

Bajpai, Nirupam; Wadhwa, Manisha

Working Paper

India's Experience with ICT in the Health Sector: Lessons for sub-Saharan Africa

ICT India Working Paper, No. 51

Provided in Cooperation with:

Center for Sustainable Development (CSD), Earth Institute, Columbia University

Suggested Citation: Bajpai, Nirupam; Wadhwa, Manisha (2021) : India's Experience with ICT in the Health Sector: Lessons for sub-Saharan Africa, ICT India Working Paper, No. 51, Columbia University, Earth Institute, Center for Sustainable Development (CSD), New York, NY

This Version is available at:

<https://hdl.handle.net/10419/249840>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

India's Experience with ICT in the Health Sector: Lessons for sub-Saharan Africa

ICT India Project Working Paper #51

Nirupam Bajpai and Manisha Wadhwa

June 2021

Abstract

Health systems challenges of northern and eastern India are similar to those in sub-Saharan Africa. Both India and Africa suffer from acute shortage of doctors, most notably specialists, like ophthalmologists, radiologists, cardiologists, oncopathologists and many more. The specialists and their services are concentrated in cities leaving rural areas isolated from their support. In India, around 68% of the population lives in rural areas where there is acute shortage of doctors and health care specialists. In sub-Saharan Africa, on average, there are less than 10 doctors per 100,000 people, and there is not even a single radiologist in 14 countries. India and Africa suffer from high burden of infectious diseases, emerging epidemic of non-communicable diseases, double burden of malnutrition, urbanisation, limited healthcare workforce, shortage of drugs and supplies, weak monitoring and evaluation systems, lack of follow-up care, limited financing mechanisms etc.

Aligned with the Sustainable Development Goals (SDGs), India and Africa share a common vision of providing universal health coverage (UHC) to their populations. Both the regions are accelerating in developing healthcare innovations, supported by various factors such as increased use of smartphones, expanding healthcare markets and strong policy initiatives in healthcare.

India shares strong historical and ongoing ties with Africa. Some of the past and ongoing joint initiatives in the healthcare sector include Pan African e-Network Project, e-VidyaBharati and e-AarogyaBharati (e-VBAB) Network Project, India-Africa Forum Summits, India Africa Health Sciences Platform, NATHEALTH-Healthcare Federation of India and Africa Healthcare Federation (AHF) Collaboration, Medical Tourism and Vaccine Maitri Initiative.

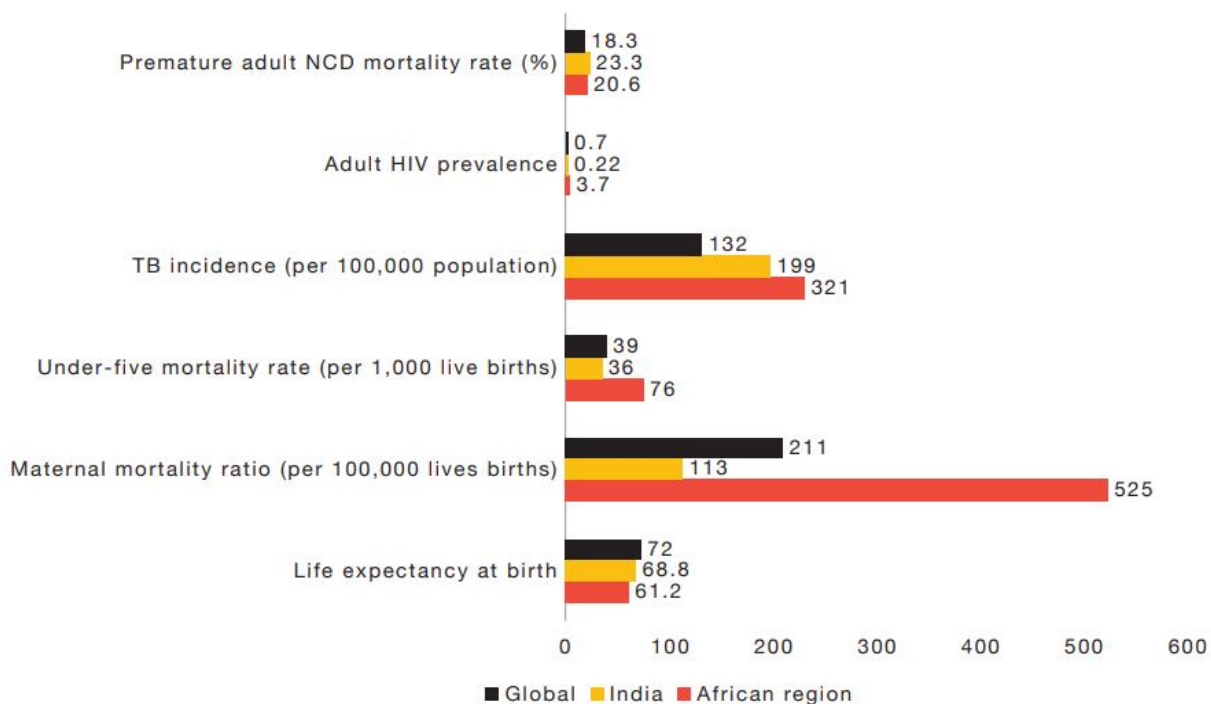
This paper describes India’s experience with ICT interventions in the Health sector which could provide valuable lessons for sub-Saharan Africa. Some of the digital health initiatives taken by India include use of telemedicine, mHealth and Artificial Intelligence to deal with COVID-19 situation, mobile teleophthalmology services, e-pharmacy, NCG-Vishwam Cancer Care Connect, Electronic Resources in Medicine (ERMED) Consortium, use of Artificial Intelligence for cancer screening and treating diabetic retinopathy, AYUSH GRID, e-Governance in healthcare, Common Service Centre Program, National Digital Wellbeing Platform (MANAS), National Digital Health Mission (NDHM) and National Nutrition Mission. Given that Africa and India share many commonalities, particularly in terms of healthcare challenges, there is considerable practical potential for Africa to learn and adopt from India’s digital healthcare interventions. Many of these initiatives could serve as a valuable solution for health problems prevalent in the sub-Saharan Africa region. Sub-Saharan African countries could learn from these initiatives and encourage similar initiatives in their region for improving the delivery of healthcare services.

Keywords: Information and Communications Technology, ICT, Health, India, Africa

Introduction

India and Africa share many commonalities not only in terms of socio-demographic profiles but also with regards to healthcare challenges. African continent consists of independent nation-states and India is a federated union of states (Passi and Guennoun 2018). Most of the Indian states have a population similar to a medium to large size country and have a distinct political and administrative system. States in India have decision-making autonomy and particularly health is a state subject. Both Africa and India face common challenges such as high burden of infectious diseases like tuberculosis and HIV/AIDS, emerging epidemic of non-communicable diseases like diabetes and hypertension, double burden of malnutrition, rapid urbanisation, shortage of drugs and supplies, limited healthcare workforce, weak monitoring and evaluation systems, lack of follow-up care, limited financing mechanisms etc. Over the years, both the regions have made significant efforts towards reducing disease morbidity and mortality; however key indicators for both the regions continue to lag behind global averages (PricewaterhouseCoopers Private Limited 2020) (see Figure 1).

Figure 1: Comparison of key health indicators: Global, India and Africa



Source: World Health Statistics 2020, WHO Global TB Report 2020, WHO Global Health Observatory data repository, NACO India HIV Estimations 2017 India factsheet, SRS Statistical report 2018, SRS Special Bulletin on Maternal Mortality in India 2016-18

Source: PricewaterhouseCoopers Private Limited. 2020. “Unlocking the Potential of India-Africa Collaboration for Healthcare Innovation.”

<https://www.nathealthindia.org/pdf/White%20Paper:%20Unlocking%20the%20potential%20of%20India-Africa%20collaboration%20for%20healthcare%20innovation.pdf>.

In line with their commitment to Sustainable Development Goals (SDGs), both the regions strive to provide universal health coverage (UHC) to their populations. In order to achieve this vision, both India and Africa are rapidly advancing in terms of healthcare innovation.

India is increasingly using digital health tools such as mobile applications, telemedicine, electronic health records etc. for health care delivery purposes. Some of the existing ICT based health platforms in India include Integrated Disease Surveillance Project (IDSP) Portal, Mother and Child Tracking System (MCTS), e-HMIS (electronic Health Management Information System), Ayushman Bharat-Health and Wellness Centre (HWC) Portal, Nikshay and NAMMIS (National AntiMalaria Management Information System). To deal with the corona virus situation, Government of India launched various digital health tools such as mobile apps for community awareness, AI-powered tools and mobile apps for screening, geofencing apps for tracking COVID-19 suspects, drones for sanitization and monitoring movement of suspects in quarantine centres, remote patient monitoring systems, robots for treatment etc. Some of the other recent initiatives by Government of India include launch of National Digital Health Mission, National Telemedicine Platform-eSanjeevani OPD and National Digital Wellbeing platform.

Sub-Saharan Africa is also witnessing increased use of digital health innovations. Mobile phones are being used for various purposes such as in South Africa for maternal healthcare, in Ghana for detecting fake drugs and in Kenya for accessing digital health-financing platform (Holst et al. 2020). Drones are being used for the purpose of transporting blood and medical supplies from one clinic to another; community health workers use apps (linked to national vital registration systems) for registering vital events; and social media is being used for health promotion throughout the region (Holst et al. 2020). Electronic Health Records are increasingly being used, with Open Source healthcare software (OpenMRS) being the most widely used (Akanbi et al. 2014). District Health Information System (DHIS-2) is being used for routine data collection and monitoring purposes in health-care facilities (Holst et al. 2020). Among 54 African nations, 41 already have their national digital health strategies and architectures (Holst et al. 2020). Some more examples of healthcare innovations in India and Africa are outlined in the Table 1.

Table 1: Examples of Health Innovation in India and Africa

Area of Innovation	India	Africa
Reproductive, maternal and child health	<ul style="list-style-type: none"> • m-health solution for frontline health workers • Neonatal hypothermia monitoring bracelet • Foot-operated new-born resuscitation system 	<ul style="list-style-type: none"> • App for women to anonymously access contraceptives • App for young people to anonymously access youth-friendly sexual and reproductive health information and chat with doctors and counsellors on such issues • Smartphone app which determines new-born asphyxia by analysing a recording of their cry
Communicable diseases	<ul style="list-style-type: none"> • AI-based technology for tuberculosis screening • Low-cost approach for tracking and improving TB medication adherence 	<ul style="list-style-type: none"> • Self-measured blood pressure (SMBP) e-reader • Automated text message service for HIV/AIDS patients • Mobile application linking HIV positive patients and their healthcare providers

Non-communicable diseases	<ul style="list-style-type: none"> • Portable AI-based breast cancer screening device • Mobile-based diagnostic system for chronic disease management • Mobile-based tele-ECG solution 	<ul style="list-style-type: none"> • Eye clinic on wheels that provides quality eye care and support to patients in low-income settings • Technology-enabled geriatric care solution
Health system strengthening	<ul style="list-style-type: none"> • Point-of-care diagnostic devices • Mobile health units for Fixed Day Health Services • Human resource management information system • Results-based financing/impact bonds to improve quality of care • Digital supply chain management solution • Telemedicine-enabled digital health facilities • Medical e-training and consultation platform • Digital solution for patient feedback • Medical claims management platform • Mobile and web-based digital pharmacies • Remote monitoring, assessment, support and intervention services for critically ill patients 	<ul style="list-style-type: none"> • Web-based integrated supportive supervision tool • Mobile-based technology that enables verification of authenticity of medicines • Mobile, on-demand, hyper local ambulance; police, and fire service call and dispatch emergency system • Multi-source data analytics and triangulation dashboard • Digital system based on smart paper technology that allows patient data to be captured on paper and then scanned, digitised, and uploaded onto a hospital management system • Credit funds providing incremental lending to small and medium healthcare enterprises linked to technical assistance programs for improving capacity and quality of care while reducing investment risks

Source: PricewaterhouseCoopers Private Limited. 2020. “Unlocking the Potential of India-Africa Collaboration for Healthcare Innovation.”

<https://www.nathealthindia.org/pdf/White%20Paper:%20Unlocking%20the%20potential%20of%20India-Africa%20collaboration%20for%20healthcare%20innovation.pdf>.

Evidently, both India and Africa are accelerating towards the adoption of digital health. India’s continuous effort in advancing healthcare innovations has gained recognition globally. As per 15-country Future Health Index (FHI) 2019 report by Royal Philips, a global leader in health technology, India is one of the leading countries in the adoption of digital health technology, with 76% of healthcare professionals already using digital health records (DHRs) in their practice (N. Mathur 2019; Philips 2019). However, in comparison, the adoption of technology in healthcare delivery in Africa is still in preliminary stages. While some African countries such as South Africa, Rwanda, and Kenya have shown progress, others are still lagging behind. As per Global Health Index 2019, Africa lags behind the global average in digital health maturity (Global Development Incubator 2019). There is a need that African governments should design and implement sustainable interventions for meeting healthcare needs of their citizens. Given that Africa and India share many commonalities, particularly in terms of healthcare challenges, there is considerable practical potential for Africa to learn and adopt from India’s affordable healthcare interventions. Africa could leverage technology to strengthen its health systems by learning from and duplicating examples and success stories existing in India.

Key past and ongoing health sector collaborations between India and Africa

Indian Technical and Economic Cooperation (ITEC) Programme

On 15th September 1964, the Indian Technical and Economic Cooperation (ITEC) Programme was launched by the Government of India (Ministry of External Affairs, Government of India 2021). The programme primarily aimed at providing technical assistance to partner countries by focussing on development of manpower. Among all the partner countries, Africa has been the largest recipients under this programme, and since then technology cooperation has been a crucial element in India’s development cooperation with Africa. Under the ITEC programme, training is imparted through two modes: ITEC onsite and e-ITEC. Under ITEC onsite, training is imparted in the partner country by deputing Indian experts/trainers in that country. Under e-ITEC, training is imparted online/through videoconferencing in real time. Through e-ITEC programme, India has played an important role in helping Africa deal with the current COVID-19 crisis. Under the e-ITEC initiative, India has conducted training webinars specifically aimed at training health-care professionals in Africa by health experts from India, and shared Covid-19 management strategies as well (Drishti The Vision Foundation 2020).

