

Bangladesh's digital health journey: reflections on a decade of quiet revolution

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Abstract

Bangladesh has made remarkable progress in digital health in recent years. Through one of the world's largest deployments to date of the open-source District Health Information Software 2 (DHIS2), the country now has a national public sector health data warehouse. Information from previously fragmented data systems is now unified in a common data repository, enabling data exchange for health information systems and decision-making. Work is ongoing to create lifetime electronic health records for all citizens that can be transferred between health facilities. Extensive customization of open-source software has laid the foundations for a national digital networking system. Initiatives have focused on producing digital solutions to aid priorities such as strengthening the health system as a whole as well as supporting specific technical interventions, for example improving the civil registration and vital statistics system. Digital solutions have also supported the Bangladesh health workforce strategy through a set of registries that electronically captures and maintains human resource information for the entire public health sector, including monitoring staff attendance through the use of low-cost biometric fingerprint time-attendance machines. Citizens are encouraged to engage in shaping health services via a web-based complaints and suggestions system, and a new system to raise health awareness via public digital displays has started in Dhaka. Strong support at the highest political level has been critical to the success of efforts to introduce these innovations. The endeavour has also generated a cadre of enthusiastic eHealth proponents, who are focused on further strengthening and expanding the existing systems and on harnessing the vast amount of information amassed at the central data repository through big data analysis, artificial intelligence and machine learning.

Keywords: Bangladesh, digital health, eHealth, DHIS2, electronic health records, health information system

Background

It is nearly 22:30 when Rahim Mia returns home from his small grocery shop in the village market. He finds his home abnormally quiet and becomes worried: his 5-year-old only daughter has had a low-grade fever since yesterday. In the small tin-shade house, he finds his wife anxiously sitting beside her daughter, crying and trying to cool the girl's head with a wet cloth to reduce her temperature. "Her temperature has been going up this evening and she is not taking anything," his wife explains. "Where can I find a doctor now in the middle of the night?" Rahim Mia exclaims, now extremely concerned about his daughter.

After a short silence, his elder son says, "Papa, I have seen on television that by calling the number 16263, anyone can get a doctor any time to discuss health problems. You should call them." Rahim Mia immediately dials 16263. Someone

answers, "I am Dr Salma. How can I help you?" After talking for a few minutes with Rahim Mia, the doctor advises him to buy and use a paracetamol suppository to reduce the girl's temperature, and to give her more fluid to drink. The doctor continues, "It would be wise to take her to the nearest upazila health complex tomorrow morning. I am sending the prescription by SMS. Please show the SMS to a medicine shop to get the paracetamol suppository."

This story illustrates the impact that one of the innovations of Bangladesh's digital health revolution is having on access to health care. Launched in 2015, the Shastho Batayon 16263 platform uses advanced interactive voice response digital technology as part of a one-stop integrated national health call centre. The internal mechanism works using advanced information technology integrated with automatic voice recognition, human interfacing, big data solutions and e-prescriptions issued by qualified doctors sent to a patient's

mobile phone to minimize communications errors. Anyone anywhere in the country can call the number any time 24 hours a day, 7 days a week to receive free instant advice and services. The platform fulfils several functions, including: (i) providing a doctor's advice and a prescription; (ii) reserving ambulances for callers; (iii) providing health information; (iv) receiving and resolving complaints about any public or private health-care provider; and (v) coordinating a response in the event of an emergency health situation. There are also other eHealth services such as telemedicine, bulk SMS for disseminating health awareness information, and a text-based grievance redress system mediated by mobile phone.

