its implementation and has lowered stock-out frequency by 80% (UNDP, n.d.). Notably, eVIN did not have to go through an adaptation process to accommodate the management of the COVID-19 vaccines (Pant, 2021).

On the other hand, India had to develop *de novo* the COVID-19 Vaccine Intelligence Network (CoWIN) to complement the eVIN. CoWIN is a cloud-based digitized platform launched in January 2021 as an open-architecture software (Pant, 2021). It facilitates beneficiary registration, scheduling appointments, and session planning. The complementarity of the two systems is depicted below in Figure 1. The primary aim of CoWIN is to enable registration of all beneficiaries while ensuring full transparency in vaccination administration (Court, 2021). In July 2021, the system was made available as open-source to allow for its adoption as a global "digital public good" (Ang, 2021).

CoWIN has several key features besides vaccination appointment scheduling, and registration of vaccination events such as enabling reminders, AEFI reporting, monitoring and analytics and digital certificate generation (Ang, 2021). The latter is a functionality provided by the software Digital Infrastructure for Verifiable Open Credentialing (DIVOC) which has been integrated into CoWIN (DIVOC, 2021). This platform was designed to enable the tracking of over a billion individuals and, to date, is operating across all states in India in over 327,000 public and private vaccination centers. Individuals can register online on the CoWIN website or via the mobile application with their national identification number to select a location and schedule a vaccination appointment. Alternatively, individuals can physically visit one of the vaccination centers where a health worker will assist them with the registration.

India and its development partners have invested significantly in these digital solutions. The roll-out of eVIN platform, including its transition over 6 years from the licensed software to an open-sourced one, cost approximately US$ 65m over a period of 6 years. Of the total cost, the largest component was accounted for by human resources followed by procurement of hardware such as mobile phones and temperature loggers, trainings and communication, with 5.5% accounted for by software development (Pant, 2021). India has received financial assistance for the COVID-19 response and vaccine roll-out, namely from UNDP with US$ 4.6m, UNICEF with US$ 6.6m, and the WHO with US$ 10m (Court, 2021). In addition, Gavi provided a technical assistance grant of US$ 4.6m for CoWIN to support additional functionalities and infrastructure that needed to be embedded in the eVIN system (Court, 2021). The design and implementation process of CoWIN lasted 12 months and incurred US$ 10m in costs for software development, hosting infrastructure (i.e., cloud-based servers) and backend support/helpdesk for citizens. Due to the nature of the services provided, as the client database grew, the hosting infrastructure requirements also grew, primarily due to the storage of data in the cloud driving up costs (Pant, 2021). The assessment of operational costs for related human resources, including trainings and other activities in the field will be part of a forthcoming more comprehensive evaluation of eVIN.

Overall, these digital solutions are providing real-time visibility into vaccine uptake. However, the data required to make informed decisions about vaccine distribution and administration locations are only now yielding insights that can improve programme planning. For example, early

data from CoWIN suggests that most vaccinations were taking place in urban areas and about half of them are walk-ins. This may have resulted in crowding in the COVID-19 vaccination centers with the unintended consequence of potentially rendering some mass campaigns to become super-spreader events (Subramanian, 2021). Current data from CoWIN indicates that most vaccination centers (73%) are in rural areas and that the majority of registrations are through walk-ins (Pant, 2021).

Routine immunization delivery

Against this backdrop, routine immunization services in India have reportedly decreased with at least 100,000 children missing their BCG vaccination and 200,000 children missing one or more Pentavalent vaccine doses. It is estimated that 49,000 additional child deaths and 2,300 additional maternal deaths could have been attributed to the disruption of healthcare services, projecting an overall increase in child mortality of 40% over the next year (Shet et al., 2021). While India currently accounts for 11% of the unvaccinated and under-vaccinated children globally (WUENIC, 2020), it is estimated that 27 million children will miss their doses of pentavalent vaccines during the pandemic (Shet et al., 2021). In order to address this, the Government of India is encouraging State governments to identify the children who missed essential vaccinations and plan catch-up campaigns under the UIP (MOHFW, 2020). While the UIP's integration of the CoWIN platform for routine vaccination is still pending, the latter's repurposing is planned to allow for identification of beneficiaries and for keeping an electronic track record of all vaccines provided under the programme (Madaan, 2021).