Pan African e-Network (PAeN)

The Pan African e-Network (PAeN) is an information and communications technology (ICT) project between India and the African Union (Wikipedia 2020). It intends to connect the 55 member states of the African Union to India and to each other through a satellite and fibre-optic network. The aim of the project is to enable access and sharing of expertise between India and African member states in the areas of tele-education and telemedicine, e-governance and e-commerce, Voice over IP, resource mapping, meteorological services and infotainment (IAS Gateway 2018). The idea of this project was first proposed in the year 2004 by the then President of India, A P J Abdul Kalam during his address to the Pan-African Parliament in Johannesburg. On 26 February 2009, first phase of the project was launched in 11 African countries (Wikipedia 2020)¹. In 2010, second phase of the project was launched in additional 12 African countries (Wikipedia 2020)². The project was implemented by the Telecommunications Consultants India Limited (TCIL) and was commissioned in 48 countries that signed the agreement³. “As of March 2017, the PAeN achieved the following: 22,000 students obtained degrees in various undergraduate and graduate disciplines from various Indian universities through the network; 770 Tele-medicine consultations and tele-expertise sessions were carried

¹ The 11 countries in which first phase was launched include: Benin, Burkina Faso, Gabon, the Gambia, Ghana, Ethiopia, Mauritius, Nigeria, Rwanda, Senegal and Seychelles.

² The 12 African countries in which second phase was launched include: Botswana, Burundi, Cote d’Ivoire, Djibouti, Egypt, Eritrea, Libya, Malawi, Mozambique, Somalia, Uganda and Zambia

³ The remaining countries where project was commissioned include: Cape Verde, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Senegal, Sierra Leone and Togo, Comoros, Kenya, Madagascar, Seychelles, Sudan, Tanzania, South Sudan, Burundi, Cameroon, Central African Republic, Chad, Congo, DRC, Gabon and Sao Tome and Principe, Mauritania, Lesotho, Namibia, Swaziland and Zimbabwe

<http://ris.org.in/sites/default/files/Together%20Towards%20a%20Healthy%20Future-India%E2%80%99s%20Partnerships%20in%20Healthcare.pdf>

out annually; and 6,700 Continuous Medical Education (CME) sessions were held through the network for nurses and doctors”(James and Bhatnagar 2019). In July, 2017, the project was handed over by the Government of India to the Africa Union (AU)(PricewaterhouseCoopers Private Limited 2020).

e-VidyaBharati and e-ArogyaBharati (e-VBAB) Network Project

The e-VidyaBharti and e-ArogyaBharti (e-VBAB) Network Project was launched by the Ministry of External Affairs, Government of India on 7th October 2019.

“On the occasion of its launch, Ms. Sushma Swaraj, External Affairs Minister, India said that it would serve as yet another bridge – a digital bridge – shrinking the distance between India and Africa even more”(James and Bhatnagar 2019).

It is primarily an extension of the Pan-African e-Network Project. This project comprises of two separate web-based portals: e-VidyaBharti and e-ArogyaBharti. e-VidyaBharti, the Tele-education component, offers continuing medical education (CME) services and e-ArogyaBharti, the Tele-medicine component, offers tele-medicine services, from India to doctors, paramedics, students and patients in all the 54 nations in Africa (PricewaterhouseCoopers Private Limited 2020; IAS Gateway 2018). This project will be fully funded by Ministry of External Affairs, Government of India for its entire duration of 5 years.

India-Africa Forum Summit (IAFS)

The India-Africa Forum Summit (IAFS) is the official platform for building India-Africa relations(PricewaterhouseCoopers Private Limited 2020). It is organized once in every three years.The first India-Africa Forum Summit (IAFS) was held in the year 2008 in New Delhi. Following this, two more summits were held in the year 2011 and 2015. During the third IAFS, health was one of the key areas for strengthening collaboration between India and Africa. India committed significant resources towards strengthening health capacities in Africa. The fourth IAFS, scheduled in 2020, was cancelled due to the COVID-19 pandemic.

India Africa Health Sciences Platform

India Africa Health Sciences Meet (IAHSM) is a collaborative platform between India and Africa for strengthening capabilities in health sector. The Indian Council of Medical Research (ICMR), in partnership with the Ministry of External Affairs, other key Indian ministries and African regional scientific and research agencies, hosted the first India Africa Health Sciences Meet (IAHSM) in September 2016 in New Delhi(PricewaterhouseCoopers Private Limited 2020). In March 2019, MoU was signed between ICMR and African Union for cooperation in areas such as healthcare services, capacity building, research and development (R&D), and manufacturing of drugs and diagnostics. As of December 2019, the ICMR has organized seven courses for African researchers and health professionals.

NATHEALTH and AHF Collaboration

On December 14th 2020, at the India Africa Health Summit, the Memorandum of Understanding (MoU) was signed between NATHEALTH-Healthcare Federation of India and Africa Healthcare

Federation (AHF) to enhance the healthcare collaboration between India and Africa⁴(ANI 2021; Mathew 2020). “The main objective of this agreement is to find solutions to the barriers of access to quality healthcare, building essential infrastructure for patients, harness technology, address the shortage of skilled workforce and medical professionals and ways to improve patient outcomes”(ANI 2021). The four specific areas of partnership include infrastructure development for hospitals and diagnostics; sustainable and medical value travel; skill transfer and training; and manufacturing, research and artificial intelligence. On collaboration in the domain of skill transfer and training, NATHEALTH and AHF will work towards identifying the key gaps that need attention and explore the potential for use of e-learning and other technologies such as simulation, augmented virtual reality, etc. in order to bring down the costs.

Medical Tourism

One of the areas of the collaboration between India and Africa is medical tourism. Patients from Africa prefer to visit India for seeking medical care because of availability of high-quality cost-effective super specialty medical services, Ayurvedic practices and India’s weather (PricewaterhouseCoopers Private Limited 2020). Health tours to India are being organized by various companies such as Vaidam, tour2Indiafor health etc. (tour2Indiaforhealth 2021; Vaidam 2021).

Vaccine Maitri Initiative

On 20th January 2021, Government of India launched Vaccine Maitri Initiative to provide COVID-19 vaccines to countries around the world(Wikipedia 2021c; Beri 2021). Since then, two COVID-19 vaccines: the Oxford-AstraZeneca Covishield manufactured by the Serum Institute of India and Covaxin manufactured by Bharat Biotech, approved by the Government of India have been supplied to the countries across the globe. As of 9th April 2021, around 64.5 million COVID-19 vaccine doses were delivered to 85 countries⁵. Seychelles was the first African country to receive vaccines from India. Other African countries that received the vaccines include Algeria, Angola, Botswana, Egypt, Ethiopia, Ghana, Kenya, Lesotho, Liberia, Malawi, Mali, Mauritius, Morocco, Mozambique, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, the Democratic Republic of Congo, and Uganda. Undoubtedly, India’s Vaccine Maitri initiative will help African nations in their fight against the pandemic and foster ties between India and Africa.

⁴ NATHEALTH represents leading healthcare service providers, medical technology providers (devices & equipment), diagnostic service providers, health insurance companies, health education institutions, healthcare publishers in India. AHF is a pan-African umbrella organisation currently unifying 27 private federations under two regional federations, The West African Healthcare Federation (FAOSPS) and the East African Healthcare Federation (EAHF). <https://www.businesstoday.in/sectors/pharma/private-healthcare-providers-of-india-africa-plan-mega-collaboration/story/424737.html>

⁵ <https://www.mea.gov.in/vaccine-supply.htm>

Suggestions for sub-Saharan Africa from India’s Experience with health ICT interventions

Telemedicine Initiatives

National Telemedicine Service: e-Sanjeevani

Both India and Africa suffer from acute shortage of doctors, especially specialists like radiologists, cardiologists, paediatricians, oncopathologists etc. The specialists and their services are concentrated in cities leaving rural areas isolated from their support. In India, around 68% of the population lives in rural areas where there is an acute shortage of doctors and health care specialists (P. Mathur et al. 2017). In sub-Saharan Africa, on average, there are less than 10 doctors per 100,000 people, and there is not even a single radiologist in 14 countries (Fraser 2000). In such a situation, telemedicine could play a crucial role in the delivery of healthcare services, particularly the specialist services in rural areas.

In November 2019, Ministry of Health and Family Welfare, Government of India launched a telemedicine portal, ‘**eSanjeevani AB-HWC**’, a doctor to doctor hub and spoke model for implementation in Health and Wellness Centres across the nation (Ministry of Health & Family Welfare, Government of India 2020). The key features of ‘**eSanjeevani AB-HWC**’ include MIS based application, Comprehensive Electronic Medical Record (EMR), Tele-consultation and video-conferencing (Ministry of Electronics & Information Technology, Government of India 2021). ‘**eSanjeevani AB-HWC**’ enables real time virtual consultation between patient and doctors & specialists via video conferencing. At the end of the consultation, ‘**eSanjeevani AB-HWC**’ generates e-prescription which could be used for obtaining medicines. Since November 2019 around 240 hubs and more than 5000 spokes have been set in various states and more than 183,000 consultations have been completed.

Amidst COVID-19 lockdown in the country, the Ministry of Health and family welfare launched a national teleconsultation service via a new portal ‘**E Sanjeevani OPD**’ (Ministry of Health & Family Welfare, Government of India 2020). It is a doctor to patient telemedicine system deployed under Ayushman Bharat Scheme of Government of India. It is the first of its kind online OPD service offered by a nation government to its citizens. It aims to provide healthcare services to the people in their homes. This initiative has been very useful during COVID-19 pandemic. “The main objective of E Sanjeevani OPD is to provide health advice to the individuals with the help of digitalisation who are finding it difficult to visit hospitals due to the pandemic of coronavirus”. This service allows even people living in the remotest areas to get their health related consultation. The platform ‘E Sanjeevani OPD’ provides the facility for online patient registration, token generation, queue management, audio-video consultation with doctor and e-Prescription (Gul 2021).

Initiatives like e-Sanjeevani could also prove to be a boon in sub-Saharan Africa, where there is an acute shortage of doctors, especially the specialists.

Private Sector Telemedicine Initiatives

Private sector has also played an important role in the delivery of telemedicine services in India. The major players include “the Apollo Hospital Group (linked with 64 nodes), Amrita Institute of

Medical Sciences (AIMS), Kochi (linked with 23 nodes), Asia Heart Foundation (AHF), Bangalore (telecardiology and mobile van), Fortis Hospital, New Delhi (linked with 27 nodes), Narayana Hrudayalaya, Bangalore (linked with 55 nodes) and Escorts Heart Institute and Research Centre (linked with 17 nodes)”(A. Kumar and Ahmad 2015). Some of these hospitals like Apollo Healthcare, Fortis Healthcare have presence in African regions (James and Bhatnagar 2019). Through this presence, use of telemedicine could be leveraged in sub-Saharan African nations.

Mobile Telemedicine

With rapid advances in mobile technology, Mobile Telemedicine, an improved version of telemedicine holds promise for the delivery of medical care to the rural population especially in the developing countries like India and Africa.

Mobile Teleophthalmology services

The burden of blindness and visual impairment is on rise in both India and Africa but both the regions suffer from acute shortage of Ophthalmologists. In India, there is only 1 Ophthalmologist/1000 population and 70% of them works in urban areas(Nethralaya 2021). Sub-saharan Africa region also suffers from shortage of ophthalmologists with only 2.5 ophthalmologists/million people(Dean et al. 2021). In such a situation mobile teleophthalmology services could serve as a potential solution to provide eye care services to the citizens. The Sankara Nethralaya mobile teleophthalmology model in India holds great potential for the delivery of comprehensive eye care services in rural areas, particularly in developing nations like India and Africa(John et al. 2021). Under the model, eye camps are conducted to provide ophthalmic services to the underserved and rural areas. Speciality consultation will be done via teleophthalmology during which images will be converted to Digital Imaging and transferred to the base hospital.

Some of the other mobile telemedicine initiatives taken in India are given in Table 2. Similar interventions could be taken by sub-Saharan Africa region to deliver healthcare services especially in rural areas.

Table 2: Mobile Telemedicine Initiatives in India

S.No	Mobile telemedicine Initiatives in India
1.	Mobile Telemedicine Bus service by SGPGI (NRC), Lucknow and AIMS Cochin(S.K Mishra 2018)
2.	“Lifeline Express”, world’s first Wi-Fi enabled hospital on train, an initiative by Impact India Foundation and Indian Railways(S.K Mishra 2018)
3.	Portable mobile telemedicine Kiosk launched by mhealth4u (S.K Mishra 2018)
4.	Yolo ATM and Kiosk launched by Yolo health(S.K Mishra 2018)
5.	The patent (pending) AmbuPod, mobile telemedicine clinic and ambulance by LYNK AmbuPod Pvt Ltd (Sridhar 2017; S.K Mishra 2018)
6.	Asha Jyoti Mobile Women's Healthcare service launched in the year 2012, an initiative by RAD-AID in collaboration with Philips Healthcare and implemented by PGIMER Chandigarh and Clinton Foundation(S.K Mishra 2018)
7.	Telemedicine through “104 service” launched by the state of Andhra Pradesh(Saroj Kanta Mishra, Kapoor, and Singh 2009)
8.	Mobile telehospital service launched by SGRH, AIMS, SRMC and AHF for providing speciality care to rural areas(Saroj Kanta Mishra, Kapoor, and Singh 2009)

9.	BPL Mobile, Maharashtra has launched a value-added service for its subscribers via which real time interaction and assistance with doctors is possible at any time and any place(Saroj Kanta Mishra, Kapoor, and Singh 2009)
10.	AROGYASREE, a mobile telemedicine initiative by ICMR in collaboration with the University of Karlsruhe, Germany(Chellaiyan, Nirupama, and Taneja 2019)

National Medical College Network

The Government of India has established National Medical College Network in the country for the purpose of Tele-education and Tele-consultation. This initiative intends to interlink all the medical colleges across the nation using the backbone of National Knowledge Network (NKN). (Ministry of Health & Family Welfare 2018; Ministry of Health and Family Welfare, Government of India 2018; 2016). Through this network, super-speciality doctors in the medical colleges will share their knowledge and experiences via virtual classroom (e-learning). Also, this network provides platform for medical consultation virtually to the patients via a web portal at home, government health centres and Common Service Centres(CSCs) in rural/remote areas. Establishment of similar network by sub-Saharan African countries would facilitate provision of Tele-education and Tele-consultation services in the field of medicine.