As a lower-middle-income country, Bangladesh made remarkable progress in public health during the Millennium Development Goal era, particularly in significantly reducing the infant and under-5 mortality rates and the maternal-mortality ratio; improving immunization coverage; and reducing the incidence of communicable diseases.¹ Through the fourth *Health, population and nutrition sector program (HPNSP) 2017–2022*,² the country is now building on these achievements to improve equity, quality and efficiency, with a view to moving towards universal health coverage and achieving Sustainable Development Goal (SDG) 3.³ The HPNSP, in turn, is guided by Bangladesh's overarching *Vision 2021*, which aims to transform the country from a lower-middle-income economy to having crossed the threshold and become a middle-income nation by 2021.⁴ A key strategy and policy focus of *Vision 2021* is exploiting information and communications technology (ICT) to the full to help steer the country's development. As a result of this strong political and policy focus, significant work has been done to introduce digital solutions to challenges facing the health sector. This has been led by the Management Information System unit in the Directorate General of Health Services (MIS-DGHS), which is the digital health hub of the Government of Bangladesh. MIS-DGHS has fostered a supportive environment for digital innovation, and progress has been rapid. This perspective paper briefly summarizes progress to date.

Enabling an integrated health information system

The year 2009 saw the start of “a quiet revolution” to harmonize the complex array of health information systems (HISs) underpinning the overall management of Bangladesh's health sector. At that time, reflecting the country's pluralistic health service delivery arrangements, Bangladesh's HISs were highly fragmented. Data generated by private and public sector providers were not linked and, in the public sector, data from urban and rural areas, and from family planning programmes, were handled separately. Multiple overlapping reporting systems made it extremely difficult to collect comprehensive and reliable data about the coverage of health services and the health status of the population.⁵ With technical support from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), MIS-DGHS implemented the open-source District Health Information Software 2 (DHIS2). DHIS2 is a modular web-based package for the collection, validation, analysis and presentation of aggregated statistical data, tailored to integrated health information management activities. The development

of DHIS2 is coordinated by the Health Information Systems Program network established by the Department of Informatics at the University of Oslo, Norway.⁶

The introduction of DHIS2 to Bangladesh catalysed the prioritization of data standardization and interoperability in eHealth software and database development. A draft guideline, the *Health informatics standards and data structure for Bangladesh*, was developed by MIS-DGHS to define standards and interoperability procedures for existing and future database systems under the Ministry of Health and Family Welfare (MoHFW), and for other ministries, nongovernmental organizations, development partners and the private sector.⁷ Bangladesh also led on the 2013 World Health Assembly resolution on eHealth standardization and interoperability, which emphasized that the lack of a seamless exchange of data within and between HISs hinders care and leads to fragmentation of HISs and that improvement in this is essential to realize the full potential of ICT in health system strengthening.⁸

A decade after the first steps were taken, almost all government-run health services have either fully or partly implemented DHIS2 and progress is being made with implementation in the private sector and nongovernmental organizations. For example, the Institute of Epidemiology, Disease Control and Research, the country's disease surveillance focal point, uses DHIS2 for inputting, processing, analysing and reporting data for disease surveillance. The real-time disease surveillance and reporting system was established in 2009; it has been implemented down to the upazila (subdistrict) level countrywide and uses standard, web-based forms based on DHIS2. Notably, under the Communicable Disease Control unit, the visceral leishmaniasis (kala-azar) elimination target of less than 1 case per 10 000 population was achieved in 2018,⁹ using a DHIS2 tracker for case-based surveillance, treatment and follow-up, including adverse drug reactions. Similarly, DHIS2 is being used for tracking data on screening, treatment and follow-up for cervical and breast cancers.

With about 50 000 end-users using the database software to push and pull data and reports, mostly through wireless modems, the MoHFW is the country's single largest mobile subscriber, and the deployment of DHIS2 in Bangladesh has been one of the world's largest and most extensive to date. Bangladesh has invested in building local capacity to maintain, develop, promote and expand the use of DHIS2 and overall HIS governance. All health sector partners have been brought together under the leadership of the DGHS to use its eHealth resources, including DHIS2 as common property, and to invest in further development. This collective vision has resulted in the continued thriving and expansion of DHIS2 and other eHealth resources, despite GIZ's assistance ending in 2015. In Bangladesh, DHIS2 has therefore become the national health data warehouse for the public sector, helping to bridge data gaps by bringing together information from previously fragmented data systems in a common data repository for all stakeholders. The system's rich data-mining functions enable the generation of reliable and accurate data for evidence-based decision-making and for planning and monitoring health interventions.