Emerging learning and opportunities

The use of the inter-linked CoWIN and eVIN systems for COVID-19 vaccination has increased visibility, accountability, and transparency, facilitated access to vaccination and enabled planning of service delivery. Based upon the observations of key stakeholders, the importance of a digitally trained health workforce that can quickly adapt to new requirements clearly emerged as a key prerequisite for such a platform's success (Pant, 2021). Similarly, the CoWIN story demonstrates the importance of ensuring the end user is also able to effectively manage the technology. The CoWIN app enabled beneficiaries to register online and receive an appointment that provided instructions on when and where to report for vaccination, receive reminders and appointments for the follow-up doses, and download digital vaccination certificates that enabled travel. The linkage with eVIN ensured vaccine availability at the respective vaccination sites.

Despite such successes, India's effort to digitalize its COVID-19 vaccine delivery has been met with some criticism and underscores important lessons to be learned around equitable access, as documented by Mukherji (2021), Sharma (2021), and Gupta et al. (2021). Digital literacy and language barriers surfaced as factors challenging the use of CoWIN initially, however, emphasis placed on training the health workforce ensures the proper use of the system including registering walk-ins.

Going forward, both CoWIN and eVIN are envisioned to be fully integrated into the UIP, thus providing for the functionalities of an eIR/eLMIS with end-to-end visibility of stocks, last-mile delivery, and beneficiary tracking, which is seen as favorable for ensuring the most vulnerable are reached. In particular, CoWIN is planned to be adapted for use as an eIR for routine immunizations, providing easy integration with other systems, including vaccine safety surveillance, given its open platform structure. The use of the integrated systems in routine immunization is intended to reduce the number of zero-dose and partially immunized children and improve immunization coverage through pre-registration of all eligible infants. The MoHFW's plan is to provide the adapted CoWIN as the interface for recording immunization sessions' data at all immunization delivery sites. A flexible database architecture is envisaged to allow the session site data to flow into eVIN from CoWIN, enabling programme managers to have access to data on immunization coverage, vaccine consumption, and wastage in real time, as well as track key performance indicators.

Conclusion

While not a panacea, digital health applications can be essential tools and enablers for immunization systems. This exploratory case study on India demonstrates that digital systems such as eVIN and CoWIN can be successfully leveraged to deliver impact at scale given their **simple and flexible design tailored to context-specific needs**. As a widely used system for routine immunization, eVIN demonstrated its flexibility in accommodating the additional vaccine supply needs as part of the pandemic response. In addition, CoWIN demonstrated how new digital technologies can be appropriately designed and implemented rapidly at scale to serve the emerging needs of an emergency immunization delivery program, as well as the information management needs of a country as large as India. Together both systems have ensured that demand at a specific vaccination site is met with the appropriate supply.

The example of India also demonstrates how **investments in human resources and digital infrastructure** are preconditions for success. Information obtained from the literature and from key-informants has consistently highlighted the importance of sufficient and adequately trained staff for the management of the systems, as well as their diffusion into the community to ensure that end users have the digital knowledge to take advantage of the technology. This is critical to the equity agenda.

Finally, previous strategic investments and **local ownership** of eVIN contributed to an enabling environment that ensured a robust vaccine supply chain during the pandemic and facilitated the development of the CoWIN system *de novo*. This demonstrates how **political commitment and a clear vision** are necessary to support the rapid and agile development and deployment of digital solutions, as

well as their sustained use. India's vision to integrate and streamline the digital solutions for both COVID-19 vaccine delivery and routine immunization was driven by the aim of maximizing system efficiency and effectiveness.

The learnings captured in this case study, while nascent, have the potential to make an important contribution to the larger dialogue on digital health. Investments in this area can positively affect the outcome of health programs and should favor a strategic and coordinated approach to thinking about critical issues around scalability, interoperability, and sustainability of the electronic systems, as evidenced by the experience in India to date.

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