Common Service Centre Program

The Ministry of Electronics & Information Technology (MeitY), Government of India has established Common Service centres (CSC) program(Vikaspedia 2021). It is a multiple-services-single-point model in which various e- services are provided from a single geographical location in rural and remote locations where availability of computers and internet is absent or almost negligible(Wikipedia 2021b). These centres serve as the access points for the delivery of e-services to villages in India. The services provided at the CSCs include: health services like Telemedicine, essential public utility services such as bill payments, online bookings etc., Rural Banking & Insurance Services like Micro-credit, Loans, and Insurance, Education, Commercial, Agriculture and Entertainment Services. It is a pan-India network and caters to regional, cultural and linguistic diversity in India.

In sub-Saharan Africa where the level of computers and Internet penetration is still low, initiatives like Common Service centres (CSC) could be useful in building a digitally and financially inclusive society.

ePharmacy

ePharmacy plays a crucial role in achieving Universal Health Coverage⁶(FICCI 2020). Over the last 5 years, the FICCI ePharmacy Working Group has been actively working in India to drive innovative models related to ePharmacy across the country. They have also encouraged pharmaceutical industry to come up with a ‘Voluntary Code of Conduct for ePharmacies’. Amidst COVID-19 crisis in the country, the Union ministry considered delivery of medicines via e-commerce as an essential service. Some of the leading players of ePharmacy market in

⁶ e-Pharmacies are online platforms where consumers can purchase medicines without having to visit brick-and-mortar pharmacies. <https://ww2.frost.com/wp-content/uploads/2019/01/Frost-Sullivan-Outlook-on-e-pharmacy-market-in-India.pdf>

India are: Ziggy, Netmeds, Bookmeds, 1MG, mChemist, Medidart, Medlife, Pharmeasy, Savemymeds, SaveOnMedicals, etc.

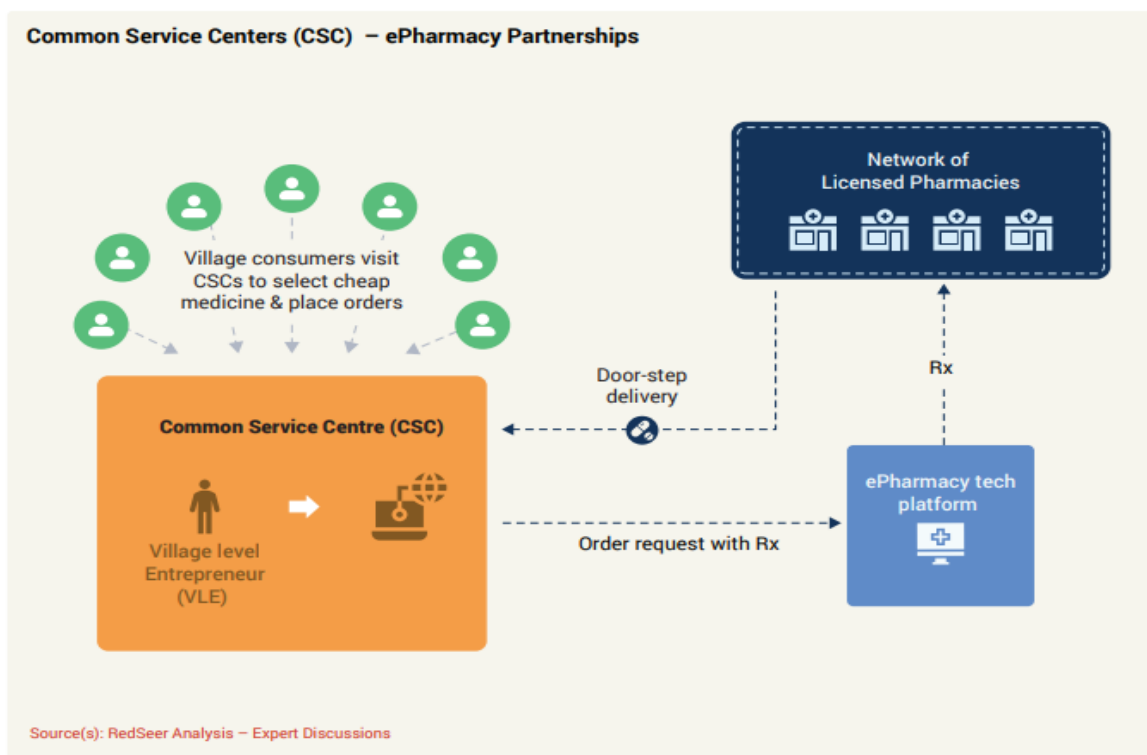
Janaushadhi Sugam Mobile app

The government of India has launched Pradhan Mantri Bhartiya Janaushadhi Pariyojana (PMBJP) under which Janaushadhi centres have been established across the country which provide quality generic medicines at affordable cost. Amidst COVID-19 situation in the country, the government has launched Janaushadhi Sugam Mobile app to avail the benefits provided by the Janaushadhi scheme. By using the app, consumer can locate nearby Janaushadhi Kendra, search Janaushadhi generic medicines, and compare generic and branded medicine for overall cost savings. However, consumers still have to physically visit the Janaushadhi Kendra for purchasing the medicines.

Common Service Centers (CSC) – ePharmacy Partnerships

The Government of India has established common services centers (CSCs) for delivering e-health services in rural parts of the country. The ePharmacy model can be aligned effectively with the common services centers (CSCs)(FICCI 2015). Common services centers (CSCs) can collaborate with ePharmacy platforms for enabling sale of medicines via Village Level Entrepreneurs(VLE). In this model, a Village Level Entrepreneur (VLE) can easily order prescription drugs and OTC products via the CSC Digital Seva Portal, on behalf of village consumers (see Figure 2).

Figure 2: Common Service Centers (CSCs)-ePharmacy partnership

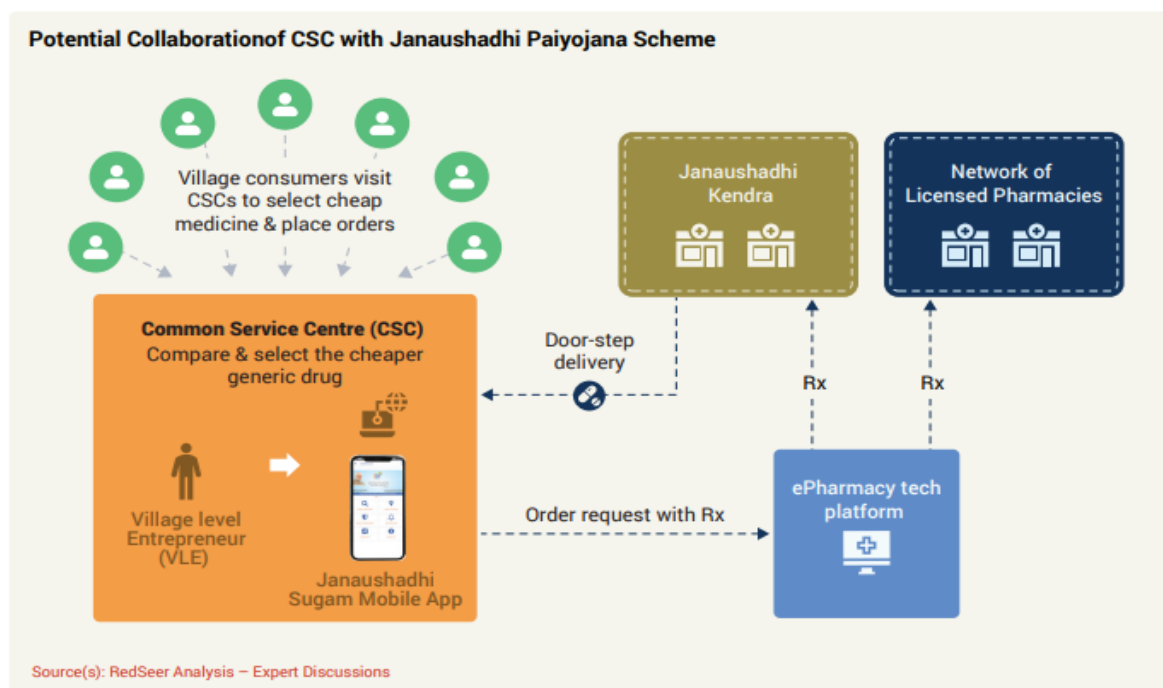


Source: FICCI. 2020. “EPharmacies at COVID-19 Frontline,” August, 36. <https://ficci.in/spdocument/23316/FICCI-ePharmacy-Whitepaper.pdf>

Potential collaboration of Janaushadhi Pariyojana with CSC Scheme

One of the ePharmacy model could be powering Common Service Centres(CSCs) with the Janaushadhi Sugam app. The village consumers could visit Common Service Centres to select cheaper medicines via the Janaushadhi Sugam app. The Village Level Entrepreneurs(VLE) can then place the order via ePharmacy platform, which will host the Janaushadhi Pariyojana centres on its app (similar to other offline pharmacies). Janaushadhi Pariyojana centres then deliver medicines to Village Level Entrepreneurs(VLE), which can be collected by village consumers (see Figure 3).

Figure 3: Potential collaboration of CSC with the Janaushadhi Pariyojana



Source: FICCI. 2020. “EPharmacies at COVID-19 Frontline,” August, 36. <https://ficci.in/spdocument/23316/FICCI-ePharmacy-Whitepaper.pdf>

ePharmacy is in nascent stages in sub-Saharan Africa and lessons could be taken from ePharmacy models in India.

ERMED Consortium

The Directorate General of Health Services (DGHS) and Ministry of Health & Family Welfare (MoHFW) initiated Electronic Resources in Medicine (ERMED) Consortium in the year 2008(National Medical Library 2020; Ministry of Health & Family Welfare, Government of India 2021). It aims to develop countrywide e-information resources in the domain of medicine to deliver effective health care. The ERMED consortium is managed by National Medical Library. Currently, 87 state and central Government-funded Institutions including All India Institute of Medical Sciences (AIIMS) are members of ERMED consortium. The consortium provides 24*7 instant online access to 242 high quality journals(National Medical Library 2020). The

consortium aims to make online journal literature accessible to medical scholars working across the country.

Lessons could be taken from ERMED Consortium by sub-Saharan African governments for establishing countrywide e-information resources in the field of medicine to enhance delivery of health care services.

NCG Vishwam Cancer Care Connect

India has launched a global cancer care network “NCG-Vishwam Cancer Care Connect” with the objective to remove disparity in the cancer care globally. NCG Vishwam Cancer Care Connect was launched by Shri K. N. Vyas, Secretary Department of Atomic Energy(DAE), GOI & Chairman Atomic Energy Commission (AEC), India on 17th September 2019 in Vienna (Department of Atomic Energy, Government of India 2020). Through this initiative, India intends to join hands with the interested partner countries in the fight against cancer. It envisages integration of hospitals and cancer institutes in partner countries with the National Cancer Grid (NCG) in India⁷. Hospitals from countries like Russia, Kazakhstan, Vietnam, Nepal, United Arab Emirates, Afghanistan, Jamaica, Bangladesh, Myanmar and Zambia have agreed to become part of this network(Department of Atomic Energy, Government of India 2019). Countries in sub-Saharan Africa region could also leverage this platform and connect with hospitals globally in delivering cancer care.

High-tech TB treatment program

Tuberculosis (TB) is a major cause of morbidity and mortality worldwide. In 2019, most of the TB cases were reported from South-East Asia (44%) and Africa (25%) regions(World Health Organization 2020). India accounts for 26% of TB cases in the world(World Health Organization 2020). TB is highly infectious and is more problematic in crowded urban areas where reliance on private providers is quite high. TB is curable if patient follows the prescribed treatment regimen, however many patients drop out before treatment completion. High out of pocket expenditure, delayed diagnosis, lack of reporting to the government, lack of systems for patient support and treatment adherence are some of issues related to private sector TB treatment.

The Government of India , in collaboration with WHO and PATH, has set up a high tech TB program - **Private Provider Interface Agency (PPIA)**(Vijayan 2019). This program makes use of ICTs and data to connect private and public health care providers. Through this program TB patients in private sector can access medicines and diagnostic services from public sector. The program is based around a central database and e-voucher system(Cory and Stevens 2020). A call center connected to the patient database runs the voucher program (e-vouchers) to support patients complete the treatment. Patient referrals and subsidies are managed through e-vouchers,

⁷ National Cancer Grid (NCG) was established in 2012. It is managed by Tata Memorial Centre (TMC) and is funded by the Department of Atomic Energy, Government of India. NCG is a network of major cancer centers, research institutes, patient groups and charitable institutions across India with the mandate of establishing uniform standards of patient care for prevention, diagnosis, and treatment of cancer. NCG has 183 participating stake holders from India which has now been made open to the cancer hospitals and other relevant institutes from foreign countries. <https://vajiramias.com/current-affairs/ngc-vishwam-cancer-care-connect/5d8460e21d5def270f654802/>

which ensure payment to the private providers. The database also enables contacting patients via text and phone calls to ensure that patients are adhering to their treatment plans. The program also has outreach workers who motivate patients to complete treatment regimen. There three main advantages of the program are: easy referrals, more robust patient tracking, and seamless payment and reimbursement. Program has enabled making decisions based on real-time data which has improved patient outcomes.

The unique ICT tools used in this program has proven to be effective. The tools have enabled quicker case notifications from the private healthcare sector into public health care system. They have made it easier for patients to get the correct diagnosis and timely treatment. This technology-intensive PPIA model has resulted in TB treatment success rate of more than 80 percent. The PPIA model has received the prestigious Porter Prize in 2018. A large scale pan-India version of the PPIA model called JEET (Joint Effort to Eliminate Tuberculosis) is being rolled out. It is projected that in the next two years, JEET will impact 3.5 million people across 22 states and 400 cities.