Accessibility has been greatly enhanced by the development of a user-friendly, integrated dashboard, which

pulls data in real time from all the various databases.¹⁰ For this purpose, in addition to using DHIS2 analytics tools, the dashboard uses business intelligence tools including Tableau, Jaspersoft, Google Chart and Highcharts for in-depth analysis and visualization. Since the SDGs emphasize measurement and accountability using reliable data,¹¹ a real-time SDG health indicator tracker has been developed and incorporated into the central dashboard on the DGHS website.¹²

Towards citizens' lifetime electronic health records and networked health facilities

MIS-DGHS is working on an ambitious shared health record (SHR) project, with the aim of creating a national electronic archive of citizens' lifetime electronic health records that can be accessed during any patient encounter anywhere in the country. Patients will not need to carry a personal health file, and doctors and health facilities will be able to retrieve and update an individual's medical record on demand. A digital gateway, the health information exchange, allows data to be transferred between health facilities and health-care providers. Adequate provisions regarding permission, credentials, privileges, confidentiality and data security are built into the system. Having been piloted in few hospitals, the SHR is now being rolled out across the country.

Preference has been given to open-source nonproprietary software, which has made software acquisition affordable and has allowed ownership of the system to be established. OpenMRS is a software platform and reference application that enables the design of a customized medical records system.¹³ OpenMRS has been extensively improved to create a robust and complete solution for hospital automation and to build a national electronic hospital networking system. The Bangladeshi version, known as OpenMRS+, is a composite of modules from OpenMRS, Odoo (previously OpenERP, a business applications suite), OpenELIS (a software and business-process framework for public health laboratories) and dcm4chee (an application for the management and archiving of clinical images). OpenMRS+ is integrated into the SHR system, so that they can work interactively through the health information exchange in transporting patients' electronic files to a central repository where up-to-date versions are stored and to the health facilities or providers that require them. A number of health facilities are currently using the system. Others, both public and private, are being encouraged to take a free copy of the software and join the national health facility automation system network.

Digital aids to health system strengthening

Health facility performance measurement

An initiative was started in 2014 to promote more structured and regular routine online reporting mechanisms and to allow for more effective measurement of the performance of public health facilities. The aim was to incentivize health managers by scoring the performance of health facilities annually, with recognition for the highest-ranking in the form of national awards from the health minister. The dashboard of the health system strengthening tool is publicly available as part of the

DGHS dashboard. This performance management tool is aligned with the six building blocks of health systems as defined by the World Health Organization (WHO): (i) health services; (ii) health workforce; (iii) health information; (iv) medical products, vaccines and technologies; (v) health financing; and (vi) leadership and governance.¹⁴ The tool is based on the WHO guidance on monitoring and evaluating health system strengthening, adapted to the local context.¹⁵ Indicators at the input, output and outcome levels, and, to some extent, at the impact level, were selected to allow assessment of the performance of facilities and community health services. Data are derived from four sources. First, scores are automatically generated from the routine health data provided by the health facilities through DHIS2 and the MoHFW human resource information system (HRIS). Second, there are on-site physical inspections using a structured data collection form to validate the routine data collected. Third, a further physical inspection by a semi-independent team of assessors of the short-listed facilities takes place. The fourth source of data is a patient satisfaction survey.¹⁶ The tool is supported by WHO, the United Nations Children's Fund, the Health Information Systems Program Bangladesh and the International Centre for Diarrhoeal Disease Research, Bangladesh.

Standardized local health bulletins

Local health bulletins have been an innovation allowing health managers easy, structured access to facility data without the need for complex searches. In 2016, re-engineering by the software development team at MIS-DGHS allowed visitors to access aggregated indicator information for any facility, from community clinic to specialized hospital. The intelligent tool mines data across all the integrated databases and compiles them into a standardized local health bulletin. The bulletins can be downloaded and can also be printed and distributed locally.