Sub-Saharan African nations with high TB burden such as Nigeria also have a dominant and largely unregulated private health sector(Stallworthy, Dias, and Pai 2020). Initiatives such as Private Provider Interface Agency (PPIA) model could be helpful in linking the private and public healthcare sectors in such regions. Such linkage would not only be helpful in tackling TB but also other critical diseases like hypertension etc.

Use of Artificial Intelligence to Prevent Blindness in Diabetics

The burden of diabetic retinopathy is on rise both in India and Africa (Burgess, Msukwa, and Beare 2013). It is estimated that in India there would be around 11-20 million people suffering from diabetic retinopathy by the year 2025(Cory and Stevens 2020). Across the globe, the Middle Eastern Crescent, sub-Saharan Africa, and India will witness the greatest relative increase in Diabetic retinopathy during the period 2000-2030(Wild et al. 2004). However, both in India and Africa, there are insufficient number of specialists and clinics to diagnose diabetic retinopathy at the right time so as to prevent people suffering from vision loss. In such a situation, Artificial Intelligence (AI) offers solutions to deal with this problem.

AI solutions from various companies like Google, Forus and Remedio are being used in India to detect diabetic retinopathy at early stages(Cory and Stevens 2020). Google’s AI model has been piloted at two locations in India: Aravind Eye Hospital in Madurai and Sankara Eye Hospital in Chennai(Cory and Stevens 2020). The latter runs around 70 satellite clinics catering to patients who cannot commute to the nearest health facility in town. At these satellite clinics, images of the patients’ retinas are captured and uploaded to Google Cloud. Then, Google’s machine learning algorithm works in consultation with the specialists to detect and diagnose diabetic retinopathy, which can be managed further based on the severity.

Similar interventions could be implemented in sub-Saharan Africa to detect diabetic retinopathy at early stages and thus prevent people suffering from vision loss.

Use of Artificial Intelligence for Cancer Screening

The Incidence of cancer is on rise in India and around 1 million new cancer cases are diagnosed each year. However, India has only few thousands of experienced oncopathologists. In such a

situation, Artificial Intelligence (AI) could prove as a boon. AI solutions can assist a pathologist in making quality diagnosis, but availability of good quality pathology datasets is one of the pre-requisite for AI solutions to work. In this respect, “NITI Aayog is in an advanced stage for launching a programme to develop a national repository of annotated and curated pathology images(NITI Aayog, Government of India 2018a)” AI based Radiomics is also an emerging field that refers to “the comprehensive quantification of tumor phenotypes by applying a large number of quantitative imaging features”(NITI Aayog, Government of India 2018a). Development of Imaging Biobank for Cancer is also being discussed(NITI Aayog, Government of India 2018a).

The burden of cancer is on rise in sub-Saharan Africa region(Sung et al. 2021). Like in India, sub-Saharan Africa also suffers from lack of experienced oncopathologists. AI solutions as implemented by India could prove to be a valuable solution for the region.

Microsoft – Apollo Hospitals’ partnership

Microsoft – Apollo Hospitals’ partnership is one of the recent development with the focus to create an AI-focused network within cardiology (a speciality of medicine).

“We built a partnership where they bring in the technology and we bring in the data, algorithms and the clinical insights into what is impacting and how this can translate into number one risk scoring and then in differential pattern and methodologies” (Sangita Reddy, Joint MD, Apollo Hospitals)(Mabiyani 2018)

“AI is going to help us in not only identifying the vulnerable patients early but also in terms of modifying the intensity of treatment after classifying them into high risk or very high risk group” (Dr (Prof) N N Khanna, Senior Consultant - Interventional Cardiology and Vascular Interventions, Indraprastha Apollo Hospitals)(Mabiyani 2018).

Apollo Hospitals have a presence in African regions: Nigeria, South Africa, Mauritius, Ethiopia, Tanzania and Zimbabwe(James and Bhatnagar 2019). Through this presence, use of AI within cardiology could also be leveraged in African regions.

SCALE Model

SCALE Program is a public private partnership between Government of Rajasthan and WISH Foundation(WISH Foundation 2021). It aims to transform primary healthcare delivery for the underserved populations by use of high impact innovative solutions. Under the model, 200 health institutions (30 Primary Health Centres and 158 Subcenters) in 12 high priority districts are being transformed into model clinics. The model makes use of technology innovations such as Health ATMs, IT enabled health kiosk offering teleconsultation, diagnostics and medicine at subcenters, LABIKE Advance diagnostics delivered through an entrepreneur, use of mHealth and Integrated data analytics platform.

Sub-Saharan African countries could also learn from ‘SCALE model in Rajasthan’ and encourage similar public private partnership initiatives in their region for improving the delivery of primary healthcare services among the underserved populations.

AYUSH GRID

A nationwide digital platform called “AYUSH GRID” is being set up by the Ministry of AYUSH to bring together all AYUSH facilities in the country including hospitals and laboratories, and to promote traditional healthcare systems (Ministry of Ayush, Government of India 2020). The Ministry of AYUSH has also launched various pilot projects such as AYUSH Hospital Management Information System (A-HMIS), Tele-AYUSH, Bhuvan Application, Yogoalactor Application, Case Registry Portal, Yoga Portal etc. which will be co-opted in “AYUSH GRID” in future (Ministry of Ayush, Government of India 2020; 2016).

Recently, Ministry of AYUSH has signed Memoranda of Understanding (MoU) with 25 foreign governments for cooperation in the field of Traditional Medicine and Homoeopathy. It includes undertaking collaborative research in AYUSH systems of medicine and setting up of AYUSH academic Chairs (Ministry of Ayush, Government of India 2021)⁸. Also, under the Central Sector Scheme for promotion of International Cooperation, (IC Scheme), Ministry of AYUSH sends AYUSH experts to foreign countries for training programmes, conducting seminars etc. for the purpose of promoting and propagating AYUSH Systems (Ministry of Ayush, Government of India 2021).

Countries in sub-Saharan Africa could also collaborate with the Ministry of AYUSH and learn from their initiatives like “AYUSH GRID” for establishing and promoting AYUSH System of medicine in their region.

MANAS: National Digital Wellbeing Platform

The burden of mental health problems in India is on rise. Between 1990 to 2017, one in every seven people from India have experienced mental illness extending from mild conditions like anxiety, depression to severe conditions like schizophrenia (ETHealthWorld 2020). On 14th April, 2021, a national digital wellbeing platform called Mental Health and Normalcy Augmentation System (MANAS) was launched by Government of India with the aim to promote health and wellbeing in the country (Office of Principal Scientific Advisor, Government of India 2021). This comprehensive and scalable platform was initiated by the Office of the Principal Scientific Adviser, Government of India (GoI). It was jointly developed by National Institute of Mental Health and Neuro Sciences (NIMHANS) Bengaluru, Armed Forces Medical College (AFMC) Pune and Centre for Development of Advanced Computing (C-DAC) Bengaluru. The initial mobile app version, launched virtually by the Principal Scientific Adviser, GoI, K Vijay Raghavan, aims at encouraging positive mental health in 15-35 years age group. MANAS platform is an integration of efforts of various government ministries, national bodies and research institutions. In future, the platform is intended to be intergrated with public health schemes such as the National Health Mission (NHM), e-Sanjeevani and National Nutrition Mission (Poshan Abhiyan).

⁸ Ministry of AYUSH has signed 25 Country to Country MoUs for Cooperation in field of Traditional Medicine and Homoeopathy namely Nepal, Bangladesh, Hungary, Trinidad & Tobago, Malaysia, WHO Geneva, Mauritius, Mongolia, Turkmenistan, Myanmar, Germany (Joint declaration), Iran, Sao Tome & Principe, Equatorial Guinea, Cuba, Colombia, Japan (MoC), Bolivia, Gambia, Republic of Guinea, China, St. Vincent & The Grenadines, Suriname, Brazil and Zimbabwe. <https://pib.gov.in/Pressreleaseshare.aspx?PRID=1696430>

Mental health problems is also a burgeoning issue in African nations. Between 2000 and 2015, there was 52% increase in number of years lost to disability because of mental and substance use disorders in Africa(Sankoh, Sevalie, and Weston 2018). In sub-Saharan Africa, there is elevation in rates of psychological disorders in adults, and rates of other mental health problems like posttraumatic stress disorder, anxiety, and depression range between 20% - 60%(Cortina et al. 2012). Sub-Saharan African countries could learn lessons from India’s MANAS platform for developing their own national platform to deal with mental health problems.

Atmiyata: Community-Led Mental Health Intervention

In India, mental illness is a substantial public health burden. Around 70 million people suffer from some form of mental illness(Shields-Zeeman et al. 2017). The situation is more severe in rural areas where there is lack of trained manpower to address the burden of Common Mental Disorders (CMDs) in the community. To address this issue, Atmiyata intervention has been implemented in one of the rural areas of Maharashtra in India. Atmiyata aims at reducing the burden of mental illnesses and promoting wellbeing by training a core group of community members as “Atmiyata Champions” and “Mitras” in rural India(Shields-Zeeman et al. 2017).The programme makes use of digital tools such as low cost mobile phone and easy to use *Atmiyata* app. The app has two versions: one for Atmiyata Champions and the other for community members/general public. The app can be used by people who are illiterate. E-Learning through community based films is also promoted under the programme. It is recommended that Atmiyata programme can be implemented more widely in low-resource settings to address the burden of Common Mental Disorders(CMDs)(Shields-Zeeman et al. 2017).

The intervention could also prove to be useful in dealing with the burden of mental illness in low-resource settings of sub-Saharan Africa.

Mann Mela: Digital Mental Health Museum

Mann Mela is India’s first digital museum that describes mental health stories from young people (18-35 years) across India(Mann Mela 2021). Making use of art and technology, Mann Mela exhibits first person stories of trauma, breaking stigma, recovery and growth. Personal stories acts as a powerful tool to connect with people facing similar mental health issues and help in their resilience and recovery. The aim of this innovative digital museum is to address mental health challenges faced by the youth of the nation.

Sub-Saharan African countries could also take such innovative initiatives such as Mann Mela to reduce the burden of mental health problems.

Ayushman Bharat Yojna: National Health Protection Scheme

In September 2018, Ministry of Health and Family Welfare, Government of India launched Ayushman Bharat National Health Protection Scheme, also referred as Ayushman Bharat Pradhan Mantri Jan Arogya Yojana(National Health Authority, Government of India 2018). The program has been designed to address health holistically via a two pronged approach: 1) Setting up of 150,000 Health and Wellness Centres (HWCs) in rural parts of the country for providing comprehensive primary healthcare services(CPHC) to all, and 2) Launching of a flagship scheme “Pradhan Mantri-Rashtriya Swasthya Suraksha Mission (PM-RSSM)” which will provide

coverage of 0.5million/family/year to 100 million low income families in the country for the purpose of secondary and tertiary hospitalization (NITI Aayog, Government of India 2018b). It is the world's largest government-funded healthcare scheme(Wikipedia 2021a). It has been designed to be digital and makes use of IT platforms for preauthorizing treatment and processing claims (Iyer 2018).

National Health Stack(NHS) is the visionary digital platform proposed by National Institute of Transforming India Aayog (NITI Aayog), Government of India(NITI Aayog, Government of India 2018b). It has been conceptualized to be built in the context of Pradhan Mantri Rashtriya Swasthya Suraksha Mission (PM-RSSM) under Ayushhman Bharat Yojna. It also intends to integrate various health verticals and their branches at national and state levels, both in public and private domain, and thus create a holistic platform. It aims to create digital health records for Indian citizens by the year 2022. A unique identifier called the “National Health Stack (NHS) ID” will be created for each beneficiary upon successful registration using national Id like Aadhar Card, Pan Card, Voter card etc. The system aims to create largest and comprehensive healthcare database in the country and will be the ultimate driving factor in the achievement of universal health coverage (UHC).

Innovative health financing strategies are needed in sub-Saharan Africa(Ifeagwu et al. 2021). Lessons could be taken from India’s Ayushman Bharat Scheme to plan and implement Health Insurance schemes in sub-Saharan Africa.

National Digital Health Mission

On August 15, 2020, Prime Minister of India Shri Narendra Modi announced the launch of National Digital Health Mission(Press Information Bureau, Government of India 2020). The vision of NDHM is “To be the best healthcare network globally” and its mission is “To provide every Indian with access to digital health services”(Ministry of Health & Family Welfare, Government of India 2019). The NDHM will integrate various digital health services by leveraging open digital systems and thus create an environment than would merge existing health information systems(Hindustan Times 2020). The key components of NDHM includes National Health Electronic Registries, a Federated Personal Health Records (PHR) framework, National Health Analytics Platform and other horizontal components which will be shared across all health programs such as Unique Digital Health ID, Health Data Dictionaries and Supply Chain Management for Drugs, payment gateways etc(Ministry of Health & Family Welfare, Government of India 2019). The expected outcomes from NDHM are outlined in Table 3.

Table 3: Expected Outcomes of NDHM

S.No.	Expected Outcomes
1.	All citizens should be able to access their Electronic Health Records in a convenient manner, preferably within 5 clicks ;
2.	Citizens need to undergo any diagnostic test ONCE ONLY , during the course of an episode, despite taking treatment from different health service providers;
3.	Citizens should get Integrated Health Services at a single point, though multiple agencies/ departments/ services providers are involved;
4.	NDHM shall assure Continuum of Care to the citizens, across primary, secondary and tertiary care and across public and private service providers;

5.	A framework for Unified Communication Centre will be prepared to facilitate voice-based services and outreach;
6.	NDHM shall support national portability for healthcare services;
7.	Privacy of personal and health data, and consent-based access of EHRs will be the inviolable norm that shall be complied by all systems and stakeholders;
8.	NDHM will be aligned to the SDG’s related to health;
9.	NDHM will enable evidence-based interventions in the area of public health;
10.	Above all, the analytical capabilities of NDHM will support data-driven decision-making and policy analysis .

Source: Ministry of Health & Family Welfare, Government of India. 2019. “National Digital Health Blueprint Report Comments Invited.”

https://www.nhp.gov.in/NHPfiles/National_Digital_Health_Blueprint_Report_comments_invite_d.pdf

Among 54 African nations, 41 already have their national digital health strategies and architectures (Holst et al. 2020). Early implementation experiences from India could be helpful for sub-Saharan African nations to successfully build and/or implement their national digital health strategies.

National Nutrition Mission

Malnutrition accounts as one of the major contributor to the burden of disease in India (Swaminathan et al. 2019). In March 2018, the Government of India launched one of its flagship programme ‘National Nutrition Mission (Poshan Abhiyaan)’ (Ministry of Women and Child Development, Government of India 2018b). It holistically addresses the burden of malnutrition in the country via use of technology, convergence, behavioral change and result-oriented approach. The National Nutrition mission is primarily an independent body to review and take stock of all the nutrition related programmes/schemes in the country on the target population. To achieve this, the mission will ensure convergence of various nutrition related programmes/schemes in the country: Pradhan Mantri Matru Vandana Yojna, Anganwadi Services, Scheme for Adolescent Girls of MWCD, National Health Mission (NHM) of MoH&FW, Swachh Bharat Mission of Ministry of Drinking Water & Sanitation (DW&S), Public Distribution System (PDS) of Ministry of Consumer Affairs, Drinking Water & Toilets with Ministry of Panchayati Raj, Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) of Ministry of Rural Development (MoRD), Food & Public Distribution (CAF&PD) and Urban local bodies through Ministry of Urban Development (Ministry of Women and Child Development, Government of India 2018b). The goal of National Nutrition Mission is to improve the status of nutrition of children aged 0-6 years, adolescent girls, pregnant women and lactating mothers. An ICT based real-time monitoring system (ICT-RTM) has been proposed to monitor activities under the mission. The ICT-RTM driven by ICDS Common Application Software (CAS) has two components: Mobile application for field functionaries and Supervisors and other, the web application with dashboard. Poshan Abhiyan also intends to create nutrition awareness through people movement ‘Jan Andolan’ (Ministry of Women and Child Development, Government of India 2018a). The community level events of Jan Andolan will be captured using an android app and will be monitored using web application with in-built dashboard feature.

The sub-Saharan Africa region also suffers from the burden of malnutrition. In sub-Saharan Africa, the number of undernourished people rose from 181 million in 2010 to around 222

million in 2016(World Health Organization 2019). Multisectoral approach like India’s National Nutrition Mission could help sub-Saharan African nations in reducing the burden of malnutrition.

e-Governance initiatives in health care

Both India and Africa suffer from various issues in delivering government healthcare services to its citizens. For instance, inefficient delivery of government healthcare services, out of pocket expenditure, lack of transparency in the administration, red-tapism, etc. One of the promising step to reduce these is to leverage Information and Communications technology (ICT) in delivering government healthcare services to citizens. In 2015, the Ministry of Health and Family Welfare (MoHFW), Government of India proposed setting up of ‘National E-Health Authority (NeHA)’ with the vision to deliver high quality health care services to Indian citizens by making use of information and communications technologies (ICT)(Ministry of Health & Family Welfare, Government of India 2017). The Ministry of Health and Family Welfare (MoHFW), Government of India has taken various e-Governance initiatives in health care sector under the division called ‘eHealth division’. Some of these initiatives are outlined in Table 4. Indian e-governance initiatives in healthcare sector could provide lessons and guidance for similar initiatives to be taken in sub-Saharan African nations.

Table 4: National level e-Governance Initiatives in Healthcare

Initiative	Description
Office Automation	
e-Office	MoHFW,GoI has started implementation of e-Office which includes creation of e-files, e-sign etc. to improve the efficiency of the government processes(Ministry of Health & Family Welfare 2018)
Video Conference facility	MoHFW,GoI has started video conferencing facility in the offices(Ministry of Health & Family Welfare 2018)
Digital Payments	Under Digital India Programme, digitization of payments has been initiated in the health sector(Ministry of Health & Family Welfare 2018)
Online Services	
Government Services Portal of India	Single window access to 40 Health services provided by GoI(Ministry of Electronics & Information Technology, Government of India 2005)
National Health Portal	Web based portal that acts as a single point of access to authentic health related information for citizens of India(Ministry of Health and Family Welfare, Government of India 2016c)
e-Hospital	Hospital Management System for delivery of services like patient care, diagnostics etc. in Government Hospitals in India(Ministry of Health and Family Welfare, Government of India 2019b)
Online registration system	Aadhaar based online registration system for booking an OPD appointment, availing services like online diagnostic reports, enquire availability of blood in any government hospital in India(Ministry of Electronics & Information Technology, Government of India 2015)
Central Government Health Services (CGHS) portal	Web application implemented in all the wellness centres across the nation since 2007 for the delivery of Central Government Health Services (CGHS)(Ministry of Health and Family Welfare, Government of India 2015c)

CSD Working Paper Series – India’s Experience with ICT in the Health Sector: Lessons for sub-Saharan Africa

Food Safety and Standards Authority of India	GoI website for providing services like issuance of licence, product approval etc. to food business operators(Ministry of Health and Family Welfare, Government of India 2020a)
National Organ & Tissue Transplant Organisation	GoI web portal for registration and retrieval for organ/ tissue transplantation (Ministry of Health and Family Welfare, Government of India 2019b)
Central Drugs Standards Control Organisation, “SUGAM”	Single window access to various stakeholders like Pharmaceutical Industry, Citizens, Regulators etc. for applications and approvals of drugs, vaccines, cosmetic products, medical devices, clinical trials and ethics committee(Ministry of Health and Family Welfare, Government of India 2019b)
Mera Aspataal	GoI initiative to capture patient feedback for the services received at the hospital(Ministry of Health and Family Welfare, Government of India 2020b)
‘Hum Do’ Website	GoI website providing information related to family planning and guidance on family planning methods(Ministry of Health and Family Welfare, Government of India 2017)
PMSMA portal	Web and android based system with help desk to facilitate Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA) programme by (MoHFW), Government of India under which free of cost ANC care is given to pregnant women on 9 th of each month (Ministry of Health and Family Welfare, Government of India 2018)
Online Medical Counseling & Admission Project	Online Counselling service by GoI for admission into Under Graduate and Post Graduate Medical colleges(Ministry of Health and Family Welfare, Government of India 2015c)
Ayushman Bharat- Pradhan Mantri Jan Arogya Yojna Portal	GoI portal providing information and services related to Pradhan Mantri Jan Arogya Yojna(National Health Authority, Government of India 2018)
Mobile Applications and Services	
Swasth Bharat (Disease, Lifestyle, First Aid)	Android based mobile application that provide reliable information related to disease conditions, symptoms, available treatment options, public health alerts, healthy lifestyle, first aid etc. (Ministry of Health and Family Welfare, Government of India 2016g)
NHP Indradhanush : Vaccine Tracker	GoI android based mobile application to help parents register and track immunisations of their children under 16 years of age(Ministry of Health and Family Welfare, Government of India 2016f)
National Health Portal Directory Services	Mobile application providing information related to hospitals and blood banks across India(Ministry of Health and Family Welfare, Government of India 2016e)
TB Missed Call Initiative	Mobile health service by GoI for providing counselling and treatment to Tuberculosis (TB) patients(Ministry of Health and Family Welfare, Government of India 2016a)
Kilkari	GoI mobile initiative that delivers free weekly 72 messages related to pregnancy care, delivery and child care to pregnant women from 2 nd trimester upto when child is 1 year of age(Ministry of Health and Family Welfare, Government of India 2016a)
M-Cessation mobile app	GoI android based mobile application to help people quit tobacco for life (Ministry of Health and Family Welfare, Government of India 2016a)

CSD Working Paper Series – India’s Experience with ICT in the Health Sector: Lessons for sub-Saharan Africa

No More Tension Mobile app	“Stress Reliever Application” launched by MoHFW, GoI for providing information related to stress and its management techniques(Ministry of Health and Family Welfare, Government of India 2016h)
Mera Aspaatal Mobile App	GoI mobile app to capture patient feedback for the services received at the hospital(Ministry of Health and Family Welfare, Government of India 2020b)
PMSMA App	Pradhan Mantri Surakshit Matritva Abhiyan mobile app provides opportunity to medical practitioners who are in voluntary sector or in private sector or are retired to provide free ANC care to the pregnant women at Government healthcare facilities on 9 th of every month (Ministry of Health and Family Welfare, Government of India 2016i)
National Health Helpline (Doctor on Call)	MoHFW initiative to provide free on call healthcare consultation to patients across India by a qualified doctor(Ministry of Health & Family Welfare 2018)
mDiabetes	Mobile initiative by MoHFW in collaboration with the WHO and other partners for the prevention and care of diabetes(Ministry of Health and Family Welfare, Government of India 2015a)
Health Information Dissemination	
NHP Health Information Kiosks	Health information Kiosks are being established in hospitals (so far done in 17 hospitals) for the purpose of disseminating authentic and reliable health related information to the citizens(Ministry of Health & Family Welfare 2018)
NHP Voice Web	National Health Portal developed a 24x7 Toll free Voice Web service for sharing authentic health information with the citizens(Ministry of Health and Family Welfare, Government of India 2016b)
Campaigns organized on Social Media (Twitter, You Tube)	For instance: Intensified Diarrhoea Control Fortnight, National Breast-feeding Week, National Nutrition Week etc. (Ministry of Health and Family Welfare, Government of India 2015c)
Process Automation	
Hospital Information System (HIS)	HIS helps in automation of hospital processes like patient registration, diagnostics, drugs, treatment, discharge, follow-up etc. It is functional in public health facilities upto CHC level(Ministry of Health and Family Welfare, Government of India 2019b)
Drugs and Vaccines Distribution Management System (DVDMS) (‘eAushidhi’)	DVDMS helps in automation of purchase, inventory management and supply of drugs, surgical items and sutures to warehouses of DH,CHC, PHC(Ministry of Health and Family Welfare, Government of India 2019b)
eRakt Kosh	Online system for connecting and streamlining the workflow of all the licensed blood banks across the nation(Ministry of Health and Family Welfare, Government of India 2019b)
Personal Health Record Management System (PHRMS)	PHRMS provides a platform for patients to upload their health data for the purpose of storage, easy access and sharing with doctors for seeking medical advice(Centre for Development of Advanced Computing (C-DAC) 2019)
ANM on Line (ANMOL)	ANMOL is a tablet based application used by ANMs to enter data related to the RCH programme (Ministry of Health and Family Welfare, Government of India 2019b)
Service Delivery and Tracking	
e-HMIS	electronic-Health Management Information System (e-HMIS) is a web based portal functioning across the nation to monitor programmes under

	National Health Mission(Ministry of Health and Family Welfare, Government of India 2019b)
Nikshay	Web based portal by GoI for tracking TB patients and monitoring National TB programme(Ministry of Health and Family Welfare, Government of India 2019b)
Mother and Child Tracking System (MCTS)	Web based portal by for tracking pregnant women and children under 5 years of age(Ministry of Health and Family Welfare, Government of India 2019b)
Ayushman Bharat – Health and Wellness Centre (HWC) portal	Web portal launched by MoHFW to monitor the delivery of comprehensive primary healthcare (CPHC) services through the health and wellness centres across the nation(Ministry of Health and Family Welfare, Government of India 2019a)
CPHC NCD Solution	MoHFW, GoI under the Ayushman Bharat Comprehensive Primary Healthcare (CPHC) program is undertaking a population-based Non-communicable diseases (NCDs) program which aims to screen all individuals above 30 at population level for five noncommunicable diseases: hypertension, diabetes, oral, breast and cervical cancers. CPHC NCD Solution helps digitize all the paper records related to the screening conducted for women and men above 30 years of age(Ministry of Health and Family Welfare, Government of India 2018a)
Digital LifeCare	A web and android based platform launched in April, 2018 by Hon’ble Prime Minister of India. It facilitates auxiliary nurse midwives (ANMs) and doctors screen and manage non-communicable diseases (NCDs), one of the comprehensive Primary health care services (CPHC) under Ayushman Bharat Yojna.
Surveillance and Monitoring	
Integrated Disease Surveillance Programme (IDSP) Portal	Web based portal by GoI for disease surveilliance in the country under National Health Mission(Ministry of Health and Family Welfare, Government of India 2009)
Central Dashboard	Central dashboard is being developed to help monitor key indicators related to various existing and upcoming National health programmes(Ministry of Health and Family Welfare, Government of India 2019b)
Regulations and Standards	
National Identification Number (NIN) to Health Facilities	Web portal for registration of health facilities in India and assigning them a unique permanent National Identification Number (NIN)(Ministry of Health and Family Welfare, Government of India 2016d)
Metadata & Data Standards (MDDS)	Health domain MDDS (Metadata & Data Standards) have been developed for bringing interoperability between various health IT applications(Ministry of Health and Family Welfare, Government of India 2019b)
EHR Standards	EHR (Electronic Health Record) Standards notified in the year 2016 by GoI include 35 set of standards for clinical terminology, E-prescription, data encryption, coding etc. (Vikaspedia 2019)
Online Registry of Clinical Establishments	Web portal for registration of all types of clinical establishments except for armed forces(Ministry of Health and Family Welfare, Government of India 2015b)
Capacity Building	
Mobile Academy	GoI Mobile initiative to provide free audio courses to train ASHAs on healthcare service delivery particularly intended to improve their

	knowledge base and communication skills (Ministry of Health and Family Welfare, Government of India 2019b)
Training Management Information System (TMIS)	This system helps in the building capacities of healthcare professionals (Ministry of Health and Family Welfare, Government of India 2019b)
NDLM (National digital Literacy Mission) – DISHA	Under this initiative IT training will be provided to 52.5 lakh persons, which includes ASHA, Anganwadi workers and authorized ration dealers across the nation (National Institute of Electronics & Information Technology 2015)
Online Consultation-Telemedicine	
National Medical College Network (NMCN)	NMCN is being established to link all the medical colleges of the nation for the purpose of establishing e-classrooms, providing teleducation, Continuous Medical Education (CME) and building capacities (Ministry of Health and Family Welfare, Government of India 2019b)
National Telemedicine Network (NTN)	NTN is being established across the nation connecting health facilities in rural areas (SC, PHC, CHC) with the district hospitals and medical college for providing telemedicine services (Ministry of Health and Family Welfare, Government of India 2019b)
SATCOM based Telemedicine Nodes	Telemedicine nodes are being established at the pilgrimage places for the purpose of providing speciality consultation, screening of diseases and providing preventive care to the devotees (Ministry of Health and Family Welfare, Government of India 2019b)
Emerging Platforms	
National Health Stack	A holistic platform supporting various health verticals and their branches at national and state levels both in public and private domain (NITI Aayog, Government of India 2018b). The system aims to create digital health records for all Indian citizens by the year 2022. The National Health Stack (NHS) ID which will be a unique identifier will be generated for each beneficiary upon successful registration using national Id like Aadhar Card, Voter card, Pan Card etc.