Facilitating civil registration and vital statistics

The Commission on Information and Accountability (CoIA) for Women's and Children's Health was created by WHO in 2010 as part of a broader effort to accelerate progress on the Millennium Development Goals concerned with improving maternal health and reducing child mortality. A CoIA report in 2011 emphasized the primary importance of a robust civil registration and vital statistics (CRVS) system to determine where investments should be focused and whether or not progress is being made.¹⁷ The Commission also noted the potential for information technology to overcome obstacles in developing birth and death registration systems. The importance of this was further reinforced in the SDGs, and target 16.9 is "to provide legal identity for all, including birth registration" by 2030.¹⁸

In 2012, with technical assistance from WHO, Bangladesh started to address the challenge of incomplete civil registration, resulting in a strategic action plan aligned with the CoIA recommendations.¹⁹ A CRVS steering committee, headed by the Cabinet Secretary, was established in 2014, and it has been leading a whole-of-government approach to establishing CRVS in Bangladesh. Use of the International Form of Medical Certificate of Cause of Death was introduced in four hospitals

in 2017, and it is being piloted at a further 19 hospitals. Training in mortality coding has been carried out as part of an initiative to develop a new cadre of statistical coders for cause of death analysis. Verbal autopsy has also been introduced in selected areas of the country for community deaths for which there is no medical certificate identifying the cause of death.²⁰ A module on medical cause of death has been developed and integrated into the national DHIS2 platform.

From the digital health perspective, an enterprise architecture for the CRVS has been developed and the MoHFW has started to notify birth and death events taking place in the community and in health facilities, with cause of death, to the Office of the Registrar General. Progress is being made on improving the links between the health sector and registration services, as well as on improving the quality and collection of verbal autopsy data by incorporating key variables into the DHIS2 to enable near-real-time community mortality data analysis. The strategic action plan is currently under revision to take account of these developments.

Supporting the Bangladesh health workforce strategy

Human resource information system

Bangladesh suffers from both a shortage of and geographical maldistribution of human resources for health. There are only 8.3 doctors, nurses and midwives per 10 000 population,²¹ which is substantially below the WHO recommended threshold. In November 2018, of more than 100 000 sanctioned posts under the DGHS, nearly 28% were vacant, with almost 20% of doctors' posts unfilled.²⁰ The *Bangladesh health workforce strategy 2015* addresses five priority areas: planning; development; distribution, retention and professional engagement; performance standards; and information systems.²² There is a strong focus on developing digital solutions to support these objectives. The MoHFW HRIS is a key milestone in this endeavour. HRIS electronically captures and maintains human resource information for the entire health sector. Developed and anchored by MIS-DGHS, HRIS comprises four registries that capture data on geolocation, facilities, sanctioned posts and providers. All human resource-related functions, such as new appointments, postings, transfers, promotions, deputations, leave, annual confidential reports and disciplinary actions are recorded, processed and reported through the platform.

One function of HRIS is monitoring nationwide staff attendance through a biometric system. Like other countries, Bangladesh faces the challenge of absenteeism among service providers in the public sector; this is a particular problem for health facilities in rural and remote areas. In 2012, the MoHFW started rolling out use of remote low-cost biometric fingerprint time-attendance machines in all public facilities. Staff are required to touch the sensor on the machine on arrival and departure. All the touch information is collected in a central server so that local and national authorities, as well as the general public, can view aggregated staff attendance data through the DGHS dashboard. The local authority can access detailed attendance information for individual staff. The MoHFW is now working to link this attendance tracking with career planning and incentive mechanisms for staff.

Videoconferencing

Three times a month, the Director General of Health Services meets with all the eight divisional and 64 district health managers, and about 500 subdistrict health managers join the meeting once per month. The Director General also meets all the principals of medical colleges and directors of postgraduate institute hospitals and medical college hospitals twice a month. No travel is involved in attending these meetings, as they are all conducted by videoconference. These meetings include discussions on management issues, reviews of progress towards health targets and dissemination of information such as new guidelines. These videoconference meetings have had a significant impact in areas such as improving health managers' communication skills, creating a positive environment for supportive supervision and closing the relationship gaps between the senior and junior managers. Staff from Bangladesh's telemedicine centres also meet weekly by videoconference. Telemedicine in Bangladesh has grown: in 2009, there were only eight centres; today, there are around 100 in medical college hospitals, district hospitals and subdistrict hospitals across the country. Videoconferencing is now used to facilitate large, medium or small group meetings, seminars and training sessions; it is also being used in emergency health situations, such as accidents, fires and natural disasters.