Use of ICT to combat COVID-19

India is witnessing world’s highest daily cases of COVID-19 (BBC News 2021). Various ICT initiatives have been taken by Indian Government to deal with the COVID-19 situation in the country. Though the spread of COVID-19 in sub-Saharan African countries have been slower compared to India and European countries, but they could take lessons from ICT initiatives taken by India to prepare for any future spike in cases. Similar interventions could also be applied to other infectious diseases prevalent in the sub-Saharan Africa region.

The Department of Telecom, Government of India has launched COVID-19 awareness messages as a caller tune instead of regular ringtone to spread mass awareness (Times of India 2020). The Government of India has made available a number of authentic information portals such as MyGov Portal, National Health Portal of India, the Ministry of Health and Family Welfare website, WhatsApp bot called MyGov Helpdesk (WhatsApp Number: +919013151515), MyGov Social Media Hub etc. (Ministry of Communications & Information Technology (Government of India) 2020). The Indian government has also launched platforms for citizen engagement such as MyGov App and COVID-19 feedback app. The Aarogya Setu App and Aarogya Setu IVRS has been developed for contact tracing by National Informatics Centre (NIC), Ministry of Electronics and Information Technology, Government of India (National Informatics Centre,

Ministry of Electronics & Information Technology, Government of India 2020). In addition to contact tracing, the Aarogya Setu App provides COVID-19 updates and facilitates registration for COVID-19 vaccination. Artificial Intelligence technology was also leveraged to deal with the COVID-19 situation(see Table 5).

Table 5: AI-based tools to combat COVID-19

AI-based citizen engagement platforms	
Conversational AI-enabled MyGov	MyGov, world’s largest citizen engagement platform was launched by the Government of India. This virtual assistant or chatbot allows citizens to ask relevant questions and clear their doubts related to COVID-19, make people aware of COVID-19 and provide them real-time updates on COVID-19(Das 2020).
IBM Watson Assistant	The Indian Council of Medical Research (ICMR) in collaboration with the tech giant IBM has implemented the Watson Assistant, an AI-based query answering system, on its portal. The Watson Assistant responds to the queries on COVID-19 raised by front-line workers and data entry operators across testing and diagnostic facilities in India(Rajan 2021).
Screening of COVID-19	
AI-enabled thermal cameras	‘Staqu’, a Gurgaon based start-up, has launched AI-based thermal camera to identify anyone with body temperature above 37°C(Awasthi 2020). The camera can identify multiple suspects at the same time and that too in the range of 100 meters.
AI based voice tool	An AI based voice tool has also been developed and designed by a professor and her students in Mumbai(Press Trust of India 2020c). This tool is able to detect COVID-19 through voice-based diagnosis using a smartphone app.
AI- based chest x-ray tool	The Defence Institute of Advanced Technology (DIAT) in Pune, Maharashtra has developed an AI based COVID-19 detection tool(Press Trust of India 2020f). The tool uses the chest x-rays of patients to identify COVID-19 infection. It will be particularly helpful for radiologists and also in telemedicine. An IIT-Roorkee Professor has also developed similar software which can detect COVID-19 and measure its severity using X-ray scan of the suspected patient(Press Trust of India 2020d).
AI-based cough sound analysis tool	The Norway India Partnership Initiative (NIPI) in collaboration with the Wadhvani Institute of Artificial Intelligence has developed an artificial intelligence (AI)-powered tool which enables identification of COVID-19 through cough sound analysis(Kumar 2020).
AI-based tools for containment of coronavirus	
Milagrow iMap 9	It is a robot designed for floor disinfection purposes which can navigate and sanitize floors without any human involvement. It was launched by Milagrow HumanTech(Press Trust of India 2020e) ⁹ .
Corona-Killer 100	Garuda Aerospace, a Chennai based start up, has developed an automated disinfecting Unmanned Aerial Vehicle (UAV) called

⁹ Milagrow HumanTech is the No. 1 Domestic Robots company in India.
<https://milagrowhumantech.com/content/4-about-us>

	“Corona-Killer 100” (a disinfectant spraying drone) ¹⁰ . Garuda Aerospace has deployed 300 “Corona-Killer 100” drones for disinfection purposes across 26 cities in India.
AI-based tools for treatment and remote monitoring	
Robots	The Kerala Government has initiated the use of robots ‘KARMI-Bot’ and ‘Nightingale-19’(Bhatia 2020; Zachariah 2020). These robots serve food and medicines to the COVID-19 patients, collect trash used by the patients, enable video call between patients and doctors or relatives and perform disinfection of the isolation ward.
Remote monitoring systems	For monitoring COVID-19 patients, Indian states are exploring the use of remote monitoring systems. These include Indore 311 mobile app by state of Madhya Pradesh, Monal 2020 by the state of Uttarakhand, Milagrow Humanoid ELF in AIIMS, New Delhi, LiFi (Light Fidelity) technology in Ahmadabad(Press Trust of India 2020e; Vora 2020; Express News Service 2020). These remote monitoring systems enables remote monitoring of patient’s vital parameters like pulse rate, blood oxygen level, body temperature, respiration rate, heart rate etc.
AI model to repurpose existing drugs	The Indraprastha Institute of Information Technology (IIIT-Delhi) has developed an AI model to repurpose existing drugs for treatment of Covid-19 ¹¹ . The AI model would help identify the drugs which have the highest probability of success against COVID-19. This model eliminates the need of trying all of the drugs in clinical trials and thus save time and money.
AI-based sero-survey platform	
Garuda: Sero survey platform	Thalamus Irwine, India based IT startup has developed an AI and IoT (Internet of Things)-based sero survey platform named ‘Garuda’ which claims to conduct a seroprevalence study with 1 crore COVID-19 samples in just one week time (Press Trust of India 2020a; The Weather Company 2020). This technology could be helpful in identification of the vulnerable groups, community and geographical pockets where least or no immunity has been developed against COVID-19(The Weather Company 2020)(The Weather Company 2020)(The Weather Company 2020)(The Weather Company 2020)(The Weather Company 2020)(The Weather Company 2020). This would be helpful in vaccine prioritisation and putting brakes on the spread of the COVID-19 infection.

The state governments have also launched mobile applications for various purposes such as mass awareness, contact tracing, monitoring suspects in quarantine etc. (See Table 6). Drones are being used to monitor movement of COVID-19 suspects in quarantine centers. They are being leveraged for video surveillance and enforcing social distancing purposes. These are particularly helpful in the red alert and containment zones and in public places where people gather in large numbers like banks, ration shops etc.

¹⁰ Garuda Aerospace focuses on the design, build and customization of unmanned aerial vehicles (UAVs) or drones for various applications. <https://www.garudaaerospace.com/about-us/>

¹¹ <https://health.economictimes.indiatimes.com/news/medical-devices/iiit-delhi-develops-ai-model-to-repurpose-existing-drugs-to-treat-covid-19/76939010>

Table 6: Mobile applications launched by various state governments

State	Name of the mobile application	Purpose
Delhi	Delhi Corona	Provides real time information on the availability of beds and ventilators at both government and private hospitals, COVID-19 cases and number of tests conducted, government orders, containment zones, COVID-19 Health Services, and lockdown services like finding a hunger relief centre or finding a shelter or to apply for ration; a platform to donate to the Chief Minister/ Lt. Governor relief Fund
Punjab	COVA Punjab	Provides access to real time dashboard for COVID-19 statistics, helpline numbers, prevention measures, government advisories, travel instructions; a geofencing app; a platform for self-screening for COVID-19 and locates nearest COVID-19 hospital
Telangana	T-COVID’19	Provides live COVID-19 statistics, access to government and WHO advisories, details related to government approved labs and test centers, isolation wards in government and private hospitals and quarantine centers; self assessment for COVID-19 ; a telemedicine platform
Kerala	Gok Direct Kerala	Generate awareness and disseminate credible information related to COVID-19
Goa	Test Yourself Goa	Assists in carrying out a self assessment test for COVID-19
Karnataka	Test Yourself Karnataka	Assists in carrying out a self assessment test for COVID-19
West Bengal	Sandhane	Trace COVID-19 suspects in rural and remote areas
Maharashtra	MahaKavach	Geofencing app: Helps track movement of COVID-19 suspect in quarantine
Tamil Nadu	Quarantine Monitor	Geofencing app: Helps track movement of COVID-19 suspect in quarantine
Karnataka	Corona Watch	Geofencing app: Helps track movement of COVID-19 suspect in quarantine
Himachal Pradesh	Corona Mukht Himachal	Geofencing app: Helps track movement of COVID-19 suspect in quarantine
Gujarat	SMC COVID-19 Tracker App	Geofencing app: Helps track movement of COVID-19 suspect in quarantine
Mizorum	mCOVID-19	Provides access to COVID-19 updates, government advisories, task force and volunteer registration, volunteer mPASS (pass to permit movement of goods, vehicles and people); a geofencing app
Maharashtra	Coviguard	The Coviguard app is helpful in monitoring the people who are in home quarantine. It also has a built-in facility for personalized chats that helps the quarantined person to communicate with the authorities.
Tamil Nadu	CoBuddy	CoBuddy is an android based mobile application being used by Police authorities in Tiruvallur district of Tamil Nadu (Barik 2020). CoBuddy is a geofencing app and helps in monitoring the movement of COVID-19 suspects under home quarantine. The app uses face verification as an added

		layer of authentication. Random messages are sent to the user throughout the day to upload his/her photograph to verify their current location.
--	--	---

Source:(Mitter 2020; Anand 2020; ET Wing, Govt of Telangana 2020; Mizoram State e-Governance Society 2020; Press Trust of India 2020b; Nag 2020; ETGovernment 2020)

Vaccine advocacy Campaigns

Both India and Africa are facing challenges related to COVID-19 vaccine hesitancy among communities. To tackle misinformation about the vaccine, India has launched Information, Education and Communication (IEC) campaign which emphasize that various prominent medical professionals and political heads are being vaccinated, suggesting ‘a role-model effect’ at play (Khandelwal and Tagat 2021). Creative routes have also been adopted by the Indian states of Maharashtra and Goa to address challenges related to vaccine hesitancy among communities (World Health Organization 2021; Ministry of Information & Broadcasting 2021). A unique outreach advocacy campaign has been launched under which cultural troupes have been deployed at 11 400 strategic locations across 36 districts in Maharashtra and 2 districts in Goa to perform street plays in local languages to spread advocacy messages. The campaign is being run collaboratively by the Regional Outreach Bureau (Maharashtra and Goa Region) under Ministry of Information and Broadcasting, Government of India, Public Health Department of Government of Maharashtra, WHO Country Office for India and UNICEF. Under this initiative, 88 empanelled performing troupes along with 16 vans (15 in Maharashtra and 1 in Goa) equipped with LED panels and audio announcement systems have been deployed for disseminating COVID-19 related information in regional languages and local dialects. The campaign addresses concerns and infodemics that spread misinformation and fuel vaccine hesitancy. The campaign’s script reiterates updated information about COVID-19, COVID-19 appropriate behaviours, and COVID-19 vaccination.

Sub-Saharan African countries also need to engage in robust outreach activities in collaboration with community leaders to address concerns related to COVID-19 vaccine (Mavhinga and Nantulya 2021). Initiatives similar to advocacy campaigns by states of Maharashtra and Goa could help overcome vaccine hesitancy in Africa region.

Infectious disease diagnostic lab (I-lab)

On 18th June, 2020, the Minister for Science & Technology, Earth Sciences launched India’s first Infectious disease diagnostic lab (I-lab) for COVID-19 testing in rural, interior and inaccessible parts of the country (see Figure 4) (Ministry of Science & Technology, Government of India 2020).

Figure 4: India’s First Infectious disease diagnostic lab (I-Lab)



Source: Ministry of Science & Technology, Government of India. 2020. “Dr Harsh Vardhan Launches DBT – AMTZ Mobile Diagnostic Unit for Covid Testing- I-Lab [Press Release].” <https://pib.gov.in/PressReleasePage.aspx?PRID=1632393>

Infectious disease diagnostic lab (I-lab) invention could be shared with Africa as it could be useful in detecting infectious diseases (including COVID-19) prevalent in the African regions.

References

- Akanbi, Maxwell O, Amaka N Ocheke, Patricia A Agaba, Comfort A Daniyam, Emmanuel I Agaba, Edith N Okeke, and Christiana O Ukoli. 2014. “Use of Electronic Health Records in Sub-Saharan Africa: Progress and Challenges,” 10. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4167769/pdf/nihms380682.pdf>
- Anand, Jatin. 2020. “Kejriwal Launches ‘Delhi Corona’ App for Real-Time Information on Availability of Hospital Beds.” Kejriwal Launches ‘Delhi Corona’ App for Real-Time Information on Availability of Hospital Beds. June 2020. <https://www.thehindu.com/news/cities/Delhi/kejriwal-launches-delhi-corona-app-for-real-time-information-on-availability-of-hospital-beds/article31729239.ece>
- ANI. 2021. “NATHEALTH And Africa Healthcare Federation Sign Historic Agreement At The First-Ever India Africa Health Summit On World UHC Day Paving The Path Towards Collaboration, Partnership, Technology Exchange And Innovation.” 2021. <http://www.businessworld.in/article/NATHEALTH-and-Africa-Healthcare-Federation-sign-historic-agreement-at-the-first-ever-India-Africa-Health-Summit-on-World-UHC-Day-paving-the-path-towards-collaboration-partnership-technology-exchange-and-innovation/14-12-2020-353366/>
- Awasthi, Prashasti. 2020. “Gurgaon-Based Start-up Launches AI-Powered Thermal Camera for Covid-19 Detection.” 2020. <https://www.thehindubusinessline.com/info-tech/gurgaon-based-startup-launches-ai-powered-thermal-camera-for-covid-19-detection/article31098664.ece>
- Barik, Soumyarendra. 2020. “Tamil Nadu Police Using Facial Recognition App to Track People in Quarantine.” Tamil Nadu Police Using Facial Recognition App to Track People in

- Quarantine. April 2020. <https://www.medianama.com/2020/04/223-face-recognition-tamil-nadu-quarantine-coronavirus/>
- BBC News. 2021. “Covid: India Sees World’s Highest Daily Cases amid Oxygen Shortage.” April 2021. <https://www.bbc.com/news/world-asia-india-56826645>
- Beri, Ruchita. 2021. “India’s Vaccine Maitri with Africa.” 2021. <https://idsa.in/idsacomments/indias-vaccine-maitri-with-africa-rberi-110321>
- Bhatia, Anuj. 2020. “From Kerala, a Robot to Take Care of Coronavirus Patients.” From Kerala, a Robot to Take Care of Coronavirus Patients - The Indian Express. April 26, 2020. <https://indianexpress.com/article/technology/tech-news-technology/from-kerala-a-robot-to-take-care-of-coronavirus-patients-6329400/>
- Burgess, Philip I, Gerald Msukwa, and Nicholas AV Beare. 2013. “Diabetic Retinopathy in Sub-Saharan Africa: Meeting the Challenges of an Emerging Epidemic.” *BMC Medicine* 11 (1). <https://doi.org/10.1186/1741-7015-11-157>
- Centre for Development of Advanced Computing (C-DAC). 2019. “Personal Health Record Management System.” 2019. https://www.cdac.in/index.aspx?id=hi_mhs_product_myhealthrecords
- Chellaiyan, VinothG, Ay Nirupama, and Neha Taneja. 2019. “Telemedicine in India: Where Do We Stand?” *Journal of Family Medicine and Primary Care* 8 (6): 1872. https://doi.org/10.4103/jfmpe.jfmpe_264_19
- Cortina, Melissa A, Anisha Sodha, Mina Fazel, and Paul G. Ramchandani. 2012. “Prevalence of Child Mental Health Problems in Sub-Saharan Africa: A Systematic Review.” *Arch Pediatr Adolesc Med* 166 (3): 276–81. <https://doi.org/10.1001/archpediatrics.2011.592>
- Cory, Nigel, and Philip Stevens. 2020. “Building a Global Framework for Digital Health Services in the Era of COVID-19.” 2020. <https://itif.org/publications/2020/05/26/building-global-framework-digital-health-services-era-covid-19>
- Das, Sejuti. 2020. “How Government Of India Used Conversational AI During COVID-19: A Case Study.” 2020. <https://analyticsindiamag.com/how-government-of-india-used-conversational-ai-during-covid-19-a-case-study/>
- Dean, William H., John C. Buchan, Stephen Gichuhi, Hannah Faal, Caleb Mpyet, Serge Resnikoff, Iris Gordon, et al. 2021. “Ophthalmology Training in Sub-Saharan Africa: A Scoping Review.” *Eye* 35 (4): 1066–83. <https://doi.org/10.1038/s41433-020-01335-7>
- Department of Atomic Energy, Government of India. 2019. “Statement by Dr K N Vyas during the Launch of NCG Vishwam Cancer Care Connect in Vienna [Press Release].” <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1585456>
- . 2020. “Launch of NCG Vishwam Cancer Care Connect.” 2020. <https://dae.gov.in/node/1309>
- Drishti The Vision Foundation. 2020. “Development In India-Africa Ties.” 2020. <https://www.drishtias.com/daily-updates/daily-news-editorials/development-in-india-africa-ties>
- ET Wing, Govt of Telangana. 2020. “T COVID’19.” April 2020. <https://play.google.com/store/apps/details?id=com.tsstate.citizen&hl=en>
- ETGovernment. 2020. “HP Govt Develops Mobile App to Monitor Quarantined People.” Corona Mukh Himachal: HP Govt Develops Mobile App to Monitor Quarantined People. March 2020. <https://government.economictimes.indiatimes.com/news/digital-india/hp-govt-develops-mobile-app-to-monitor-quarantined-people/74907032>

- ETHealthWorld. 2020. “What India Must Do to Solve Its Mental Health Crisis?” February 2020. <https://health.economicstimes.indiatimes.com/news/industry/what-india-must-do-to-solve-its-mental-health-crisis/74314862>
- Express News Service. 2020. “ECIL Develops Remote Monitoring System for Covid-19 Patients.” ECIL Develops Remote Monitoring System for Covid-19 Patients. May 5, 2020. <https://indianexpress.com/article/cities/hyderabad/ecil-develops-remote-monitoring-system-for-covid-19-patients/>
- FICCI. 2015. “E-Pharmacy in India: Last Mile Access to Medicines.” https://ficci.in/spdocument/20746/E-Pharmacy-in-India-Last-Mile-Access-to-Medicines_v5.pdf
- . 2020. “EPharmacies at COVID-19 Frontline,” August, 36. <https://ficci.in/spdocument/23316/FICCI-ePharmacy-Whitepaper.pdf>
- Fraser, H. S F. 2000. “Information Technology and Telemedicine in Sub-Saharan Africa.” *BMJ* 321 (7259): 465–66. <https://doi.org/10.1136/bmj.321.7259.465>
- Global Development Incubator. 2019. “The State of Digital Health 2019: Global Digital Health Index.” <https://static1.squarespace.com/static/5ace2d0c5cfd792078a05e5f/t/5d4dcb80a9b3640001183a34/1565379490219/State+of+Digital+Health+2019.pdf>
- Gul, Afsha. 2021. “E Sanjeevani OPD: Patient Registration, Esanjeevaniopd.in Appointment.” 2021. <https://pmmodiyojana.in/e-sanjeevani-opd/>
- Hindustan Times. 2020. “Explained: What Is National Digital Health Mission and How It Will Benefit People.” 2020. <https://www.hindustantimes.com/india-news/explained-what-is-national-digital-health-mission-and-how-it-will-benefit-people/story-qOKlv3rbkrvB0aR9ZQyvdk.html>
- Holst, Christine, Felix Sukums, Danica Radovanovic, Bernard Ngowi, Josef Noll, and Andrea Sylvia Winkler. 2020. “Sub-Saharan Africa—the New Breeding Ground for Global Digital Health.” *The Lancet Digital Health* 2 (4): e160–62. [https://doi.org/10.1016/S2589-7500\(20\)30027-3](https://doi.org/10.1016/S2589-7500(20)30027-3)
- IAS Gateway. 2018. “E-VBAB Network & Pan-African E-Network Project.” 2018. <https://iasgateway.com/e-vbab-network-pan-african-e-network-project/>
- Ifeagwu, Susan C., Justin C. Yang, Rosalind Parkes-Ratanshi, and Carol Brayne. 2021. “Health Financing for Universal Health Coverage in Sub-Saharan Africa: A Systematic Review.” *Global Health Research and Policy* 6 (1): 8. <https://doi.org/10.1186/s41256-021-00190-7>
- James, T C, and Apurva Bhatnagar. 2019. “Together Towards a Healthy Future India’s Partnerships in Healthcare.” Research and Information System for Developing Countries. <http://ris.org.in/sites/default/files/Together%20Towards%20a%20Healthy%20Future-India%20E2%80%99s%20Partnerships%20in%20Healthcare.pdf>
- John, Sheila, Lavanya Allimuthu, Ranjitha Kannan, Ramesh BabuSekar, Martin Manoj Mathiyazahan, Padmavathy Appasamy, and Sangeetha Srinivasan. 2021. “The Mobile Teleophthalmology Unit in Rural and Underserved Areas of South India.” *Telehealth and Medicine Today*, April. <https://doi.org/10.30953/tmt.v6.257>
- Kumar, Arun, and Sartaj Ahmad. 2015. “A Review Study on Utilization of Telemedicine and E-Health Services in Public Health.” *Asian Pacific Journal of Health Sciences* 2 (1): 60–68. <https://doi.org/10.21276/apjhs.2015.2.1.10>

- Kumar, Ruchir. 2020. “Bihar Nod to NIPI to Develop AI-Powered Tool to Track Covid-19 Suspects.” Bihar Nod to NIPI to Develop AI-Powered Tool to Track Covid-19 Suspects. April 2020. <https://www.hindustantimes.com/patna/bihar-nod-to-nipi-to-develop-ai-powered-tool-to-track-covid-19-suspects/story-YDXNp1x8jLpfOrKup4Uh6K.html>
- Mabiyan, Rashmi. 2018. “How Artificial Intelligence Can Help Transform Indian Healthcare.” 2018. <https://health.economictimes.indiatimes.com/news/health-it/how-artificial-intelligence-can-help-transform-indian-healthcare/64285489>
- Mann Mela. 2021. “Mann Mela.” 2021. <https://www.mannmela.in/>
- Mathew, Joe C. 2020. “Private Healthcare Providers of India, Africa Plan Mega Collaboration.” 2020. <https://www.businesstoday.in/sectors/pharma/private-healthcare-providers-of-india-africa-plan-mega-collaboration/story/424737.html>
- Mathur, Nandita. 2019. “Digital Health Technology Can Revolutionise Healthcare in India: Report.” 2019. <https://www.livemint.com/news/india/digital-health-technology-can-revolutionise-healthcare-in-india-report-1566457450376.html>
- Mathur, Pankaj, Shweta Srivastava, Arati Lalchandani, and Jawahar L Mehta. 2017. “Evolving Role of Telemedicine in Health Care Delivery in India.” *Primary Health Care Open Access* 07 (01). <https://doi.org/10.4172/2167-1079.1000260>
- Mavhinga, Dewa, and Carine Kaneza Nantulya. 2021. “Overcoming Covid-19 Vaccine Hesitancy Across Africa.” 2021. <https://www.hrw.org/news/2021/03/07/overcoming-covid-19-vaccine-hesitancy-across-africa>
- Ministry of Ayush, Government of India. 2016. “Report on Tele-AYUSH Project.” https://main.ayush.gov.in/sites/default/files/report%20on%20TeleMedicine_1.pdf
- . 2020. “Nationwide ‘AYUSH Grid’ Connecting All Hospitals and Laboratories to Promote Traditional Systems of Medicines [Press Release].” <https://pib.gov.in/Pressreleaseshare.aspx?PRID=1605619>
- . 2021. “Promoting Ayush Practice in the International Sphere [Press Release].” <https://pib.gov.in/Pressreleaseshare.aspx?PRID=1696430>
- Ministry of Communications & Information Technology (Government of India). 2020. “MyGov.” 2020. <https://play.google.com/store/apps/details?id=in.mygov.mobile>
- Ministry of Electronics & Information Technology, Government of India. 2005. “National Government Services Portal.” 2005. <https://services.india.gov.in/>
- . 2015. “Online Registration System.” 2015. <https://ors.gov.in/index.html>
- . 2021. “E-Sanjeevani.” 2021. https://www.cdac.in/index.aspx?id=hi_pr_eSanjeevani
- Ministry of External Affairs, Government of India. 2021. “Indian Technical and Economic Cooperation (ITEC) Programme.” 2021. <https://www.itecgoi.in/about>
- Ministry of Health & Family Welfare. 2018. “E-Governance & Telemedicine.” Annual Report 2017-2018. <https://mohfw.gov.in/sites/default/files/20Chapter.pdf>
- Ministry of Health & Family Welfare, Government of India. 2017. “National EHealth Authority (NeHA).” 2017. https://www.nhp.gov.in/national_eHealth_authority_neha_mtl
- . 2019. “National Digital Health Blueprint Report Comments Invited.” https://www.nhp.gov.in/NHPfiles/National_Digital_Health_Blueprint_Report_comments_invited.pdf
- . 2020. “Health Ministry’s Telemedicine Service e Sanjeevani Completes 9 Lakh Consultations [Press Release].” <https://pib.gov.in/PressReleasePage.aspx?PRID=1677674>

- . 2021. “National Medical Library - ERNET.” 2021. <https://nmcn.in/nml.php>
- Ministry of Health and Family Welfare, Government of India. 2009. “Integrated Disease Surveillance Programme.” 2009. <https://idsp.nic.in/>
- . 2015a. “MDiabetes.” 2015. <http://mdiabetes.nhp.gov.in/>
- . 2015b. “Online Registry of Clinical Establishments.” 2015. <http://clinicalestablishments.gov.in/AuthenticatedPages/Users/UserLogin.aspx>
- . 2015c. “Organization & Infrastructure.” Annual Report 2014-2015. <https://mohfw.gov.in/sites/default/files/563256988745213546.pdf>
- . 2016a. “Mobile Health Services.” 2016. <https://pib.gov.in/newsite/PrintRelease.aspx?relid=134503>
- . 2016b. “National Health Helpline.” 2016. https://www.nhp.gov.in/national-health-helpline-toll-free-number-1800-180-1104-nhp-voice-web_pg
- . 2016c. “National Health Portal.” 2016. <https://www.nhp.gov.in/>
- . 2016d. “National Identification Number to Health Facility of India.” 2016. <https://nin.nhp.gov.in/login.php>
- . 2016e. “NHP Health Directory Services.” <https://www.nhp.gov.in/mobile-app-directory>
- . 2016f. “NHP Indradhanush.” 2016. https://www.nhp.gov.in/nhp-indradhanush_pg
- . 2016g. “NHP Swasthya Bharat.” 2016. https://www.nhp.gov.in/nhp-swasth-bharat_pg
- . 2016h. “No More Tension.” 2016. <https://www.nhp.gov.in/mobile-no-more-tension>
- . 2016i. “Pradhan Mantri Surakshit Matritva Abhiyan.” 2016. <https://www.nhp.gov.in/mobile-pmsma>
- Ministry of Health and Family Welfare, Government of India. 2016. “Telemedicine.” July 2016. https://www.nhp.gov.in/telemedicine_pg
- Ministry of Health and Family Welfare, Government of India. 2017. “Hum Do.” 2017. <https://humdo.nhp.gov.in/>
- . 2018. “Pradhan Mantri Surakshit Matritva Abhiyan.” 2018. <https://pmsma.nhp.gov.in/>
- Ministry of Health and Family Welfare, Government of India. 2018. “E-Health & Telemedicine.” June 2018. <https://mohfw.gov.in/about-us/departments/departments-health-and-family-welfare/e-Health%20%26%20Telemedicine>
- Ministry of Health and Family Welfare, Government of India. 2019a. “Ayushman Bharat - Health and Wellness Centre.” 2019. <https://ab-hwc.nhp.gov.in/>
- . 2019b. “E-Health & Telemedicine.” 2019. <https://mohfw.gov.in/Organisation/departments-health-and-family-welfare/e-Health-Telemedicine>
- . 2020a. “Food Safety and Standards Authority of India.” 2020. <https://fssai.gov.in/>
- . 2020b. “Mera Aspataal (My Hospital).” 2020. <https://meraaspataal.nhp.gov.in/>
- Ministry of Information & Broadcasting. 2021. “Maharashtra and Goa Use Popular Performing Arts and Folk Media for COVID Vaccination Advocacy [Press Release].” <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1707455>
- Ministry of Science & Technology, Government of India. 2020. “Dr Harsh Vardhan Launches DBT – AMTZ Mobile Diagnostic Unit for Covid Testing- I-Lab [Press Release].” <https://pib.gov.in/PressReleasePage.aspx?PRID=1632393>
- Ministry of Women and Child Development, Government of India. 2018a. “Jan Andolan Guidelines : Poshan Abhiyaan.” <https://icds-wcd.nic.in/nnm/NNM-Web-Contents/LEFT-MENU/Guidelines/JanAndolanGuidelines-English.pdf>