Engaging the community through digital pathways

Bangladesh's digital innovations underpin the country's goal of ensuring that all citizens of Bangladesh enjoy health and well-being by expanding access to high-quality and equitable health care in a healthy environment. Citizens are also encouraged to participate in service improvements through a digital complaints and suggestions management system that was launched in 2012. In each of the 739 public hospitals and health organizations, there is a display board mounted on the wall in a prominent place. The display board describes how to send, by SMS, complaints about the quality of services or suggestions to improve them. As soon as an SMS is sent, a web server instantly receives, processes and displays it on the web portal for public viewing. One person is dedicated to following up each text message and contacts both the complainant and the complaine to resolve the issue, providing full feedback to the complainant.

The MoHFW recently installed several large digital displays in various locations in Dhaka to raise public awareness on health, nutrition and family planning issues and to disseminate important health information and success stories. Video clips and extracts from Microsoft Office files, such as PowerPoint slides, are also shown. The data they show are remotely controlled and pushed via the internet from a common location at the DGHS.

Big data, artificial intelligence and robotics

The rapid expansion of the eHealth programme has resulted in a vast amount of data being amassed at the central data repository of the DGHS. As a result, the DGHS is now looking

at opportunities to harness this information to improve health service delivery using big data analysis, artificial intelligence and machine learning. The DGHS is keen to collaborate with potential partners to work in this new area. In February 2019, the MoHFW held an international conference in Dhaka on big data for health. This allowed local and international experts to examine (i) international experiences with big data applications that have led to improvements in health outcomes; (ii) existing and potential big data sources for health-related applications in Bangladesh; and (iii) strategies for building capacity to develop health-related big data applications. For example, public sector health services in Bangladesh are operating with substantial shortages of human resources, and workload is high. Research has estimated that, even if vacant positions were filled, staff gaps in terms of demand and supply relative to workload would remain high in most facilities.²³ One option may be for robotics and bots to have a role in mitigating the country's severe shortages in the health workforce.

Conclusion and next steps

The past decade has been exciting, with remarkable achievements in digital health being made in Bangladesh. The stimulus and inspiration came from national policy in the form of *Vision 2021*, based on the aspirations of the Honourable Prime Minister Sheikh Hasina. The achievements were recognized when Bangladesh was awarded a United Nations Digital Health for Digital Development Award in 2011. Undoubtedly, very strong support at the highest political level has been critical to the success of efforts to introduce digital health innovations.

In common with other countries, several priorities will need to be addressed as Bangladesh continues to scale up digital health, such as strengthening governance and regulation of technologies, including data privacy and security and accreditation of health apps for consumers.²⁴ Continued investment will be needed to support the capacity to maintain, develop, promote and expand the use of DHIS2, as well as sustaining the coordination of health partners and programmes towards an integrated system.

There are opportunities for greater capitalizing on digital health advances to obtain disaggregated data for decision-making in line with the SDG commitments. In turn, robust evidence will be needed on the relevance, effectiveness and appropriateness of different information modalities for front-line services, to explore the potential for greater integration and scalability. Efforts to further strengthen accountability will continue to 'emphasize health managers' understanding of and commitment towards more effective measurement of health facilities performance. These, and other future initiatives, will be enhanced by fostering greater networking opportunities among countries through south-south and triangular collaborations.

Bangladesh's decade of "quiet revolution" has generated a strong cadre of enthusiastic eHealth proponents. Supported by the visionary leadership shown thus far, they will be instrumental in ensuring that digital health continues to yield dividends for Bangladesh and also in providing an example for other countries.

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