- . 2018b. “National Nutrition Mission: Administrative Guidelines.” https://icds-wcd.nic.in/nnm/NNM-Web-Contents/UPPER-MENU/AdministrativeApproval-Guidelines/Administrative_Guidelines_NNM-26022018.pdf
- Mishra, Saroj Kanta, Lily Kapoor, and Indra Pratap Singh. 2009. “Telemedicine in India: Current Scenario and the Future.” *Telemedicine and E-Health* 15 (6): 568–75. <https://doi.org/10.1089/tmj.2009.0059>
- Mishra, S.K. 2018. “Telemedicine for Rural Mass-Current Initiatives and Future Scope.” <http://nmcn.in/nrc/ppt/Telemedicine%20for%20Rural%20Masses%20current%20initiative%20and%20future%20scope%20Oditeleon.pdf>
- Mitter, Sohini. 2020. “Coronavirus: 7 Contact Tracing and Patient Monitoring Apps Being Used by India.” Coronavirus: 7 Contact Tracing and Patient Monitoring Apps Being Used by India. April 2020. <https://yourstory.com/2020/04/coronavirus-contact-tracing-patient-monitoring-apps-india>
- Mizoram State e-Governance Society. 2020. “MCOVID-19.” 2020. <https://mcovid19.mizoram.gov.in/>
- Nag, Jayatri. 2020. “West Bengal Government Launches App to Track COVID-19.” West Bengal Government Launches App to Track COVID-19. April 2020. <https://mumbaimirror.indiatimes.com/coronavirus/news/west-bengal-government-launches-app-to-track-covid-19/articleshow/75069663.cms>
- National Health Authority, Government of India. 2018. “Ayushman Bharat-Pradhan Mantri Jan Arogya Yojna.” 2018. <https://www.pmjay.gov.in/>
- National Informatics Centre, Ministry of Electronics & Information Technology, Government of India. 2020. “Aarogya Setu Mobile App.” Aarogya Setu Mobile App | MyGov.In. May 12, 2020. <https://www.mygov.in/aarogya-setu-app/>
- National Institute of Electronics & Information Technology. 2015. “National Digital Literacy Mission (NDLM).” 2015. <http://beta.nielit.gov.in/ajmer/content/national-digital-literacy-mission>
- National Medical Library. 2020. “ERMED Consortium.” 2020. <http://www.irmed.in/>
- Nethralaya, Sankara. 2021. “Teleophthalmology at Sankara Nethralaya.” 2021. <https://sankaranethralaya.org/teleophthalmology.html>
- NITI Aayog, Government of India. 2018a. “National Strategy for Artificial Intelligence #AIFORALL.” https://niti.gov.in/writereaddata/files/document_publication/NationalStrategy-for-AI-Discussion-Paper.pdf
- . 2018b. “National Health Stack : Strategy and Approach.” https://niti.gov.in/writereaddata/files/document_publication/NHS-Strategy-and-Approach-Documents-for-consultation.pdf
- Office of Principal Scientific Advisor, Government of India. 2021. “Community Mental-Health Digital Platform MANAS Launched by the Principal Scientific Adviser [Press Release].” <https://pib.gov.in/PressReleaseDetail.aspx?PRID=1711860>
- Passi, Ritika, and Ihssane Guennoun. 2018. *Securing the 21st Century Mapping India-Africa Engagement*. Rabat: OCP Policy Center. <https://www.orfonline.org/wp-content/uploads/2018/09/GP-ORF-India-Africa.pdf>
- Philips. 2019. “Future Health Index 2019: Transforming Healthcare Experiences - Exploring the Impact of Digital Health Technology on Healthcare Professionals and Patients.”

- https://www.ehdc.org/sites/default/files/resources/files/Philips_Future_Health_Index_2019_report_transforming_healthcare_experiences.pdf
- Press Information Bureau, Government of India. 2020. “The Prime Minister Shri Narendra Modi Addressed the Nation from the Ramparts of the Red Fort on the 74th Independence Day [Press Release].” 2020. <https://pib.gov.in/PressReleasePage.aspx?PRID=1646044>
- Press Trust of India. 2020a. “Indian Startup Develops Tech to Complete COVID-19 Sero Survey of 1 Crore Samples in a Week.” 2020. <https://www.thehindu.com/news/national/indian-startup-develops-tech-to-complete-covid-19-sero-survey-of-1-crore-samples-in-a-week/article33319027.ece>
- . 2020b. “COVID-19: Guj Govt Launches App to Track Home-Quarantined Persons.” COVID-19: Gujarat Launches App to Track Home-Quarantined Persons. March 2020. <https://www.thequint.com/news/india/coronavirus-gujarat-government-launches-mobile-app-to-track-home-quarantined-as-covid-suspects>
- . 2020c. “AI-Enabled Voice Tool Designed By Mumbai Professor To Detect COVID-19 Being Tested.” Coronavirus: Artificial Intelligence Enabled Voice Tool. April 2020. <https://www.ndtv.com/india-news/coronavirus-artificial-intelligence-enabled-voice-tool-designed-by-mumbai-professor-to-detect-covid-2212853>
- . 2020d. “IIT Professor Develops Software to Detect COVID-19 within 5 Seconds Using X-Ray Scan.” IIT Professor Develops Software to Detect COVID-19 within 5 Seconds Using X-Ray Scan. April 2020. <https://economictimes.indiatimes.com/news/science/iit-professor-develops-software-to-detect-covid-19-within-5-seconds-using-x-ray-scan/articleshow/75344027.cms?from=mdr>
- . 2020e. “AIIMS Deploying Milagrow Robots at Covid-19 Ward to Contain Spread of Disease.” AIIMS Deploying Milagrow Robots at Covid-19 Ward to Contain Spread of Disease. April 22, 2020. https://economictimes.indiatimes.com/magazines/panache/aiims-deploying-milagrow-robots-at-covid-19-ward-to-contain-spread-of-disease/articleshow/75286073.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst
- . 2020f. “Pune Institute Develops AI for Detection of COVID-19.” Pune Institute Develops AI for Detection of COVID-19 - Fullstory. June 21, 2020. http://www.ptinews.com/news/11528013_Pune-institute-develops-AI-for-detection-of-COVID-19.html
- PricewaterhouseCoopers Private Limited. 2020. “Unlocking the Potential of India-Africa Collaboration for Healthcare Innovation.” <https://www.nathealthindia.org/pdf/White%20Paper:%20Unlocking%20the%20potential%20of%20India-Africa%20collaboration%20for%20healthcare%20innovation.pdf>
- Rajan, Nandagopal. 2021. “Covid-19 Pandemic Has Accelerated Adoption of AI, Says IBM India’s Chief Tech Officer.” 2021. <https://indianexpress.com/article/technology/tech-news-technology/covid-19-pandemic-has-accelerated-adoption-of-ai-says-ibm-indias-chief-tech-officer-7129802/>
- Sankoh, Osman, Stephen Sevalie, and Mark Weston. 2018. “Mental Health in Africa.” *The Lancet Global Health* 6 (9): e954–55. [https://doi.org/10.1016/S2214-109X\(18\)30303-6](https://doi.org/10.1016/S2214-109X(18)30303-6)
- Shields-Zeeman, Laura, Soumitra Pathare, Bethany Hipple Walters, Nandita Kapadia-Kundu, and Kaustubh Joag. 2017. “Promoting Wellbeing and Improving Access to Mental Health Care through Community Champions in Rural India: The Atmiyata Intervention

- Approach.” *International Journal of Mental Health Systems* 11 (1): 6.
<https://doi.org/10.1186/s13033-016-0113-3>
- Sridhar, Naga G. 2017. “Ambupod, a Motorless Micro-Ambulance for Rural Areas, on Display at GES,” November 28, 2017. <http://www.ambupod.com/product.php>
- Stallworthy, Guy, Hannah Monica Dias, and Madhukar Pai. 2020. “Quality of Tuberculosis Care in the Private Health Sector.” *Journal of Clinical Tuberculosis and Other Mycobacterial Diseases* 20 (August): 100171. <https://doi.org/10.1016/j.jctube.2020.100171>
- Sung, Hyuna, Jacques Ferlay, Rebecca L. Siegel, Mathieu Laversanne, Isabelle Soerjomataram, Ahmedin Jemal, and Freddie Bray. 2021. “Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries.” *CA: A Cancer Journal for Clinicians* 71 (3): 209–49. <https://doi.org/10.3322/caac.21660>
- Swaminathan, Soumya, Rajkumar Hemalatha, Anamika Pandey, Nicholas J Kassebaum, Avula Laxmaiah, Thingnganing Longvah, Rakesh Lodha, et al. 2019. “The Burden of Child and Maternal Malnutrition and Trends in Its Indicators in the States of India: The Global Burden of Disease Study 1990–2017.” *The Lancet Child & Adolescent Health* 3 (12): 855–70. [https://doi.org/10.1016/S2352-4642\(19\)30273-1](https://doi.org/10.1016/S2352-4642(19)30273-1)
- The Weather Company. 2020. “India’s Indigenous AI- and IOT-Based Sero-Survey Technology Could Help Prioritize COVID-19 Vaccination.” 2020. <https://weather.com/en-IN/india/coronavirus/news/2020-12-19-indias-indigenous-ai-and-serosurvey-based-technology-could-help>
- Times of India. 2020. “Coronavirus: This Is How Government Will Be ‘Using’ Your Phone to Spread Awareness.” Coronavirus Awareness Messages - Times of India. May 9, 2020. http://timesofindia.indiatimes.com/articleshow/74534000.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst
- tour2Indiaforhealth. 2021. “African Country Patients Resource Page.” 2021. <https://www.tour2india4health.com/Medical-Tourism-from-African-countries-to-India.html#:~:text=INTRODUCTION&text=Tour2india4health%20is%20the%20first%20registered,healthcare%20provider%20group%20of%20India.&text=The%20network%20is%20spread%20in,healthcare%20professionals%20in%20the%20panel>
- Vaidam. 2021. “Discover High Quality And Affordable Treatment With Unmatched Personal Care.” 2021. <https://www.vaidam.com/about-us>
- Vijayan, Shibu. 2019. “Finding the Missing Millions: The Importance of Private Sector Engagement for Eliminating Tuberculosis.” 2019. <https://www.path.org/articles/finding-missing-millions-importance-private-sector-engagement-eliminating-tuberculosis/>
- Vikaspedia. 2019. “Electronic Health Record Standards for India.” 2019. <http://vikaspedia.in/health/nrhm/national-health-policies/electronic-health-record-standards-for-india>
- . 2021. “Common Service Centre Program.” 2021. <https://vikaspedia.in/e-governance/resources-for-vles/common-service-centres-programme>
- Vora, Rutam. 2020. “LiFi Technology to Monitor Covid-19 Patients.” LiFi Technology to Monitor Covid-19 Patients - The Hindu. April 8, 2020. <https://www.thehindubusinessline.com/news/science/lifi-technology-to-monitor-covid-19-patients/article31287574.ece#>
- Wikipedia. 2020. “Pan-African e-Network Project.” 2020. https://en.wikipedia.org/wiki/Pan-African_e-Network_project

- . 2021a. “Ayushman Bharat Yojana.” 2021. https://en.wikipedia.org/wiki/Ayushman_Bharat_Yojana
- . 2021b. “Common Service Centres.” 2021. https://en.wikipedia.org/wiki/Common_Service_Centres
- . 2021c. “Vaccine Maitri.” 2021. https://en.wikipedia.org/wiki/Vaccine_Maitri#cite_note-3
- Wild, S., G. Roglic, A. Green, R. Sicree, and H. King. 2004. “Global Prevalence of Diabetes: Estimates for the Year 2000 and Projections for 2030.” *Diabetes Care* 27 (5): 1047–53. <https://doi.org/10.2337/diacare.27.5.1047>
- WISH Foundation. 2021. “SCALE Rajasthan.” 2021. <https://www.wishfoundationindia.org/scale/rajasthan>
- World Health Organization. 2019. “Strategic Plan to Reduce Malnutrition in Africa Adopted by WHO Member States.” 2019. <https://www.afro.who.int/news/strategic-plan-reduce-malnutrition-africa-adopted-who-member-states>
- . 2020. “Global Tuberculosis Report.” <https://apps.who.int/iris/bitstream/handle/10665/336069/9789240013131-eng.pdf>
- . 2021. “Maharashtra and Goa Use Popular Folk Performing Arts for COVID Vaccination Advocacy.” 2021. <https://www.who.int/india/news/feature-stories/detail/maharashtra-and-go-a-use-popular-folk-performing-arts-for-covid-vaccination-advocacy>
- Zachariah, Serene Sarah. 2020. “Kerala’s ‘Nightingale-19’ Robot Serves Meals, Helps Doctors Treat COVID-19 Patients.” Kerala’s ‘Nightingale-19’ Robot Serves Meals, Helps Doctors Treat COVID-19 Patients. April 2020. <https://www.thebetterindia.com/224546/covid-19-kerala-robot-nightingale-19-innovation-protect-health-workers-india-ser106/>